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## OLIGOCHÆTA.

BY

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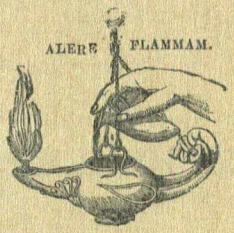

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# AUTHOR'S PREFACE.

THE present work follows in general the plan adopted for the other volumes of the series to which it belongs. The few remarks which follow may facilitate its use.

The species of each genus are arranged in alphabetical order. It is true that within certain genera we can distinguish a number of groups of allied species; but this is by no means always so, and even where it is possible to do this, the majority of the species of the genus do not as a rule allow themselves to be thus grouped; an arrangement according to affinities is therefore for the most part impossible. There seemed to be no particular advantage in a chronological order, according to the date of description of the several species; while the alphabetical arrangement has at least the merit of convenience.

In the synonymies which head the accounts of the species I have given a complete list of the Indian references,—references to all the records from India, Ceylon, and Burma, and to all accounts of anatomy etc. based on Indian material; in the case of species found only in India, therefore, the list forms a complete bibliography.

In the case of species found also in other parts of the world I have often added to the Indian references, and separated from them by a line, other references to papers of importance,—for example, to such as contain accounts of the anatomy or of important structural details. In the case of species which have been known for a number of years I have often given references to Beddard's Monograph and to Michaelsen's Tierreich Volume, where the older sources will be found. But it would be impracticable in a work like this

to give a complete bibliography of the widely distributed species ; a number of species are practically worldwide, and the majority of the items would merely be records of occurrence in various parts of the globe.

In the case of genera I have given references which appear likely to be of use ; but for a number of widely distributed genera even this is unnecessary, since the lists in Michaelsen's Tierreich volume will supply what is wanted.

It may be convenient, for bibliographical purposes, to subjoin a list of the changes in nomenclature, etc., proposed herein for the first time.

*Æolosoma hemprichi* (Stephenson, 1909) is renamed *Æ. kashyapi.*

I have emended the current diagnosis of the genus *Slavina.*

*Slavina montana* is used for *Slavina* sp. (Stephenson, 1916).

*Aulophorus michaelseni* is used for *A. palustris* (Stephenson, 1913).

In accordance with my views on the significance of "tufted" nephridia (*cf.* p. 184), *Megascolides hastatus* Steph. and *Notoscolex sarasinorum* Mich. are transferred to *Woodwardia.*

*Megascolides oneili* Steph. becomes *Notoscolex oneili.*

*Megascolides tenmalai*, Mich. var. *karakulamensis* Steph. becomes *Notoscolex tenmalai* var. *karakulamensis.*

*Megascolex phaseolus* Steph. becomes *M. cochinensis* Steph. var. *phaseolus.*

*Megascolex pentagonalis* Steph. becomes *M. travancorensis* Mich. var. *pentagonalis.*

*Megascolex curtus* Steph. disappears being united with *M. varians* var. *simplex* Mich.

*Perionyx aborensis* Steph. disappears, being united with *P. depressus* Steph.

Similarly *Perionyx parvulus* Steph. disappears, being united with *P. excavatus* E. Perr.

*Perionyx aborensis*, var. *heterochætus* Steph. becomes *P. heterochætus* Steph.

The name *Perionyx polytheca* is to be substituted for *Perionyx* sp. Steph. (Rec. Ind. Mus. xii, p. 323, 1916).

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The name *Perionyx sikkimensis* var. *michaelseni* is introduced for certain specimens of *P. sikkimensis* Mich. 1910.

*Eudichogaster kinneari* Steph. becomes *E. ashworthi* Mich. var. *kinneari*.

*Eutyphœus koboensis* and *magnus* Steph., and *chittagongianus* Mich. disappear, being merged in *E. gammiei* (Bedd.).

*Eutyphœus annandalei* Mich., var. *fulgidus* Steph. becomes *E. incommodus* (Bedd.) var. *fulgidus*.

*Eutyphœus bastianus* Mich. disappears, being merged in *E. masoni* (A. G. Bourne).

*Hoplochætella affinis* Steph. becomes *Erythrœodrilus suctorius* (Steph.) var. *affinis*.

I may mention that I have given in the Introduction a section on Methods, which I trust may be of some use to those who are beginning systematic work on what will certainly prove to them a very interesting group; I hope it may save some of those who may be obliged to work at a distance from expert assistance from wasting time on procedures which are not calculated to give the best results, and from putting forth work which could easily be improved by adopting a more suitable technique.

My thanks are due to Sir Arthur Shipley for his interest in the progress of the work, for many useful suggestions and for much kind help while the volume was passing through the press; to the authorities of the British Museum for kindly allowing me to examine a number of type and other specimens; and to the Council of the Zoological Society for permission to make use of material previously published in the Proceedings of the Society. And I have finally gratefully to acknowledge the help I have received in the course of the preparation of this volume from Dr. Annandale, Director of the Zoological Survey of India. He has kindly lent a number of blocks for the text-figures, and given permission for the reproduction of other figures, for which blocks were not available, from the Memoirs and Records of the Indian Museum; and he has at various times sent me many type and other specimens from the Museum collections

for examination. Indirectly, this work is indebted to him for far more than this ; since my studies on the Oligochæta of India, which I have pursued during the last sixteen years, and which have led up to the preparation of the present volume, have been largely carried out on the extensive collections of the Indian Museum, and have throughout owed much to Dr. Annandale's interest and kind encouragement.

March 1923.

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(137) 1883. Vejdovsky, F. Revisio Oligochætorum Bohemiæ. Sb. Böhm. Ges. Prag, 1883.

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# ABBREVIATIONS OF TITLES OF JOURNALS, ETC.

**Abh. Senckenb. Ges.**—Abhandlungen, herausgegeben von der Senckenbergischen naturforschenden Gesellschaft. Frankfurt a. M.

**Abh. Ver. Hamburg.**—Abhandlungen aus dem Gebiete der Naturwissenschaften hrsg. vom naturwissenschaftlichen Verein in Hamburg. Hamburg

**Ann. Hofmus. Wien.**—Annalen des K. K. naturhistorischen Hofmuseums. Wien.

**Ann. Mag. N. H.**—The Annals and Magazine of Natural History, including Zoology, Botany, and Geology. London.

**Ann. Mus. Genova.**—Annali del Museo civico di Storia naturale di Genova. Genova.

**Ann. Natal Mus.**—Annals of the Natal Museum. London.

**Annuaire Mus. St. Pétersb.**—Annuaire du Musée zoologique de l'Académié Impériale des Sciences de St. Pétersbourg. St. Pétersbourg.

**Arch. f. Naturgesch.**—Archiv für Naturgeschichte. Berlin.

**Ark. f. Zool.**—Arkiv för Zoologi, utgiftet af k. Svenska Vetenskapsakademien. Stockholm.

**Atti Acc. Torino.**—Atti della Reale Accademia delle Scienze di Torino. Torino.

**Boll. Mus. Torino.**—Bolletino dei Musei di Zoologia ed Anatomia comparata della Reale Università di Torino. Torino.

**Bull. Ac. Belgique.**—Bulletins de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. Bruxelles.

**Bull. Ac. Sci. St. Pétersb.**—Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg. St. Pétersbourg.

**Bull. Illinois Lab.**—Bulletin of the Illinois State Laboratory of Natural History. Peoria, Springfield.

**Bull. Soc. Philom. Paris.**—Bulletin de la Société philomathique de Paris. Paris.

**Capita Zool.**—Capita zoologica. 's Gravenhage.

**Ergeb. Magalh.**—Ergebnisse der Hamburger Magalhaensischen Sammelreise. Hrsg. vom Naturhistorischen Museum zu Hamburg. Hamburg, 1896–1900.

**Fauna Laccad. Archip.**—J. Stanley Gardiner. The Fauna and Geography of the Maldive and Laccadive Archipelagoes. Vol. I. Cambridge, 1903.

**Fauna S.W. Austral.**—Die Fauna Südwest-Australiens. Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905. Bd. i, Lief. 2, Oligochaeta. Jena, 1907.

**Geog. Verbr. Olig.**—W. Michaelsen. Die geographische Verbreitung der Oligochaeten. Berlin, 1903.

**J. Asiatic Soc. Bengal.**—Journal of the Asiatic Society of Bengal. Calcutta.

**Jb. böhm. Ges.**—Jahresbericht der Kön. Böhmischen Gesellschaft der Wissenschaften. Prag.

**J. Bombay Soc.**—Journal of the Bombay Natural History Society. Bombay.

**J. Coll. Sci. Tokyo.**—Journal of the College of Science, Imperial University of Tokyo. Tokyo.

**J. Linn. Soc.**—Journal of the Linnean Society—Zoology. London.

**Journ. and Proc. Asiatic Soc. Bengal.**—Journal and Proceedings of the Asiatic Society of Bengal. Calcutta.

**Mem. As. Soc. Bengal.**—Memoirs of the Asiatic Society of Bengal. Calcutta.

**Mem. Ind. Mus.**—Memoirs of the Indian Museum. Calcutta.

**Mem. Soc. Zool. Fr.**—Mémoires de la Société zoologique de France. Paris.

**Mjöberg's Austral. Exp.**—Results of Dr. E. Mjöberg's, Swedish Scientific Expeditions to Australia 1910–1913. XIII Oligochäten. Kungl. Svenska Vetenskapsakademiens Handlingar, lii, no. 13. Stockholm, 1916.

**Monog.**—F. E. Beddard, A Monograph of the Order of Oligochaeta. Oxford, 1895.

or F. Vejdovsky, System und Morphologie der Oligochaeten. Prag, 1884.

**Mt. Mus. Hamburg.**—Mitteilungen aus dem naturhistorischen Museum in Hamburg. Hamburg.

**N. Arch. Mus. Paris.**—Nouvelles Archives du Muséum d'Histoire naturelle. Paris.

**Neue wirbell. Thiere.**—L. K. Schmarda, Neue wirbellose Thiere, beobachtet und gesammelt auf einer Reise um die Erde 1853–1857. Leipzig, 1859–61.

**Olig. Subantarctic Is.**—Subantarctic Islands of New Zealand. Art. xii, W. B. Benham, Report on Oligochæta of the Subantarctic Islands of New Zealand. Wellington, New Zealand, 1909.

**Olig. Suisse.**—E. Piguet and K. Bretscher, Catalogue des Invertébrés de la Suisse. Fasc. 7, Oligochètes. Genève, 1913.

**Olig. Tiefsee Exp.**—Die Oligochäten der deutschen Tiefsee-Expedition, nebst Erörterung der Terricolenfauna Oceanischer Inseln, insbesondere der Inseln des subantarktischen Meeres. 1903.

**O. südpolar Exp.**—Die Oligochaeten der deutschen südpolar-Expedition 1901–1903, nebst Erörterung der Hypothese über einen früheren grossen der Südspitzen der Kontinente verbindenden antarktischen Kontinent. 1905.

**P. Ac. Philad.**—Proceedings of the Academy of Natural Sciences of Philadelphia. Philadelphia.

**P. Calif. Ac.**—Proceedings of the California Academy of Sciences. Zoology. San Francisco.

**Proc. U.S. Nat. Mus.**—Proceedings of the United States National Museum. Washington.

**P.Z.S.**—Proceedings of the Zoological Society of London. London.

**Quart. J. Mic. Sci.**—Quarterly Journal of Microscopical Science. London.

**Rec. Ind. Mus.**—Records of the Indian Museum. Calcutta.

**Rev. Suisse Zool.**—Revue Suisse de Zoologie et Annales du Musée d'Histoire Naturelle de Genève. Genève.

**Sb. Böhm. Ges. Prag.**—Sitzungsberichte der Königlichen Böhmischen Gesellschaft der Wissenschaften in Prag. Mathematisch-naturwissenschaftliche Klasse. Prag.

**Spol. Zeyl.**—Spolia Zeylanica. Colombo.

**Süsswasserf. Deutsch.**—Die Süsswasserfauna Deutschlands, hsgn. A. Brauer. Heft 13, Oligochaeta und Hirudinea. Jena, 1909.

**Tier., x.**—Das Tierreich, vol. x, Oligochaeta. Berlin, 1900.

**Tr. and Proc. New Zeal. Inst.**—Transactions and Proceedings of the New Zealand Institute. Wellington, New Zealand.

**Tr. Linn. Soc.**—Transactions of the Linnean Society of London. London.

**Tr. Roy. Soc. Edin.**—Transactions of the Royal Society of Edinburgh. Edinburgh.

**Verh. naturw. Ver. Hamburg.**—Verhandlungen des naturwissenschaftlichen Vereins in Hamburg. Hamburg.

**Zool. Anz.**—Zoologischer Anzeiger. Leipzig.

**Zool. Jahrb. Syst.**—Zoologische Jahrbücher. Abtheilung für Systematik, Geographie und Biologie der Thiere. Jena.

**Zweit. deutsch. Zent.-Afr.-Exp.**—Ergebnisse der Zweiten deutschen Zentral-Afrika-Expedition 1910–1911 unter Führung Adolf Friedrichs, Herzogs zu Mecklenburg. I. Zoologie, Teil 1. Leipzig, 1915.

**Z. wiss. Zool.**—Zeitschrift für wissenschaftliche Zoologie. Leipzig.

# OLIGOCHÆTA.

## METHODS OF EXAMINATION; SYSTEMATIC DESCRIPTION.

Good systematic description is an art, and to practise this it is necessary to know what to observe, and how to manipulate in order to observe; the observations must then be clearly expressed, and arranged in a definite order. We may consider the methods employed in the systematic examination of the Oligochæta along with the enumeration of the characters to be observed; and for this purpose we will first take an earthworm of one of the families Moniligastridæ, Megascolecidæ, or Lumbricidæ.

The investigator often has no control over the fixation and preservation of the material submitted to him; if, however, he is making his own collection, he will find it advantageous to paralyse the worms by placing them in water and gradually adding spirit; when they are completely insensible they are transferred to 10 per cent. formalin in a flat dish, and allowed to become stiff in the fully extended position; after twenty-four hours in the formalin they are transferred to spirit.

The dissecting microscope used in the examination and dissection should be a binocular, and one with a long arm is much the best, since the smaller instruments, where the dissecting dish has to be placed on the stage, do not allow enough room. Cataract knives are used for the dissection, with fine needles and the finest scissors and forceps. The pins for pinning out the specimens are entomological pins, obtainable in varying degrees of fineness for the larger and smaller worms.

The *length*, *diameter*, *number of segments*, and *colour*, are to be noted, along with any special variations of the latter in different parts of the body; the colour is frequently altered by the preservative. The *form* may require mention; *e.g.*, the anterior end may be markedly bulbous; the ventral surface may be flattened; the body, or the hinder end, may be four-cornered in transverse section; the dorsal surface may be grooved, etc.

The *prostomium* is to be noted. If not marked off by a groove from the first segment it is said to be zygolobous (text-fig. 1). If marked off, but not encroaching on the first segment, the separating groove being strictly transverse, it is prolobous (text-fig. 2). If it encroaches but slightly on the first segment it is proepilobous

(text-fig. 3); if more markedly, epilobous (text-fig. 4). The posterior prolongation into the region of the first segment is called the tongue; it may be delimited behind by a transverse groove, when the tongue may be said to be cut off behind; or there may be no such groove, when the tongue is open, or not cut off behind. The length of the tongue is of importance; if it extends through one-third, or a half, or two-thirds of the length of the first segment, the description runs "prostomium epilobous $\frac{1}{3}$, or $\frac{1}{2}$, or $\frac{2}{3}$," etc. If the tongue goes back to the groove between segments i and ii, the prostomium is said to be tanylobous (text-fig. 5). These forms are sometimes found combined; thus there may be a transverse groove at the anterior limit of the first segment as in the prolobous form, together with a tongue which extends through part or the whole of the first segment—conditions which may be described as "combined pro- and epilobous" (text-fig. 6), and

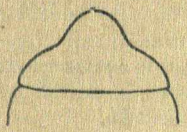

Fig. 1.

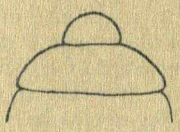

Fig. 2.

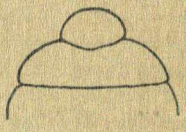

Fig. 3.

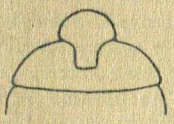

Fig. 4.

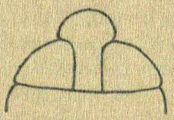

Fig. 5.

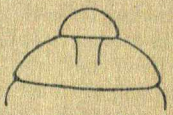

Fig. 6.

Fig. 1. Zygolobous prostomium.
Fig. 2. Prolobous prostomium.
Fig. 3. Proepilobous prostomium.
Fig. 4. Epilobous prostomium.
Fig. 5. Tanylobous prostomium.
Fig. 6. Combined pro- and epilobous prostomium.

"combined pro- and tanylobous" respectively. Special shapes of the tongue may sometimes require notice; its sides may converge backwards, even meeting to form a V; or occasionally they diverge.

The *segments* themselves are suitably expressed by roman numerals:—i, ii, iii, iv, etc.; while fractions, or successive arabic numerals separated by an oblique line, are used to denote the intersegmental furrows, or, in the internal anatomy, the septa. Thus the furrow, or, according to the context, the septum, between segments x and xi is denoted by $\frac{10}{11}$ or 10/11.

The segments are often divided by secondary grooves into *annuli*, and it may be useful to note the extent of this subdivision; as an example, "segms. iv and v biannular, vi–vii triannular, viii–xiii with four or five annuli, post-clitellar segms. triannular." The first segment is sometimes withdrawn within

the mouth aperture; but a mistake in enumeration will usually be avoided by observing that in this case the setæ begin on the first apparent segment.

*Dorsal pores* are present in most species of earthworms, beginning some distance behind the anterior end. The groove in which they begin is to be observed; this is suitably done when the worm is pinned out preparatory to opening, by gently pressing apart with needles the sides of the intersegmental grooves in the preclitellar region.

The *setæ* are amongst the most important characters for systematic purposes. In the earthworms they begin usually on the second segment, but occasionally further back. They may be arranged either in two couples on each side of each segment (the lumbricine arrangement), or they may be more numerous and disposed in a ring (perichætine arrangement). In the lumbricine arrangement the most ventrally placed seta on each side is denoted by the letter *a*, the other seta of the ventral couple by *b*, the

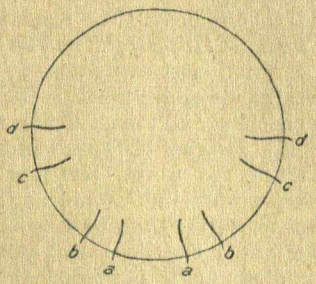


Fig. 7.—Lumbricine arrangement of setæ.

more ventral of the dorsal couple is called *c*, the most dorsally placed is *d* (text-fig. 7). The relative extent of the intervals between neighbouring setæ are recorded—*i. e.*, the intervals *aa*, *ab*, *bc*, and *cd*. The observations are perhaps most easily made by holding the worm between the fingers of the two hands under the dissecting binocular, and rotating it as required. The mode in which these ratios are expressed has hitherto varied considerably, but I have adopted the following as convenient: the distance *ab* is taken as the unit, and is compared first with the interval *aa*—say it is one-third of *aa*; by slightly rotating the body of the worm it is now compared with *bc*—it may perhaps be equal to half *bc*; observations made by rotating the worm so as to bring *ab* and *cd* alternately into view may give, as a relation between these two, $ab = \frac{3}{4}\, cd$. The interdorsal interval *dd* (measured over the dorsal surface) is also to be estimated in terms of the whole circumference; it is sometimes more, sometimes less than half the circumference, according as the seta *d* is below or above the lateral line of the body. A complete expression of the ratios can now be given in the following short and convenient form:—$ab = \frac{1}{3}\, aa = \frac{1}{2}\, bc = \frac{3}{4}\, cd$; $dd = \frac{1}{2}$ circumference.

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As, however, the above ratios often vary in different parts of the body, the operations have to be repeated; three such will as a rule suffice—one about the middle of the body-length, one in the region behind the clitellum, and one in front of the clitellum; *dd* need usually be given only once—at the middle of the body.

In worms with the perichætine arrangement, the setæ of each side are denoted *a b c d e* . . . . beginning from the one nearest to the midventral line; and those on the dorsal side *z y x* . . . . beginning from the middorsal line, without regard to the actual number in the ring. The relative sizes of the intersetal intervals in the different parts of the ring are to be observed; *e. g.*, the setæ may be set closer together ventrally than dorsally; and if, as is usual, there is a gap in the ring in the middorsal and midventral lines, the size of the gap is to be estimated in terms of the next intersetal interval—*e. g.*, $aa = 2\,ab$, $zz = 3\,yz$.

The number of setæ in the ring is also to be counted; and as this differs in different parts of the body, several counts have to be made. Convenient segments for this purpose are v, ix, xii, xix, and one in the middle of the body. The results may be expressed thus:—Setæ 24/v, 30/ix, 32/xii, 36/xix, and 34/mid-body.

The counting is, I think, most easily done by holding the worm in the fingers of both hands under the dissecting binocular, fixing on the appropriate segment, and then, keeping the worm in focus, gradually rotating it. Bourne (**20**) recommends cutting open the anterior portion of the worm, scraping out the viscera, flattening out the empty body-wall between two glass slides, and allowing it to harden in spirit; then heating with caustic potash, placing in glycerine and mounting. But this of course is not allowable where a limited number of specimens only are available; and in any case it is needlessly troublesome; practice in the simpler method will give facility.

Certain setæ are sometimes enlarged relatively to the others: *e. g.*, the ventralmost setæ, *a b c*, of some of the anterior segments in certain perichætine worms. This is to be noted where it occurs.

It is to be observed that the positions of the setæ give useful points of reference in describing the situation of such features as the external apertures of the body. For this purpose, in the worms with the lumbricine arrangement, the setæ *a b c d* on each side may be imagined as connected by longitudinal lines; and we may describe the male pores as lying, for example, between the lines of setæ *a* and *b*, or even more shortly as being in *ab*; in a perichætine form they might perhaps be between the lines *f* and *g*.

Certain setæ may be modified in form; this is especially the case with the penial setæ so commonly found near the male pores. These are to be specially and minutely described, since the features they present are among the most trustworthy of specific distinctions. The length, thickness at the middle of the shaft, curvature, characters of the point, and ornamentation by lines,

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spines or teeth, are the principal characters; it is usually advisable to give an illustration in addition to a verbal description. Certain setæ in the neighbourhood of the spermathecal pores may also be modified ("copulatory setæ" in the genera *Octochætus* and *Eudichogaster*).

Though the penial setæ may at times be seen projecting for some distance through the male pore, it is never safe to try to remove them from outside. They invariably break; and the only way is, at the close of the internal dissection, to seize the setal sac and its surrounding muscular bundles from the inside; withdraw the whole, and place it in a drop of glycerine on a slide; carefully, with fine needles, separate off the muscular fibres from the bases of the setæ, and cover. In some very small worms of the genus *Dichogaster*, the setal sacs may be too minute to be easily recognisable even under the dissecting microscope; and since in this genus the penial setæ are specially important, they must be obtained by taking hold of the prostatic duct as near the body-wall as possible, and removing the whole of the prostate; the setæ in their sac will be found adhering to the ectal end of the duct.

The extent of the *clitellum* is of systematic importance, and also its form—ring-shaped or saddle-shaped—*i. e.*, extending all round the body, or absent on the ventral surface. Sometimes setæ are present, and sometimes the intersegmental grooves are visible; the colour also often differs from that of the neighbouring parts of the body.

The position of the *genital apertures* (male pores, prostatic pores, female pores and spermathecal pores) are to be noted. The male pores are properly the endings of the vasa deferentia; if prostate glands are present, they may open at the male pores in common with the vasa deferentia, or may discharge separately. After a statement of the segment or intersegmental groove in which they occur, their exact positions are often best defined by reference to the lines of the setæ (*v. sup.*)—*e. g.*, male pores on xviii between the lines of setæ *a* and *b*, female pores on xiv anterior and internal to seta *a*, spermathecal pores in grooves 7/8 and 8/9 slightly outside the line of *b*. In some genera the two prostatic pores of the same side are connected by a seminal groove, the characters of which (straight, bowed outwards or inwards, etc.) are to be noted.

Very important for systematic purposes is an accurate description of the papillæ, ridges, pits and other *genital markings* which in many worms make their appearance at sexual maturity. These are often variable to some extent, and if possible a number of specimens should be examined, in order to discover which characters are constant. It is frequently useful to add a drawing to the description.

Having completed the account of the external characters, the investigator proceeds to the dissection of the worm. If the

specimen is single, and there is a possibility of its turning out to be a new species, the greatest care must be exercised, and the least possible amount of damage done, since the specimen will have to be preserved for future reference as the type of the new species.

The worm is to be pinned out and the anterior part of the body opened by a median dorsal incision. In pinning out the worm, the pin at the anterior end may be passed obliquely downwards and backwards through the mouth, so as to avoid damage to the prostomium.

The student who has had the usual laboratory training will often be tempted to examine the smaller earthworms by longitudinal sections of the anterior end instead of by dissection. For earthworms, however, this is scarcely ever necessary, and, where material is limited, should only be resorted to in very exceptional cases. Not to speak of the time required (which is scarcely a valid argument), the alimentary canal often contains earth, which interferes with the cutting and may practically destroy the whole specimen; it is also much easier to give an accurate description of the shape and relations of the organs—*e. g.*, of a spermatheca with diverticula—from dissection than from the reconstruction of sections; the penial setæ, too, are destroyed in sections, and these are of decisive importance in precisely that genus—*Dichogaster*—where, on account of the small size of the worms, sectioning is most likely to be employed.

By practice it will be found possible to obtain quite satisfactory systematic descriptions from dissections in worms down to 1½ mm. in diameter, or even down to 1¼ mm., and there are very few earthworms of smaller size than this.

The above refers especially to the cases where only one or a very few specimens are available; it is of course not meant that sections should not be attempted when a number of examples are at hand. But it will be seen that I disagree with the opinion of Smith (Proc. U.S. National Museum, lii, 1917, p. 159), that "an adequate study of earthworms for systematic purposes demands serial sections of sexually mature specimens, although much important information can be gained by careful dissection." This author recommends (in the case of types, or where material is scarce) splitting the anterior portion in the sagittal plane, and removing the dirt from the alimentary canal; one half of the anterior end is then to be sectioned.

In case the material is ample, a second dissection from the ventral surface is sometimes useful—*e. g.*, to determine the relations of the testis sacs, and whether or not those of the same segment are united below the alimentary tube. Benham (J. Linn. Soc. Lond., Zool., xxvi, 1897) recommends a dissection from the side; but of this I have scarcely any experience.

The worm having been opened, the *septa* in the anterior part of the body are first observed. Some of these may perhaps be absent; others may be thickened, in which case the various degrees of thickening are to be noted.

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The chief features of systematic importance in the *alimentary canal* are the following:—(1) The presence and position of a gizzard or gizzards. If the gizzard is far forwards, it is not always easy to determine which segment it belongs to, since the septa here are usually funnel-shaped, with their parietal much in front of their œsophageal attachment; they may thus closely invest the sides of the gizzard, and the one in front of which the gizzard really lies may appear to be attached to its sides or even to its anterior end; moreover the septa here may be extremely thin, and in badly preserved specimens may be in danger of being overlooked altogether. (2) The calciferous glands—their number, position, and whether stalked or attached by a broad base to the œsophagus. (3) The segment in which the intestine begins, and the presence and position of intestinal cæca. (4) Some authors note the characters of the typhlosole.

Not many characters of the *vascular system* are used in systematic descriptions of earthworms. The chief of these is the number of *hearts*, and more especially the position of the last (most posterior) heart. Sometimes the dorsal vessel is double (very rarely indeed in Indian worms).

Nephridia occur either as *meganephridia*, or as *micronephridia*. The micronephridia vary much in size and arrangement. There may be a large number of minute nephridia scattered irregularly over the inner surface of the body-wall and on the septa; or the number in each segment may be fewer, and they may then be arranged in definite transverse rows on the parietes—one or two rows in each segment. All the micronephridia may not be of the same size—*e.g.*, the most ventrally situated may be the largest. These points of number and relative size are of some importance in certain genera of the Octochætinæ (*Octochætus*, *Eudichogaster*) and Megascolecinæ (*Megascolides*, *Megascolex*). In micronephridial genera bushy nephridial tufts are usually found in the anterior segments by the side of the pharynx and anterior part of the œsophagus.

The *sexual organs* are the most important of all for systematic purposes. The *testes* and their associated *funnels* may be one or two pairs; they may be enclosed in special compartments of the cœlom (*testis sacs*), or may lie free in their segments. In an advanced stage of sexual maturity the testes are quite small, and may be quite undiscoverable; the presence of the funnels, sometimes apparently large and glistening through adherent spermatozoa, may, however, usually be taken as an indication of the presence of testes also. The *seminal vesicles*, in which the spermatozoa ripen, communicate with the testis segments, or the testis sacs; their position, size, and lobulation or its absence are to be noted.

In connection with the external pores, or in the neighbouring segments, there may be *prostate* (spermiducal) glands. In the Moniligastridæ, the shape and character of the surface of the gland are important; in the Megascolecidæ, the form (whether tubular or compact, and in the latter case whether much or slightly lobed),

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size, and position of the glandular portion and the length, thickness, course and character (whether smooth and shining, or the reverse) of the duct require description. The ectal end of the male apparatus may be dilated and eversible as a bursa copulatrix.

The female organs comprise the *ovaries*, female *funnels* and *oviducts*, and sometimes *ovisacs* (receptacula ovorum); these have not as a rule the same importance as the male organs. The *spermathecæ* are among the most important of the genital organs; their number and position are to be noted, the ampulla and its duct are to be described; and especially the characters of the diverticulum or diverticula (if any), and the place of its junction with the main portion of the apparatus. In the Moniligastridæ, it is important to note any dilatation of the end, or the characters of any sac (atrium) opening into the end, of the spermathecal duct.

In many of the smaller Megascolecidæ, the characters of spermatheca and diverticulum are best ascertained by removing one and mounting it in glycerine. The preparation will usually become sufficiently transparent in this medium; if not, it may be rendered clearer by being treated on the slide with a small drop of glacial acetic acid before mounting in glycerine.

The small, usually aquatic Oligochæta of the families Æolosomatidæ, Naididæ, Tubificidæ and Enchytræidæ require quite different methods of examination. These are mainly microscopic.

The examination of the living worms should never be omitted if opportunity offers. The Æolosomatidæ, and most of the Naididæ, are transparent enough to allow the whole anatomy (except that of the sexual organs in the mature worms) to be investigated, and many details are more evident than in fixed specimens. The worms are, however, sometimes very active, crawling out from under the cover-glass, or not remaining long enough in one position to allow of examination; much patience is often needed, especially in warm weather. Piguet (**133**) recommends the use of ice; but the introduction of a drop of 1 per cent. solution of cocaine hydrochloride is often destructive. Less is to be learned from examination alive in the case of the Tubificidæ and Enchytræidæ.

It is very difficult indeed to examine worms which in the process of killing have screwed themselves up into all kinds of curves. The investigator will often receive worms for examination which have had no particular care bestowed on their fixation, and in such cases he must, of course, do the best he can with them. When, however, he collects material for himself, it is worth while taking some trouble in the matter.

A good way of getting worms killed in the extended position is to take two glass slides, and to place one on the top of the other, so that the longer edge of the lower projects some distance beyond that of the upper; a worm is now placed in a drop of water in the angle where the edge of the upper meets the surface of the

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lower slide. The worm will extend itself and crawl in one direction or the other along this angle; at a suitable moment it is deluged with the fixing solution, preferably hot, in order to kill it before it has time to throw itself into curves.

If a number of worms have to be dealt with at one time, a fairly good method is to place them in a shallow glass dish, and drain off all the water. They will soon begin to extend themselves and crawl about on the moist bottom of the dish, when they may be deluged with the hot fixing solution. Some no doubt will be contorted, but while none will be absolutely straight, a number will be quite suitably disposed for microscopical examination or sectioning. I do not regard a slight ventral curve, which most of the worms will have, as altogether a disadvantage, since this is a help in orienting it for section cutting, and causes no distortion.

Or the worms may be simply dropped from a pipette into hot fixing solution in a test-tube or beaker. The solution should, to get the best results, be some way under boiling point.

I do not recommend preliminary narcotization with chloretone, chloral, or methyl alcohol, at any rate for the Naididæ, which are very delicate and easily injured.

As fixing solutions for ordinary work, hot formalin (10 per cent.), and hot dilute sublimate and acetic are good. Piguet (**133**) recommends 1 per cent. sublimate for the large species of Naididæ and 0·1 per cent. for the others. In this latter case presumably the heat is the chief fixative agent; the results, however, are excellent. The same solution of formalin, and stronger solutions of sublimate, or sublimate and acetic, may be used for Tubificidæ and Enchytræidæ.

In the Naididæ, the most important systematic characters are those of the setæ. It is very difficult to examine these adequately in whole worms, since they do not usually, in the intact animal, lie in one plane under the microscope, and neither their length nor the form of their distal end can be judged accurately. In preserved material nothing can be done, except to choose for examination such setæ as may be most suitably disposed; but if the living worms are available, most excellent preparations can be made (at the sacrifice of the specimen for other purposes) according to the method well explained by Piguet (**133**). Place the worm in water under a cover-glass, without air-bubbles; remove any excess of water, and then allow evaporation to proceed; the animal becomes more and more compressed, and finally bursts and flattens completely, the empty skin remaining with the setæ in place. When this has happened, and before the evaporation is so complete that air is drawn in under the cover-glass, a small drop of glycerine is placed at the margin of the cover-glass; this will be drawn in to replace the water lost by evaporation; any excess is removed, and a ring of varnish applied. Setæ are best examined in water or glycerine; it is difficult to see them well in balsam, owing to the refractive index, which is nearly the same for both setæ and balsam.

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The setæ are not of such chief importance in the Enchytræidæ, nor, as a rule, in the Tubificidæ, while the bodies of these worms are too resistant to flatten out completely under the above treatment. Similar preparations may, however, be obtained by killing the worms by dilute alcohol, or by leaving them for some time in a small quantity of water, which is not changed; if after death they are left in the water for some time longer—say over night—they decompose and become sufficiently soft to give good setal preparations.

I know of no way of getting good setal preparations from preserved material. I have tried softening the specimens with solutions of caustic potash; but the prolonged action which is necessary affects the shape of the setæ, causing them to swell.

In no group of worms, not even in the Naididæ, can the sexual organs be adequately examined in the living condition; the opaque clitellum entirely obstructs the view. Here dilacerations of fresh or of preserved specimens may give considerable help, and will allow the size and shape of parts of the apparatus to be more easily apprehended than can be done from sections. Benham (114) gives some useful hints for the examination of worms of the size of the Phreodrilidæ; a specimen was "bisected in the region of the reproductive organs, and the latter were partially isolated by removal, under a dissecting lens, of the gut and part of the body-wall, so that the true form and disposition of the spermiducal gland could be studied." In another case, after bisecting, one half was cut into a series of transverse sections; in the other half, the male apparatus was first studied *in situ* as an opaque object; "it was then gently removed from its attachment to the body-wall near the pore, and later cleared in glycerine, in which it was possible to turn it over and examine first one side, then the other. Finally, it was stained and mounted in balsam. But, as is known to students of the Oligochæta, the glycerine preparation is of greater value in tracing out ducts, etc., than the balsam preparation."

But for the complete description, and usually for the identification, of an Enchytræid or Tubificid worm (and also for the description of the sexual apparatus of one of the Naididæ), serial sections are essential. Attempts have often been made to describe species—especially of the Enchytræidæ—without going to the trouble of sectioning one or more specimens, but I cannot consider the results satisfactory. These two families, the Enchytræidæ and Tubificidæ, with the Lumbriculidæ and one or two other small groups which do not occur in India, are by far the most troublesome of all the Oligochæta to identify and describe; too large for microscopical examination, and too small for dissection, they must be sectioned if an adequate account of their anatomy is to be obtained. I prefer a series of longitudinal sections rather than transverse, since in the first place a satisfactory series can be obtained from specimens which are even fairly strongly curved, provided that the curve is approximately in one plane; and

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secondly, larger portions of the systems are visible in one section, and their mutual relations are more easily ascertained; while it is much easier, also, to fix the numbering of the segments in a longitudinal series.

The characters to be observed in the Microdrili are largely the same as, though fewer than, in the Megadrili; there are however certain additions.

The characters of the *setæ*, as has been explained, are of more importance, especially in the Naididæ and in some of the Tubificidæ. In the double-pronged setæ (crotchets) of the former family, the number in a bundle, length, thickness, degree of curvature, position of nodulus, the relative length and thickness of the terminal prongs, and sometimes their shape and the size of the angle between them, are to be determined. It is to be noted that the ventral setæ in the most anterior segments (ii–iv, or more usually ii–v) sometimes have different proportions from those which occur throughout the rest of the body. The dorsal bundles may contain either hair or needle setæ, or both; the numbers of each in a bundle, the length of the hair setæ, and whether or not they are perfectly smooth, the length and shape of the needles, the position of the nodulus, and especially the characters of the tip, for which the use of the oil immersion lens is necessary, are the chief points to be observed. Occasionally fan-shaped or pectinate setæ are met with. Penial setæ are important, if present.

The size, shape, and other characters of the cœlomic corpuscles (if present) in the Naididæ and Enchytræidæ; the shape of the cerebral ganglion; the presence or absence of a stomachal dilatation of the alimentary tube; the characters of the various organs which have been termed prostates; the length and disposition of the vas deferens, and the characters of the atrium (the terminal dilated portion of the male apparatus) are examples of the points that require to be observed. Other features may deserve note in certain families or genera—*e.g.*, the colour of the oil-like globules in the integument of the Æolosomatidæ; the distribution of the so-called copulatory glands which surround the ventral nerve cord in certain Enchytræidæ; the length, relatively to the thickness, of the peculiar cylindrical male funnels in this family; the presence and characters of the penial bulb in a number of Enchytræid genera; the segment in which the dorsal vessel begins in this family; the presence or absence of head-pores, the proportions of the anteseptal and postseptal parts of the nephridia, and the origin and direction of the nephridial duct in the same worms; the segments in which the peculiar "chyle-cells" occur in the genus *Fridericia*; the presence or absence of supraintestinal, subintestinal, and integumentary vessels in the Tubificidæ; the presence of gills in certain genera; the characters of the penis, and of the chitinous penis-sheath in certain genera of Tubificids; the occurrence of spermatophores, etc.

One further point is of importance in the Æolosomatidæ and Naididæ. These families reproduce themselves principally by fission; a "budding zone" is first produced—in other words, a number of new segments are formed at some point in the animal's body, and fission takes place through this zone of newly proliferated segments, in such a way that some of them form the tail end of the anterior animal, and the rest the head of the posterior. The number of the segments in front of the budding zone (*i. e.*, the number of segments of the original animal which enter into the body of the anterior daughter animal) is denoted by *n*; it is constant for a number of species of *Æolosoma* and *Chætogaster*, but varies within wider or narrower limits for most species of Naididæ.

But systematic descriptions of the Microdrili are much less uniform in type than those of the earthworms, and the characters which are used for purposes of discrimination vary so much in the different families and genera that they can scarcely be learnt, except from a perusal of the descriptions themselves.

## THE GEOGRAPHICAL DISTRIBUTION OF INDIAN OLIGOCHÆTA.

The regional division of India adopted below for the Oligochæta is largely similar to that employed by Dr. Annandale in the volume of the present series which deals with Freshwater Sponges, Hydroids and Polyzoa. Dr. Annandale's division takes Blanford's physiographical regions as its basis. Mine differs from Annandale's mainly in recognising a southern region (very distinct as regards the Oligochæte fauna), which comprises the narrower southern end of the peninsula, below the level of Goa and south of the 15th parallel, from the eastern to the western shore; the Malabar (here called the Western) region and main Peninsular area are correspondingly reduced. It may be noted that the limits of these areas do not always correspond exactly with those of the political divisions whose names are used in defining them; thus I have placed Rangamati, which belongs politically to Bengal, in the Burma Region rather than in the Indo-Gangetic Plain.

As in Dr. Annandale's lists, varieties are ignored, as not having a geographical significance.

### 1. NORTH-WESTERN TERRITORY.*

(The drainage system of the Indus, so far as comprised in the plains of India; the Punjab, N.-W. Frontier Province, N. Rajputana, Sind.)

ÆOLOSOMATIDÆ.

Æolosoma kashyapi (Lahore).
Æolosoma viride (Lahore).

* For the significance of Roman and Italic type in the following lists, *cf.* p. 25.

NAIDIDÆ.

Chætogaster bengalensis (Peshawar; Nowshera; Gurdaspur Dist.).
Chætogaster langi (Lahore).
Chætogaster orientalis (Lahore).
Nais communis (Lahore; Peshawar).
Nais paraguayensis (Lahore).
Nais raviensis (Lahore).
Naidium minutum (Lahore).
Pristina longiseta (Lahore).
Pristina æquiseta (Lahore).
Branchiodrilus hortensis (Lahore).
Hæmonais laurentii (Lahore).
Slavina appendiculata (Lahore).
Stylaris lacustris (Lahore).
Dero limosa (Lahore).
Aulophorus furcatus (Lahore).

TUBIFICIDÆ.

Limnodrilus socialis (Lahore).
Branchiura sowerbyi (Lahore).

ENCHYTRÆIDÆ.

Fridericia bulbosa (Lahore).
Enchytræus harurami (Lahore).

MEGASCOLECIDÆ.

Microscolex phosphoreus (Peshawar).
Megascolex mauritii (Lahore; Kapurthala).
Pheretima elongata (Karachi).
Pheretima hawayana (Lahore).
Pheretima heterochæta (Lahore; Peshawar).
Pheretima houlleti (Rawal Pindi).
Pheretima posthuma (widely spread).
Octochætus fermori (Hoshiarpur).
*Eutyphœus ibrahimi* (Kapurthala).
Eutyphœus incommodus (Ambala; Rawal Pindi; Hoshiarpur Dist.).
Eutyphœus waltoni (Hoshiarpur Dist.).
Eutyphœus mohammedi (Rawal Pindi).
Ocnerodrilus occidentalis (Rawal Pindi; Mardan).

LUMBRICIDÆ.

Helodrilus caliginosus (widely spread).
Helodrilus parvus (widely spread).

## 2. WESTERN HIMALAYAN REGION.

(From Hazara to the border of Nepal, including Kashmir.)

NAIDIDÆ.

Chætogaster limnæi (Naini Tal).
Nais communis (Kasauli).

Slavina montana (Bhim Tal).
Stylaria kempi (Bhim Tal).
Aulophorus tonkinensis (Bhim Tal).

MONILIGASTRIDÆ.

Drawida japonica (Murree; ? Simla).
Drawida nepalensis (Dehra Dun)..

MEGASCOLECIDÆ.

Pheretima hawayana (Dehra Dun; Garhwal).
Pheretima heterochæta (Simla; Naini Tal).
Pheretima houlleti (Dehra Dun; Bhim Tal).
Pheretima posthuma (Dehra Dun).
*Perionyx bainii* (Simla).
Perionyx excavatus (Dehra Dun; Kumaon Dist.; Simla Dist.).
*Perionyx nainianus* (Kumaon Dist.).
*Perionyx simlaensis* (Simla).
Octochætus fermori (Kasauli).
*Eutyphœus annandalei* (Kumaon Dist.).
*Eutyphœus masoni* (Dehra Dun).
*Eutyphœus nainianus* (Naini Tal).
*Eutyphœus orientalis* (Dehra Dun).
Eutyphœus waltoni (Dehra Dun).
*Eudichogaster parvus* (Dehra Dun).

LUMBRICIDÆ.

Helodrilus caliginosus (Kashmir; Gilgit; Simla; Naini Tal).
Helodrilus constrictus (Simla Hills).
Helodrilus eiseni (Naini Tal; Painsur).
Helodrilus fœtidus (Simla).
*Helodrilus kempi* (Simla).
*Helodrilus mariensis* (Murree).
Helodrilus parvus (Kashmir; Simla Hills; Naini Tal).
*Helodrilus prashadi* (Kashmir).
Helodrilus roseus (Kashmir).
Helodrilus rubidus (Naini Tal; Simla).
Octolasium lacteum (Simla Hills).

### 3. NORTH-EASTERN FRONTIER REGION.

(Nepal and eastwards, including Assam.)

TUBIFICIDÆ.

Branchiura sowerbyi (Manipur).
Bothrioneurum iris (Kurseong).

ENCHYTRÆIDÆ.

Fridericia carmichaeli (Darjiling Dist.).

MONILIGASTRIDÆ.

*Drawida decourcyi* (Abor).
*Drawida kempi* (Abor).

Drawida nepalensis (Nepal).
Drawida pellucidus (Abor).
*Drawida rosea* (Cherrapunji).
*Drawida rotungana* (Abor).

MEGASCOLECIDÆ.

*Plutellus aborensis* (Abor).
*Plutellus sikkimensis* (Darjiling Dist.).
*Megascolides bergtheili* (Darjiling Dist.).
*Notoscolex oneili* (Abor, Darjiling Dist.).
*Notoscolex stewarti* (Abor).
*Notoscolex striatus* (Abor).
*Megascolex dubius* (Kurseong).
*Megascolex horai* (Cherrapunji).
Pheretima hawayana (Kurseong; Nepal; Manipur).
Pheretima heterochæta (widely spread).
Pheretima houlleti (Cherrapunji).
Pheretima lignicola (Dibrugarh).
*Perionyx alatus* (Darjiling Dist.).
*Perionyx annandalei* (Darjiling Dist.; Cherrapunji).
*Perionyx annulatus* (Abor).
*Perionyx depressus* (Abor).
Perionyx excavatus (widely spread).
*Perionyx fossus* (Shillong).
*Perionyx foveatus* (Abor).
*Perionyx gravelyi* (Darjiling Dist.).
*Perionyx heterochætus* (Darjiling Dist.).
*Perionyx himalayanus* (Darjiling Dist.).
*Perionyx inornatus* (Darjiling Dist.).
*Perionyx kempi* (Abor).
*Perionyx koboensis* (Abor).
*Perionyx m'intoshi* (Nepal).
*Perionyx modestus* (Cherrapunji).
*Perionyx nanus* (Darjiling Dist.).
*Perionyx pallidus* (Darjiling Dist.).
*Perionyx pincerna* (Darjiling Dist.).
*Perionyx pokhrianus* (Darjiling Dist.).
*Perionyx pulvinatus* (Darjiling Dist.).
*Perionyx rimatus* (Darjiling Dist.).
*Perionyx shillongensis* (Shillong).
*Perionyx sikkimensis* (Darjiling Dist.).
*Perionyx turaensis* (Garo Hills).
*Perionyx variegatus* (Darjiling Dist.).
*Octochætus hodgarti* (Nepal).
*Eutyphœus aborianus* (Abor).
*Eutyphœus gammiei* (Garo Hills; Abor; Darjiling Dist.).
*Eutyphœus manipurensis* (Manipur).
*Eutyphœus nepalensis* (Nepal).
*Eutyphœus pharpingianus* (Nepal).
*Eutyphœus turaensis* (Garo Hills).
Dichogaster crawi (Darjiling Dist.).

LUMBRICIDÆ.

Helodrilus constrictus (Darjiling Dist.).
Helodrilus fœtidus (Darjiling Dist.).
Helodrilus rubidus (Darjiling Dist.).

## 4. INDO-GANGETIC PLAIN.

(United Provinces, Bihar, Bengal.)

ÆOLOSOMATIDÆ.

Æolosoma bengalense (Calcutta).

NAIDIDÆ.

Chætogaster bengalensis (Calcutta).
Chætogaster spongillæ (Calcutta).
Nais communis (Agra).
Nais elinguis (Calcutta).
Nais obtusa (Lucknow; Calcutta).
Nais paraguayensis (Calcutta; Sirsiah).
Nais pectinata (Agra).
Pristina longiseta (Calcutta).
Pristina æquiseta (Calcutta; Allahabad).
Pristina proboscidea (Calcutta).
Branchiodrilus hortensis (Agra).
Hæmonais laurentii (Agra).
Slavina appendiculata (Alipur).
Stylaria lacustris (Calcutta).
Dero limosa (Agra).
Aulophorus tonkinensis (Calcutta; Lucknow).

TUBIFICIDÆ.

Limnodrilus socialis (Calcutta).
Branchiura sowerbyi (Calcutta, Lucknow, Agra).

MONILIGASTRIDÆ.

*Drawida jalpaigurensis* (Jalpaiguri).
Drawida nepalensis (Kierpur).

MEGASCOLECIDÆ.

Megascolex mauritii (widely spread).
*Pheretima alexandri* (Calcutta).
*Pheretima anomala* (Calcutta).
Pheretima hawayana (Bindra Ban).
Pheretima heterochæta (Siliguri).
Pheretima houlleti (Calcutta; Raniganj; Allahabad).
Pheretima posthuma (widely spread).
Perionyx excavatus (Calcutta; Sibpur; Rajshahi; Pilibhit Dist.).
*Perionyx fulvus* (Calcutta).
*Perionyx m'intoshi* (Sibpur).
Octochætus beatrix (Calcutta).

Octochætus fermori (Raniganj; Saharanpur).
*Eutyphœus bishambari* (Pusa).
*Eutyphœus comillahnus* (Comillah).
*Eutyphœus gammiei* (Comillah).
Eutyphœus incommodus (widely spread).
*Eutyphœus masoni* (Calcutta; Rajshahi; Sirsiah; Bara Banki; Basti Dist.).
Eutyphœus mohammedi (Allahabad).
*Eutyphœus nicholsoni* (widely spread).
*Eutyphœus orientalis* (Calcutta).
*Eutyphœus paivai* (Pusa).
*Eutyphœus quadripapillatus* (Calcutta; Saraghat; Sirsiah).
*Eutyphœus scutarius* (Comillah).
Eutyphœus waltoni (widely spread).
*Ramiella bishambari* (Saharanpur).
*Eudichogaster bengalensis* (Calcutta; Raj Mahal).
Dichogaster bolaui (Calcutta).
Dichogaster modiglianii (Calcutta).

LUMBRICIDÆ.

Glyphidrilus papillatus (Lucknow).
*Glyphidrilus tuberosus* (Jalpaiguri).
*Helodrilus indicus* (Calcutta).

## 5. BURMA.

(Including the Andamans and Nicobars.)

NAIDIDÆ.

Chætogaster annandalei (Inle L.).
Chætogaster bengalensis (Inle L.).
Chætogaster limnæi ? (Inle L.).

TUBIFICIDÆ.

Branchiura sowerbyi (Inle L., Kaung-Daing).

MONILIGASTRIDÆ.

*Desmogaster doriæ* (Meteleo).
*Eupolygaster browni* (N. Shan Hills).
Drawida barwelli (Padaung Dist.).
Drawida burchardi (Andamans).
*Drawida affinis* (Rangamati).
*Drawida hodgarti* (Rangamati).
Drawida nepalensis (Rangamati).
*Drawida papillifer* (Rangamati).
*Drawida ranyamatiana* (Rangamati).

MEGASCOLECIDÆ.

*Woodwardia burkilli* (W. Akyab Dist.).
Megascolex mauritii (Mandalay; Andamans).
*Pheretima andamanensis* (Andamans).

*Pheretima andersoni* (Amherst).
*Pheretima birmanica* (Bhamo).
*Pheretima bournei* (Cheba Dist.).
*Pheretima carinensis* (Cheba Dist.).
*Pheretima fecæ* (Amherst Dist.).
Pheretima hawayana (Rangamati).
Pheretima heterochæta (Rangamati ; N. Shan States).
Pheretima houlleti (Pegu Dist.).
Pheretima lignicola (Lower Burma).
*Pheretima osmastoni* (Andamans).
Pheretima peguana (Rangoon).
*Pheretima suctoria* (Andamans).
*Perionyx arboricola* (Cheba Dist.).
Perionyx excavatus (widely spread).
*Perionyx fulvus* (Inle L.).
*Perionyx m'intoshi* (Akyab).
*Eutyphœus foveatus* (Rangoon).
*Eutyphœus gigas* (Rangamati).
*Eudichogaster chittagongensis* (Rangamati).
Dichogaster bolaui (Rangamati).
Ocnerodrilus occidentalis (Andamans).

LUMBRICIDÆ.

Pontoscolex corethrurus (Andamans).
Glyphidrilus papillatus (Cheba Dist.).
Helodrilus fœtidus (Nicobar Is.).
Lumbricus rubellus (Nicobar Is.).

## 6. MAIN PENINSULAR AREA.

(Including S. Rajputana and the Central India Agency.)

NAIDIDÆ.

Nais gwaliorensis (Gwalior).
Nais paraguayensis (Gwalior; Pachmarhi; Saugor; Barkuda).
Nais pectinata (Gwalior).
Pristina longiseta (Gwalior).

TUBIFICIDÆ.

Monopylephorus parvus (Chilka L.).
Aulodrilus remex (Burhanpur).

ENCHYTRÆIDÆ.

Enchytræus barkudensis (Chilka L.).

MONILIGASTRIDÆ.

Drawida willsi (Bilaspur; Hyderabad).

MEGASCOLECIDÆ.

Pontodrilus bermudensis (Chilka L.).
*Megascolides annandalei* (Godaveri Dist.).

Megascolex mauritii (widely spread).
Pheretima bicincta (Hyderabad).
Pheretima elongata (Hyderabad).
Pheretima hawayana (Udaipur).
Pheretima posthuma (Ajmere; Udaipur; Gwalior).
Perionyx sansibaricus (Khandwa, Kala Kund).
*Octochætus barkudensis* (Chilka L.).
Octochætus fermori (Gwalior).
*Octochætus paliensis* (Bina; Palia; Indore).
*Octochætus phillotti* (Hyderabad).
*Octochætus surensis* (Sur L.; Barkul).
Eutyphœus waltoni (Gwalior).
*Ramiella pachpaharensis* (S. Rajputana).
*Eudichogaster ashworthi* (widely spread).
*Eudichogaster barkudensis* (Chilka L.).
*Eudichogaster bengalensis* (Jubbulpore; Cuttack).
*Eudichogaster faleifer* (Jubbulpore; Saugor).
*Eudichogaster prashadi* (numerous localities).
*Eudichogaster pusillus* (Saugor).
Dichogaster bolaui (E. Rajputana).
Ocnerodrilus occidentalis (Kotah).

LUMBRICIDÆ.

Pontoscolex corethrurus (Hyderabad).
*Glyphidrilus tuberosus* (Cuttack).
Criodrilus lacuum (Chilka L.).
Helodrilus caliginosus (Mt. Abu).
Helodrilus parvus (Partabgarh; S. Rajputana).

## 7. SOUTHERN REGION.

(S. of Latitude 15°.)

NAIDIDÆ.

Nais communis (Travancore).
Nais pectinata (Travancore).
Naidium breviseta (Madras).
Pristina longiseta (Travancore).
Branchiodrilus semperi (Madras).
Branchiodrilus menoni (Madras).

TUBIFICIDÆ.

Branchiura sowerbyi (Madras).
Tubifex tubifex (Nilgiris).

MONILIGASTRIDÆ.

*Moniligaster deshayesi* (Cochin; Travancore).
*Moniligaster perrieri* (Travancore; Palni Hills).
*Drawida annandalei* (Tanjore).
Drawida barwélli (Travancore).

*Drawida brunnea* (Cochin).
*Drawida chalakudiana* (Cochin).
*Drawida chlorina* (Nilgiris).
*Drawida elegans* (Coorg).
*Drawida fakir* (Arumanallur).
*Drawida ghatensis* (Travancore; Cochin).
*Drawida grandis* (Nilgiris).
*Drawida matthaii* (Calicut).
*Drawida minuta* (Salem).
*Drawida modesta* (Coorg).
*Drawida naduvatamensis* (Nilgiris).
*Drawida nilamburensis* (Nilambur).
*Drawida paradoxa* (Coorg).
*Drawida parambikulamana* (Cochin).
*Drawida parva* (Nilgiris).
Drawida pellucida (Nilgiris; Travancore).
*Drawida ramnadana* (Madura Dist.).
*Drawida robusta* (Nilgiris).
*Drawida sapphirinaoides* (Nilgiris).
*Drawida scandens* (Mysore, Coorg).
*Drawida shunkarai* (C. Comorin).
*Drawida somavarpatana* (Coorg).
*Drawida sulcata* (Nilgiris).
*Drawida travancorensis* (Travancore).
*Drawida uniqua* (Nilgiris).

MEGASCOLECIDÆ.

*Plutellus aquatilis* (Nilgiris).
*Plutellus dubariensis* (Coorg).
*Plutellus indicus* (Palni Hills).
*Plutellus palniensis* (Palni Hills).
*Plutellus timidus* (Muvattupuzha).
Pontodrilus bermudensis (Ennur).
*Woodwardia hastatus* (Cochin).
*Spenceriella duodecimalis* (Palni Hills).
*Comarodrilus gravelyi* (Cochin).
*Megascolides cochinensis* (Cochin).
*Megascolides duodecimalis* (Cochin).
*Megascolides pilatus* (Cochin).
*Notoscolex ponmudianus* (Travancore).
*Notoscolex scutarius* (Palni Hills).
*Notoscolex tenmalai* (Travancore).
*Megascolex cochinensis* (Cochin).
*Megascolex curgensis* (Coorg).
*Megascolex eunephrus* (Travancore).
*Megascolex filiciseta* (Cochin).
*Megascolex hendersoni* (Palni Hills).
*Megascolex imperatrix* (Nilgiris).
*Megascolex insignis* (Travancore; Cochin).

*Megascolex kavalaianus* (Cochin).
*Megascolex konkanensis* (Travancore; Cochin; Coorg; S. Malabar Coast).
Megascolex mauritii (numerous localities).
*Megascolex pheretima* (Coorg).
*Megascolex polytheca* (Cochin).
*Megascolex pumilio* (Travancore).
*Megascolex ratus* (Travancore; Coorloon).
*Megascolex sylvicola* (Palni Hills).
*Megascolex travancorensis* (Travancore).
*Megascolex trivandranus* (Travancore).
*Megascolex vilpattiensis* (Palni Hills).
Pheretima bicincta (Travancore).
*Pheretima burliarensis* (Nilgiris).
Pheretima elongata (Coorg).
Pheretima heterochæta (Nilgiris; Palnis).
Pheretima houlleti (widely spread).
*Pheretima travancorensis* (Travancore).
*Pheretima trivandrana* (Travancore).
*Diporochæta pellucida* (? locality).
*Perionyx mysorensis* (Mysore).
*Perionyx saltans* (Nilgiris).
Perionyx sansibaricus (Nilgiris; Palnis).
*Howascolex bidens* (Mysore).
*Howascolex corethrurus* (Mysore, Coorg).
*Howascolex markaraënsis* (Coorg).
*Ramiella heterochæta* (Coorg).
*Octochætus aitkeni* (Travancore).
Octochætus fermori (Karakulam).
*Octochætus maindroni* (Weyra Karur; S. Arcot).
*Octochætus pattoni* (Madras).
*Octochætus pittnyi* (Travancore; Mangalore).
*Octochætus thurstoni* (Madras).
Dichogaster affinis (Travancore).
Dichogaster bolaui (Travancore; Cochin).
Dichogaster malayana (Travancore).
*Dichogaster curgensis* (Coorg).
*Dichogaster travancorensis* (Travancore).
Ocnerodrilus occidentalis (Travancore).
*Curgia narayani* (Coorg).
Eudrilus eugeniæ (Travancore?).
*Gordiodrilus travancorensis* (Travancore).

LUMBRICIDÆ.

Pontoscolex corethrurus (widely spread).
*Glyphidrilus annandalei* (numerous localities).
Helodrilus fœtidus (Travancore; Nilgiris; Palnis).
Helodrilus caliginosus (Nilgiris).
Helodrilus constrictus (Nilgiris).

## 8. WESTERN REGION.

(Goa to Cutch, the Ghats to the Sea.)

### NAIDIDÆ.

Chætogaster bengalensis (Satara).
Chætogaster spongillæ (Khandala).
Nais communis (Khandala).
Pristina longiseta (Bombay).
Aulophorus furcatus (Bombay; Khed).

### ENCHYTRÆIDÆ.

Enchytræus indicus (Bombay).

### MONILIGASTRIDÆ.

Drawida barwelli (Bombay).
*Drawida kanarensis* (N. Kanara).

### MEGASCOLECIDÆ.

Pontodrilus bermudensis (Bombay; Pamban; Goa).
*Megascolides prashadi* (W. Ghats).
*Megascolex konkanensis* (N. Konkan; Bombay).
Megascolex mauritii (widely spread).
*Megascolex trilobatus* (Baroda).
Pheretima elongata (Bombay).
Pheretima hawayana (Bombay).
Pheretima houlleti (Bombay).
Pheretima lignicola (Bombay).
Pheretima posthuma (Bombay; Baroda).
Pheretima suctoria (Bombay).
Perionyx excavatus (Castle Rock).
*Perionyx millardi* (Bombay; Igatpuri).
*Perionyx minimus* (Belgaum).
*Perionyx pullus* (Belgaum).
Perionyx sansibaricus (numerous localities).
*Erythræodrilus suctorius* (Goa).
*Erythræodrilus inornatus* (Castle Rock).
*Erythræodrilus kempi* (Castle Rock; Bombay).
*Erythræodrilus kinneari* (Castle Rock).
*Erythræodrilus anomalus* (Belgaum).
Octochætus beatrix (Baroda; Bombay).
*Octochætus castellanus* (Castle Rock).
Octochætus fermori (widely distributed).
*Octochætus guneshæ* (Castle Rock; Poona).
*Octochætus montanus* (Mahableshwar).
*Octochætus paliensis* (Poona).
*Octochætus prashadi* (Kalyan; Mahableshwar).
Eutyphœus waltoni (Baroda; Ahmedabad; Navli).
*Ramiella pallida* (Panchgani; Mahableshwar).
*Eudichogaster ashworthi* (Nasik).

*Eudichogaster barodensis* (Baroda).
*Eudichogaster indicus* (Bombay).
*Eudichogaster mullani* (Bombay).
*Eudichogaster poonensis* (Poona).
*Eudichogaster prashadi* (Poona; Surat).
*Eudichogaster trichochætus* (Bombay; Palchar).
Dichogaster affinis (Bombay; Baroda).
Dichogaster bolaui (several localities).
Ocnerodrilus occidentalis (Bombay).

LUMBRICIDÆ.

Pontoscolex corethrurus (Bombay; Poona; Ahmedabad).

9. CEYLON.

ÆOLOSOMATIDÆ.

Æolosoma ternarium (Galle).

NAIDIDÆ.

Dero zeylanica (Kandy).
Aulophorus oxycephalus (Galle; interior).
Aulophorus michaelseni (Kandy).

TUBIFICIDÆ.

Limnodrilus socialis (Kandy).

PHREODRILIDÆ.

Phreodrilus zeylanicus (Nuwara Eliya).

MONILIGASTRIDÆ.

*Drawida friderici* (Trincomali).
Drawida pellucida (several localities).

MEGASCOLECIDÆ.

*Plutellus halyi* (Colombo).
*Plutellus singhalensis* (Nuwara Eliya).
Pontodrilus bermudensis (Belligamme).
*Pontodrilus agnesæ* (Nuwara Eliya; Horton Plains).
*Woodwardia sarasinorum* (Peradeniya?).
*Woodwardia uzeli* (Peradeniya; Avissavela).
*Notoscolex ceylanensis* (Nuwara Eliya).
*Notoscolex crassicystis* (Nuwara Eliya).
*Notoscolex dambullaensis* (N. Ceylon).
*Notoscolex decipiens* (numerous localities).
*Notoscolex gravelyi* (Kandy).
*Notoscolex jacksoni* (Nuwara Eliya; Trincomali).
*Notoscolex kraepelini* (Central Ceylon).
*Notoscolex termiticola* (Peradeniya).
*Notoscolex trincomaliensis* (N. Ceylon).
*Megascolex acanthodriloides* (Peradeniya).
*Megascolex adami* (Adam's Peak).

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*Megascolex bifoveatus* (Pattipola; Horton Plains).
*Megascolex brachycyclus* (Adam's Peak).
*Megascolex cæruleus* (Peradeniya; Kandy; Nuwara Eliya).
*Megascolex campester* (Horton Plains).
*Megascolex ceylonicus* (locality ?).
*Megascolex cingulatus* (Avissavela; Kandy; Peradeniya; Badullah).
*Megascolex escherichi* (Peradeniya; Horton Plains).
*Megascolex funis* (Kandy).
*Megascolex hortonensis* (Horton Plains).
*Megascolex insignis* (Panadhure).
*Megascolex kempi* (Horton Plains).
*Megascolex leucocyclus* (Nuwara Eliya; Kandy).
*Megascolex longiseta* (Nuwara Eliya; Kandy).
*Megascolex lorenzi* (Peradeniya; Kandy).
Megascolex mauritii (widely spread).
*Megascolex multispinus* (Peradeniya).
*Megascolex nureliyensis* (Nuwara Eliya; Horton Plains).
*Megascolex pattipolensis* (Pattipola).
*Megascolex pharetratus* (Kandy).
*Megascolex quintus* (Pattipola).
*Megascolex sarasinorum* (Trincomali; Kaniya; Mahavali Ganga).
*Megascolex schmardæ* (Adam's Peak).
*Megascolex sextus* (Pattipola).
*Megascolex singhalensis* (Nuwara Eliya).
*Megascolex spectabilis* (Vaxvella).
*Megascolex templetonianus* (Colombo).
*Megascolex varians* (Pattipola; Horton Plains; Nuwara Eliya; prob. Peradeniya).
*Megascolex willeyi* (Labugama).
*Megascolex zygochætus* (Ratnapura).
Pheretima elongata (Panadhure; Kandy).
Pheretima hawayana (Pattipola).
Pheretima heterochæta (Adam's Peak; prob. Peradeniya).
Pheretima houlleti (Peradeniya; Colombo).
Pheretima taprobanæ (Peradeniya).
*Perionyx ceylanensis* (Peradeniya; Point de Galle).
Perionyx excavatus (Kandy; Peradeniya).
*Perionyx polytheca* (Peradeniya).
Dichogaster affinis (Peradeniya; Anuradhapura).
Dichogaster parva (Peradeniya).
Dichogaster saliens (Peradeniya).
Nematogenia panamaensis (Peradeniya).
Ocnerodrilus occidentalis (Panadhure).
Eudrilus eugeniæ (widely spread).

LUMBRICIDÆ.

Pontoscolex corethrurus (widely spread).

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The difference of type in the above lists indicates the different values of the various species for Zoogeography; italic type signifies that the species has to be taken account of, ordinary type that it may be neglected, in zoogeographical discussions. This difference of value depends on the following considerations.

The Oligochæta may be divided into three biological groups—limnic, littoral, and terrestrial, each with its distinctive modes of spreading.

Limnic forms have a great diversity of means of dispersal. They may spread directly thoughout a river system, through all the canals and into all the tanks and reservoirs supplied from it. Their cocoons are easily transported in the mud which adheres to the feet of wading birds; some forms are known to encyst, and hence may be transported in this manner even in the adult state. An Enchytræid has been found frozen in a block of ice, and recovered (Beddard, **30**).

As a consequence the same genera—sometimes the same species even—are found in widely distant places. The case is similar to that of the Rotifera and Protozoa, of which the same genera and species are found in ponds and streams all over the world. There appears to be but one genus, *Branchiodrilus*, of the limnic Oligochæta which is peculiar to India, while a number of species are found both in England and India, or in Europe and India (species of *Nais*, *Chætogaster*, *Dero*, *Aulophorus*, *Pristina*, etc.).

Littoral forms live on the shore, exposed at times to submersion in salt water. Like the last group, these have a wide distribution; being, unlike earthworms in general, immune to salt water, they can be transported in masses of seaweed; or more commonly their cocoons are so transported, entangled in masses of weed or other detritus. Not only can they take possession of a whole coast, and spread along the shore-line, but they may in this way travel over sea for long distances. The most noteworthy genus is *Pontodrilus*, which occurs along the coasts of India, and has a circummundane distribution.

Terrestrial forms constitute the bulk of the Oligochæta. Here the means of spreading are more limited; for the most part earthworms are dependent on their own activities for reaching new regions, and hence their wanderings must be very slow. According to Michaelsen, worms which are found outside their burrows apparently wandering about have for the most part been obliged to leave their homes by illness, or by unfavourable conditions such as the flooding of the burrows; many worms, if extracted from their holes, are unable to make new ones, and must die. Some, however, certainly possess the power of active wandering, as is shown by the numbers sometimes found under heaps of manure. But it is obvious that the peopling of a territory by earthworms through their own exertions can only be very slow.

Not only so, but they are limited in their wanderings by desert tracts—some degree of moisture in the soil is essential. Snow-covered mountain ranges are another obstruction. And

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especially the sea limits them, the majority of earthworms being quite unable to pass even a narrow arm of salt water.

We have to recognize, however, that not all the terrestrial forms are so strictly limited in their means of dispersal as the above would imply. A tree-trunk floating down stream, or earth between the hoofs of cattle, may transport worms or their cocoons. More important is the part that man has played; Lumbricids, natives of Europe, have been introduced all over the world along trade routes; in W. Australia they are almost the only earthworms to be found near the towns; the indigenous fauna is to be sought in the remoter parts of the country. One of the commonest worms of the Punjab is *Helodrilus caliginosus*; certain species of *Pheretima* have been carried round the globe, far from the region where the genus is endemic. Small worms are more likely to be carried in this way than larger ones; and small species of *Dichogaster*, an African genus, are common throughout the Malay Archipelago, and not rare in India. Botanical Gardens are obviously likely to be centres of dispersal for such introduced species in a new country. Records at Kew and Hamburg leave no doubt of the reality and abundance of these transfers through the agency of man.

There are also, of course, differences in the powers of the worms themselves. Some species seem to be able to travel more widely than others, and more quickly, and to adapt themselves to new surroundings and establish themselves more easily; and it may thus happen that a species spreads over a large region quite apart from human interference. It is not always possible to distinguish between these cases and those of introduction by man; and Michaelsen has adopted the name peregrine for the widely wandering species, whether they owe their diffusion to man's agency or to their own unaided powers.

For the purposes of Zoogeography, the distribution of freshwater and littoral forms is of little or no importance; and the same holds for the peregrine forms among the terrestrial group. It is these whose names are printed in ordinary type in the foregoing lists; while the names of those earthworms (in the strict sense) which have a definite and limited range, and which are therefore of importance in discussions of the place of origin and past history of genera or larger groups, and in drawing conclusions as to the former distribution of land and water, are printed in italics. The distinction of type does not coincide with that between endemic and non-endemic forms (since a number of freshwater species are endemic, found only in a limited district), it only indicates zoogeographical value.

Considering now the chief characters of the several regions, as brought out in the tables, the *North-western Territory* strikes the eye at once as being particularly poor in earthworms, and especially in indigenous earthworms. Of these there is but one—a species of *Eutyphœus*—that has any claims to be considered; its locality (Kapurthala) represents the westery limit

of the home of the genus, which is practically confined to the Indo-Gangetic Plain and the two Himalayan regions. The large number of Naididæ in the North-Western Territory—nearly all from Lahore—is merely due to the fact that my own studies were carried out there.

The Eastern portion of the Western Himalayan Region forms part of the endemic area of the genera *Perionyx* and *Eutyphœus*. *Helodrilus mariensis*, *H. prashadi*, and *H. kempi* may perhaps represent outposts of the Lumbricinæ—a Palæarctic group—advancing from the North-West; but the numerous other Lumbricidæ are all well-known peregrine forms. A peregrine Moniligastrid (*Drawida japonica*), and one (*D. nepalensis*) which is peregrine in some degree, are curious members of the fauna.

The area of distribution of the large Moniligastrid genus *Drawida* is discontinuous, one portion being in the North-East Frontier and neighbouring part of the Burma regions, the other—the main home of the genus—in the South. The North-East Frontier Region is one of the most interesting of the Indian areas, since it harbours indigenous species of several of the more primitive Megascolecine genera,—of *Plutellus*, *Megascolides*, *Notoscolex*, as well as two species of *Megascolex*. The meaning to be attached to these facts of distribution is not in all cases clear; it may mean that these genera, evolved outside India, entered round the head of the Bay of Bengal, and have left colonies behind them in their passage over this region; but in the case of *Megascolex* at any rate it probably means an independent evolution, nearly 1500 miles away from the main home of the genus, of isolated species with the morphological characters of *Megascolex*. The North-East Frontier is the great focus of evolution of species of *Perionyx*, and forms a part of the endemic home of *Eutyphœus*.

The Indo-Gangetic Plain is the chief home of *Eutyphœus*, while at its eastern end it just includes the western edge of the *Pheretima* area (two indigenous species at Calcutta). Curiously, it scarcely forms any part of the area of *Perionyx* (the two italicized species of *Perionyx* in the list are in some degree peregrine), which has evolved so luxuriantly in the neighbouring North-East Frontier Region; or of that of *Eudichogaster*, the characteristic genus of the main Peninsular area. The single Lumbricine may (like *H. mariensis*, *prashadi*, and *kempi* in the Western Himalayas) be an outpost of this powerful and advancing subfamily. One or two species of *Drawida* are also included.

Burma is well within the *Pheretima* region. A part of the separated northern home of *Drawida* is on its border, and two other genera of Moniligastridæ are represented each by a single species. Here again it is noteworthy that the area has scarcely been invaded by *Perionyx* from the North-Eastern Frontier Region (two of the three italicized species are the semiperegrine species of the Indo-Gangetic Plain); or by *Eutyphœus* from the Indo-Gangetic Plain. It is likely that these genera are but recently evolved.

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The Main Peninsular Area is by far the largest of the regions, yet notwithstanding its size it strikes the attention at once by the smallness of the number of recorded forms; only the small Western Himalayan Region has fewer; and only this and the North-Western Territory have fewer indigenous forms. With the Western Region, it forms the home of *Eudichogaster*, and with the Western and Southern Regions, of *Octochætus*. The only other indigenous species (one each of *Megascolides*, *Ramiella* and *Glyphidrilus*) occur near its borders.

The Southern Region, though by no means one of the largest, has considerably more species, and more indigenous species, than any other area. The indigenous species belong largely to the genus *Drawida*, of which this region is *par excellence* the home. But the more primitive Megascolecinæ (*Plutellus*, *Woodwardia*, *Spenceriella*, *Comarodrilus*, *Megascolides* and *Notoscolex*) are well represented, and the region harbours a large number of indigenous species of *Megascolex*, the principal genus of Ceylon. The two species of *Perionyx* represent an extension of the Western home of this genus, while the species of *Octochætus* join on to those of the main Peninsular area. It is curious, however, to find here indigenous species of *Pheretima*. *Dichogaster travancorensis* and *D. curgensis* are possibly not indigenous; the genus has its home in Africa, but many species are widely peregrine, and it is very possible that these two may yet be found to have their home elsewhere, and so to be only casual settlers in India.

In Coorg and Mysore occur the Indian species of *Howascolex*, as well as the only representative of the genus *Curgia*; Michaelsen has shown that these two genera indicate a relationship of the fauna to that of Madagascar; and that this area possesses an earthworm fauna which has no immediately obvious relations to that of neighbouring regions; especially striking is the difference from Cochin and Travancore. The Southern is decidedly the most interesting of all the Indian regions.

The Western Region forms part of the *Eudichogaster* and *Octochætus* areas, and comprises all the known species of *Erythræodrilus*. It presents several problems; there are several species of *Perionyx* which are separated by the whole of the large main Peninsular area from the chief home of the genus in the North-Eastern Frontier Region; a *Megascolex*, too (*M. trilobatus*), appears in isolation at a considerable distance from the chief home of the genus. The other indigenous *Megascolex* and the *Drawida* represent merely the northerly limits of the proper homes of these genera.

Ceylon, a very small region, has the second largest number both of total species and of indigenous species. But this is due entirely to the enormous number of species of *Megascolex*, and the fauna does not present the same interest as that of Southern India. It is to be noted that while *Megascolex*, the chief genus of Ceylon, is abundantly represented by endemic species in

Southern India, *Drawida*, the chief genus of Southern India, is almost unrepresented in Ceylon. As in Southern India, there are indigenous species of the more primitive Megascolecinæ, especially of *Notoscolex*. *Pontodrilus agnesæ* and the two species of *Perionyx* present problems similar to those of *Perionyx* and *Megascolex* in the Western Region.

The total numbers of species, and the number of species of indigenous earthworms, in the several regions may be tabulated as follows :—

| Region | Total number of species of Oligochæta. | Number of species of indigenous earthworms. |
|---|---|---|
| N.W. Territory .... | 36 | 1 |
| W. Himalayan Region. | 33 | 11 |
| N.E. Frontier ..... | 57 | 43 |
| Indo-Gangetic Plain .. | 52 | 18 |
| Burma ..... | 41 | 21 |
| Main Peninsular Area. | 36 | 13 |
| Southern Region .... | 105 | 78 |
| Western Region .... | 49 | 25 |
| Ceylon ..... | 69 | 47 |

We have now to consider the extra-Indian geographical relations of the Indian genera of earthworms. The little that can be said about the Lumbricidæ has been included above, and there fall to be discussed here the family Moniligastridæ, and the subfamilies Megascolecinæ, Octochætinæ, and Diplocardiinæ of the great family Megascolecidæ.

(*a*) The Megascolecinæ.

*Diplotrema*, from which the subfamily takes its origin, is not represented in India ; it occurs in Queensland and New Caledonia. *Plutellus*, found in India in Ceylon, S. India, and the E. Himalayas, occurs in Australia and Tasmania, and several species are found in the western part of North America. *Megascolides* (S. India, Western Region, and E. Himalayas) also occurs in Australia and Tasmania, and one species in western North America. *Notoscolex* (Ceylon ; also S. India and E. Himalayas) is found in Australia and New Zealand. *Megascolex* (in India almost exclusively in Ceylon and S. India) occurs in Australia, Tasmania, the N. Island of New Zealand, and Norfolk Island (between New Zealand and New Caledonia). *Pheretima* is a genus of which many members have wandered widely ; its proper home, however, is S.E. Asia and the Malay Archipelago ; from Burma on the one side it reaches to Japan on the other ; one species is perhaps endemic in Queensland, and perhaps one in the Comoro Islands. *Diporochæta*, represented by one species only in India (probably in the South, the locality is not given), is found principally outside India in Victoria and Tasmania, but also in Queensland, New Zealand,

and (one species) on the Chatham Islands (E. of New Zealand). *Perionyx* (E. Himalayas, Western Region, and a few species in other parts of India) occurs in Victoria, Tasmania, and the Auckland Islands, while one endemic species is found in Sumatra and Java. *Woodwardia* (Ceylon, S. India, Burma) is found in Australia and Java. *Comarodrilus* is purely Indian, the single species being found in the extreme south. *Spenceriella* (S. India) occurs also in Victoria.

It will be seen that nearly the whole of the Indian genera (all except the small genus *Comarodrilus*) are represented in Australia; a number are found also in New Zealand, a few in the islands near New Zealand, and a few in the islands of the Malay Archipelago.

The conclusion drawn by previous writers (see especially Michaelsen, **54**, **58**) from the occurrence of the parent genus *Diplotrema* in Queensland is that the subfamily took its rise from somewhere in this region, which is not very far from the centre of the area now inhabited by the subfamily. The descendants have travelled further afield—towards India, towards Tasmania, towards New Zealand and the neighbouring islands, and northward throughout the Malay Archipelago to Japan. And of course the important point is that they must have travelled by land. The reason for the absence of so many of the genera from the islands intervening between Australia and India is that here the mighty genus *Pheretima* has crushed all competitors; it is the youngest, most highly specialized, and most vigorous genus of the subfamily; it is still spreading, many species are among those most commonly introduced by man, and they show themselves most successful colonists.

Michaelsen did not, however, assume the prolonged existence of a broad land connection between the regions mentioned. The relations were much more complicated, and were often changing. Perhaps there was not a complete bridge at any time; the normal condition of the region intervening between Australia and New Zealand on the one hand and India on the other was that of an archipelago, which extended to Ceylon and S. India over the present Bay of Bengal. The boundaries of the islands often changed: sometimes they joined, sometimes they separated—and no doubt in a different place; and in this way paths became available for the continued expansion of the various genera.

Moreover, since certain Indian genera have such a definitely limited area (certain of those already noticed being confined to S. India, *Perionyx* being chiefly an inhabitant of the Himalayan region, and *Eutyphœus*, to be mentioned subsequently, being confined to the Gangetic plain), India itself was split up into a number of large islands. Thus the Malay Archipelago is the only remaining part of a larger archipelago which existed in the early Tertiary, of which the middle part is submerged, and the Western has consolidated to form the present India. The occurrence of two of these genera (*Plutellus* and *Megascolides*) in North America

is supposed to point to their having travelled over the Angara continent.

The other groups which fall to be considered are less extensive; they have been held to reinforce the above conclusions, and permit the formulation of a few more.

(*b*) The Octochætinæ.

*Octochætus*, widely distributed in India, occurs also in New Zealand, but not elsewhere—not in Australia. *Erythræodrilus*, *Eutyphœus* and *Eudichogaster* are purely Indian genera. *Dinodrilus* is a genus which occurs in New Zealand only.

The relationships here indicated differ from those of the Megascolecinæ; they exclude Australia, and concern only India and New Zealand. The conclusion which was drawn by Michaelsen is that at the time of the dispersal of the Octochætinæ there was a connection between India and New Zealand which did not extend to Australia; perhaps it passed entirely to the north, through the great islands of the Malay Archipelago. The Octochætinæ do not occur at present in the Malay Archipelago because they have been unable to survive in competition with the dominant *Pheretima*.

Michaelsen has recently (99) recorded *Howascolex*, perhaps the most archaic genus of Octochætinæ, from Southern India; the genus had previously been found only in Madagascar. The relationship thus indicated between the faunas of these two regions is confirmed by the occurrence of the Ocnerodriline genus *Curgia* in Southern India; the single species of this genus, with the endemic Indian species of *Gordiodrilus*, constitute the end of a line of relationship which stretches from Madagascar and Zanzibar through the Seychelles to India.

(*c*) The Diplocardiinæ.

The geographical relations of this subfamily are quite different from those of the preceding groups. *Diplocardia*, the ancestral genus, is found in North and Central America, and its descendant *Trigaster* in Central America and the West Indies; these genera are not found in India. *Dichogaster*, a descendant of *Trigaster* and the only Indian genus of the subfamily, is endemic in Central America and the West Indies, and also in tropical Africa; all the species that are found in India are introduced, with the possible exceptions of one or two only. *Eudichogaster*, previously included in this subfamily, is now recognized as belonging to the Octochætinæ. The subfamily as at present constituted has therefore little bearing on the problems of Indian distribution.

(*d*) The Moniligastridæ.

This family consists of only a few genera. *Desmogaster*, the supposed ancestral genus, is found in Borneo, Sumatra, and Lower Burma, and its descendant *Eupolygaster* has a similar distribution.

*Drawida*, the largest genus of the family, is predominantly South Indian ; *Moniligaster*, a small genus very close to *Drawida*, belongs to the same region.

Michaelsen has supposed that South India and Ceylon were peopled by this family by means of a land-bridge across the Bay of Bengal, and rejected the supposition that the forerunners of the present South Indian Moniligastrids could have travelled by land round the head of the Bay ; they would, he thought, have left some trace of their passage in that region (a number of endemic species of *Drawida* have, in fact, recently been shown to inhabit this region).

Such are the main facts of the extra-Indian distribution of Indian genera of earthworms, and such the principal conclusions that have been drawn from them. I have, however, in a recent discussion of the subject (**95**) given reasons for dissatisfaction with certain of these conclusions, and have suggested alternatives.

The present tendency of geological speculation rejects the assumption of frequent and large upheavals and depressions of land masses, and favours the permanence of continents and oceans. Zoological evidence, moreover—*e. g.*, the distribution of Monotremes and Marsupials,—shows that there has been no land connection between Australia and New Zealand on the one hand and South-East Asia on the other, at least since the Eocene—probably the early Eocene. A number of the genera of earthworms which are common to both sides have, however, probably evolved since this period.

There are other possibilities to account for this. There is the possibility of spreading by means of "rafts." And especially there is the possibility of the separate evolution of the same combinations of morphological characters, *i. e.*, the same genera, in different regions ; in other words, some of the genera which occur both in the Australian and Indian regions may be diphyletic—may have originated both in Australia and in India, and may never have crossed a land bridge from one to the other. I have endeavoured to show that not only is a polyphyletic origin *a priori* probable for some of the genera of Megascolecidæ, but that in the case of one genus (*Megascolex*) we can hardly avoid the assumption that it has occurred. For a fuller discussion, and especially for a more detailed consideration of the several land bridges that have been postulated by other writers, I must refer to the original article.

Lastly, as this work is going to press, a paper by Michaelsen has appeared (**106**), in which he employs Wegener's recent hypothesis to explain the distribution of the Oligochæta, not only in the Indo-Australian region but in other parts of the world also. According to Wegener's view, the great land masses of the earth were at an earlier period massed together, and have broken apart and gradually diverged from one another ; a map, reproduced by Michaelsen, shows India and Australia in actual contact in the

Carboniferous period, and an elongated Southern India lying alongside and communicating through Madagascar with the S.E. coast of Africa. It is obvious that such a disposition of the land masses, if it could be assumed to have existed within recent geological periods, would help considerably to explain the presence of the same genera at the two ends of the Indo-Australian region.

My own view is that the genera of earthworms which exist at the present day are of comparatively recent origin (**95**); Michaelsen would contest this (**106**), at any rate as regards the more primitive of the genera known to us. But however this may be with regard to these more primitive genera, I cannot think that the Palæozoic connections of Wegener's hypothesis will assist us in the matter of the distribution, for example, of *Perionyx*, the last genus to be developed along one of the lines of descent, or of *Megascolex*, the penultimate genus along another line—both genera with the marks of youth strongly impressed on them, and both occurring alike in the Indian and Australian regions; nor would such connections have any bearing on the question, as regards these and other genera, even if they were in existence for a long time subsequently to the Carboniferous.

## BIONOMICS.

The few and scattered observations on the bionomics of Indian Oligochæta may be gathered together under three headings—seasonal variations, habitats, and commensalism.

### (i) Seasonal Variations.

The only observations on variations in numbers of worms found at different seasons are those of Prashad (**82**). In Lahore there are five chief species—*Pheretima hawayana*, *P. heterochæta*, *P. posthuma*, *Helodrilus caliginosus*, and *H. parvus*. In the winter, which is comparatively severe, the predominant forms are *H. caliginosus* and *H. parvus*; *P. hawayana* also occurs in numbers under flower-pots or logs and stones. In the spring *H. caliginosus* diminishes in numbers, and in May is not found at all. All three species of *Pheretima* increase during this period; *Helodrilus parvus* is found along with the other worms. *Megascolex mauritii* is rare, and has only been found in the autumn.

Observations on the period of sexual maturity of the Indian Microdrili have been made by Mehra (**94**) and myself (**55**, **58** *a*, **76**, **78**). In Lahore the Naididæ are sexual in the spring, from February to May, and not at other times. In Agra sexual specimens have been observed in October and November. The difference may be due to the difference in the character of the seasons; in Agra the rains are abundant from June or July to September, the ponds begin to dry up in October, and the cold weather appears to be the unfavourable period. In Lahore, however, the rains are later and scantier than in Agra, and the

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hot weather therefore more prolonged; May, June, and July, when the ponds are dry, and the ground baked hard, represents the most unfavourable season of the year for pond-life; "whether the sexual phase makes its appearance in Spring or Autumn, therefore, it seems to be a measure of protection against approaching adverse conditions; the ova, quiescent or developing slowly within the cocoon, are probably able to withstand such conditions better than the adult animal" (Mehra, 94).

*Branchiura sowerbyi* may become sexual in Calcutta in May, and *Limnodrilus socialis* has been found sexual in Lahore in December and February. In March, however, the large majority of these latter worms are found to be headless; and I have made the suggestion (67) that by the expulsion of the genital products the anterior segments of the body are so much damaged that they die and are thrown off; the worms, however, continue to live, though it may be doubted if they are capable of regenerating the head, and they probably die after a time. In a somewhat similar way Mehra finds in *Nais pectinata* that the anterior portions of the worms, containing the genital organs, separate off as a sort of cocoon, while the hinder part of the animal lives for some time, but is unable to regenerate and ultimately dies.

### (ii) Habitat.

Except as noted below, under Commensalism, there is not much room for striking variations in habitat among the Oligochæta. The terrestrial families—the earthworms—inhabit the soil; and the aquatic families of Microdrili live in ponds, tanks, and streams.

While it would in general be impossible for any of the Æolosomatidæ, Naididæ, or Tubificidæ to live out of water, earthworms on the other hand can sometimes adapt themselves to life in other media than the earth. The Moniligastridæ seem to require moister conditions than any other family of earthworms, taken as a whole. They are found only in regions of great rainfall; though in number of species *Drawida* is third among Indian genera, it has never been able to spread in the drier parts of the country. Often the species live in water; thus *D. annandalei* was found in mud below the water in the Caveri R.; *D. kempi* in a stream, under a stone in the water; *D. robusta* var. *ophidioides* in swamps and wet ground; *D. sapphirinaoides* in very wet black mud under turf; *D. pellucidus* var. *bournei* was found among roots in damp ground near the outflow of a hot spring; *D. grandis* was found before the rains only at depths of 9–10 feet, but was seen crawling about on the surface after rain. Seeing that in most species we have no data as to the character of the habitat, these facts seem to betoken a much larger proportion of aquatic species than is usual in the genera of terrestrial Oligochæta. As a rule, too, dorsal pores are wanting in the family, and absence of dorsal pores is usually connected with an aquatic habitat.

Another genus that inhabits only regions of great rainfall is

*Perionyx* (E. Himalayas, Malabar). Here, too, we have definitely aquatic species. *P. excavatus* is often, though not always, found in water or in very moist situations—in the leaves of water-plants, under stones or in mud by a tank, in the hollows of trees in accumulations of dead leaves and rain-water. *P. fulvus* was found in a few feet of water; and some indeterminable specimens of the genus were taken from hill-streams near Sitong in the Darjiling District.

A few other species are aquatic or semi-aquatic; *Glyphidrilus tuberosus* lives in canals, ponds, or mud; *Pontoscolex corethrurus* may be found in mud; and *Helodrilus parvus* has been taken at the edge of a stream.

A number of species of *Megascolex* and *Perionyx* have been found in rotten wood. A more curious habitat, however, is adopted by a number of worms—the bases or axils of the leaves of trees at some distance above the ground; thus *Dichogaster bolaui* subsp. *palmicola* has been found in the Museum compound at Calcutta at the base of the leaves of a tall palm-tree, or, again, at the crown of a palm-tree; a species of *Eudichogaster* was also taken in the Museum compound at the base of leaves of a tall palm-tree; *Perionyx arboricola* is found on trees, especially in the axils of the leaves; *Perionyx depressus* was taken at the base of the leaves of the screw-pine and plantain 10, 15, or 20 feet above the ground. A batch of indeterminable specimens of *Perionyx* was found coiled up on the upper or under sides of leaves in dense jungle, forming a compact gelatinous mass; when touched, these worms spring to life, performing somersaults and other acrobatic feats. Parenthetically, it may be mentioned that *Perionyx saltans* is also "a very strong little worm; the name refers to its power of leaping in the air when touched."

### (iii) Commensalism.

Among Indian Oligochæta it is only certain of the Naididæ that enter into the loose associations between animals belonging to different groups that go under the name of Commensalism. The other partners in these associations are certain freshwater Sponges, Polyzoa, and Snails.

The advantages in partnerships of this kind may be either one-sided or reciprocal. In most cases in which Indian Oligochæta are concerned, while the worms certainly receive shelter they probably do not repay their hosts for their hospitality; *Chætogaster spongillæ*, however, which receives food as well as shelter from its host, appears to play an active part in the economy of the sponge in which it lives (Annandale, **50**, **107**); it "often occurs in enormous numbers in dead or dying sponges of *S. carteri*, apparently feeding on the decaying organic matter of the sponge and assisting by its movements in releasing numerous gemmules. In so doing it undoubtedly assists in the dissemination of the species." Species of *Chætogaster* are found in India, as all over the world, in association with freshwater snails.

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*Nais communis* is found in *Spongilla carteri* in two forms—one with eye-spots and one without. Both forms were found, again together, living freely at Kasauli; so that the absence of eye-spots does not seem to be related to the habitat.

I subjoin a list of Indian Oligochæta that have been found in these and similar associations, and of their partners:—

*Chætogaster annandalei* in *Ephydatia fluviatilis*.
*Chætogaster bengalensis* in *Ephydatia fluviatilis* and *Spongilla carteri*, and on several species of water-snails of the genus *Limnæa*.
*Chætogaster limnæi* on a *Limnæa*; and a worm perhaps belonging to this species was found in *Ephydatia fluviatilis*.
*Chætogaster spongillæ* on *Spongilla carteri*, *S. decipiens*, *S. crateriformis*, and on *Plumatella repens* var. *emarginata*.
*Chætogaster* sp. on *Plumatella repens* var. *emarginata*.

Specimens of *Nais communis* var. *punjabensis* found by Annandale in Seistan were living in relatively long mucilaginous tubes to which colonies of *Lophopodella* had attached themselves; they were found in Lahore in tubes which had probably been abandoned by insect larvæ. The worms have also been found in *Spongilla carteri*.

*Nais communis* var. *cæca* in *Spongilla carteri*.
*Nais elinguis* in *Spongilla carteri* and on *Plumatella emarginata*.
*Nais obtusa* on *Plumatella emarginata* and *Plumatella fruticosa*.
*Nais pectinata* in *Spongilla carteri*.
*Nais pectinata* var. *inæqualis* in *Spongilla carteri*.
*Pristina longiseta* in *Spongilla crassissima* and *Spongilla carteri*, on *Plumatella fruticosa* and *Plumatella emarginata*.
*Pristina æquiseta* in *Spongilla carteri*.
*Pristina proboscidea* in *Spongilla carteri* and *Spongilla crassissima*.
*Pristina proboscidea* var. *paraguayensis* on *Plumatella fruticosa* and *Plumatella emarginata*.
*Slavina appendiculata* on *Plumatella emarginata*.

A different kind of association is that between worms of different species—indeed, of different genera—often or usually found living together. The worms may not be particularly common—rather the reverse perhaps; so that the associations are hardly the result of chance.

Thus *Branchiura sowerbyi* and *Branchiodrilus semperi* were long ago found together by Beddard in the *Victoria regia* tank in the Royal Botanic Society's Gardens in Regent's Park; *Branchiura sowerbyi* and another species of *Branchiodrilus* (*B. hortensis*) were

found, along with a species of *Dero*, living together at Lahore; *Branchiura sowerbyi*, *Branchiodrilus hortensis*, *Dero limosa*, and a *Hæmonais* were found together by Mehra near Agra. Along with the *Branchiura* and other worms at Lahore were numbers of *Limnodrilus socialis*; and I received these two worms together from the same pools in Kyoto in Japan.

Finally, it may be mentioned that *Aulophorus tonkinensis* often builds the tube in which it lives mainly of the free statoblasts of *Plumatella*. "It apparently makes no selection in so doing, but merely gathers the commonest and lightest objects it can find, for small seeds and minute fragments of wood as well as sponge gemmules and statoblasts of other genera are also collected by it. I know of no better way of obtaining a general idea as to what sponges and phylactolæmata are present in a pond than to examine the tubes of *Aulophorus tonkinensis*" (Annandale, **107**).

## CLASSIFICATION.

The classification of the Oligochæta here adopted is, with modifications, that of Michaelsen in the Tierreich (**38**). For the Indian Oligochæta, the families Æolosomatidæ, Naididæ, Tubificidæ, Enchytræidæ, Moniligastridæ, Megascolecidæ, and Lumbricidæ are recognized; the Lumbricidæ here include the Glossoscolecidæ, according to Michaelsen's later views (**87** *a*). In addition, the genus *Phreodrilus* is separated from the Tubificidæ as a distinct family, Phreodrilidæ (Michaelsen, Olig. deutschen Tiefsee-Exp. 1903); and the Moniligastridæ of previous authors become a subfamily, the Moniligastrinæ, in consequence of the discovery of the very distinct genus *Syngenodrilus*, which becomes the representative of another subfamily, the Syngenodrilinæ.

Michaelsen has quite recently (Arch. f. Naturgesch., 86 Jahrg. 1920, Abt. A, 8 Heft) proposed a new classification, as follows:—

Order OLIGOCHÆTA.

Suborder ARCHIOLIGOCHÆTA (setæ an indeterminate number per bundle; male ducts opening to the exterior one segment behind their funnels).

Series *Naidina* (asexual reproduction by regular fission).

Families Æolosomatidæ.
Naididæ.

Series *Enchytræina* (spermathecæ widely separated from the gonads).

Family Enchytræidæ.

Series *Tubificina* (asexual reproduction not occurring; spermathecæ situated not far from the gonads).

Families Tubificidæ.
Phreodrilidæ.

Suborder NEOOLIGOCHÆTA (setæ lumbricine or perichætine; male pores not as a rule on the segment behind that of the funnels).

Series *Lumbriculina* (male pores on same segment as that of their funnels).

Families Lumbriculidæ.
Branchiobdellidæ.
Acanthobdellidæ.

Series *Phreoryctina* (male pores on the next to third next segment behind the testis segment).

Families Phreoryctidæ.
Alluroididæ.
Syngenodrilidæ.
Moniligastridæ.

Series *Lumbricina* (spermathecal pores, *i. e.* the female copulatory pores, in number and position not in general correlated with the male copulatory pores).

Families Glossoscolecidæ.
Sparganophilidæ.
Microchætidæ.
Hormogastridæ.
Criodrilidæ.
Lumbricidæ.

Series *Megascolecina* (spermathecal pores, *i. e.* the female copulatory pores, in number and position in general or primitively correlated with the male copulatory pores or prostatic pores).

Family Acanthodrilidæ.

Subfamilies Acanthodrilinæ.
Octochætinæ.
Diplocardinæ.
Trigastrinæ.
Ocnerodrilinæ.

Family Eudrilidæ.

Subfamilies Pareudrilinæ.
Eudrilinæ.

Family Megascolecidæ.

This scheme is based in part on certain newer genetic considerations which have hardly as yet had time to establish their validity, and for the present I prefer to abide by the above modification of the older scheme.

## *Key to the Families of Indian* Oligochæta.

(The Indian members of the several families are alone considered in the following key.)

1. Asexual reproduction by fission predominates over sexual reproduction ..... 2.
   Asexual reproduction does not normally occur ..... 3.
2. Cerebral ganglion permanently in connection with the epidermis; septa for the most part wanting ..... [p. 40. **Æolosomatidæ,**
   Cerebral ganglion free in the body-cavity; septa present ..... **Naididæ**, p. 43.
3. Spermathecæ in v, spermathecal pores in groove 4/5; no gizzard ..... **Enchytræidæ**, p. 110.
   Spermathecæ situated behind v, or absent (if spermathecæ in v, then a strong gizzard present) ..... 4.
4. Male pores not more than one segment behind the funnels to which they correspond ..... 5.
   Male pores more than one segment behind the funnels to which they correspond .. 7.
5. Two or more gizzards at the beginning of the intestine ..... [p. 116. **Moniligastridæ,**
   No gizzard ..... 6.
6. Testes in x, ovaries in xi; male pores on xi; spermathecal pores on x; setæ an indeterminate number per bundle ..... **Tubificidæ**, p. 95.
   Testes in xi, ovaries in xii; male pores on xii; spermathecal pores on xiii (apparently on xiv in the only Indian species); ventral setæ two per bundle ..... **Phreodrilidæ**, p. 108.
7. Prostates present; male pores on xvii, xviii, or xix, separate from or opening in common with the prostatic pores ..... [p. 162. **Megascolecidæ,**
   Prostates usually absent (if present, spermathecal pores in groups of several or of several pairs behind testis segments); situation of male pores varies ..... **Lumbricidæ**, p. 487.

## Family ÆOLOSOMATIDÆ.

Small freshwater worms, at most 10 mm. long, reproducing chiefly asexually, by fission. Prostomium ventrally with cilia. Setæ in four bundles per segment, the number in each bundle indefinite; both dorsal and ventral bundles with capillary setæ, and often with slender single- or double-pointed hooked or needle setæ in addition. Septa wanting for the most part, rarely septum 1/2 present. No gizzard. Lateral vascular commissures wanting. Cerebral ganglion permanently in connection with the epidermis. Testes and ovaries (which may fuse, becoming single instead of paired) in v and vi respectively; no proper vasa deferentia, the spermatozoa being evacuated by the nephridia of the genital region. Spermathecæ 1–3 pairs, in iii–v.

ÆOLOSOMA Ehrbg. is the only genus, with the characters of the family.

I reject the genus *Pleurophleps* Vaill. Schmarda (3) described in 1861 two small worms, one from Ceylon and one from Central America, under the names of *Æolosoma ternarium* and *Æ. macrogaster* respectively, which resemble the other species of the genus very closely in general form, but differ in having no oildrops in the integument, and in possessing a pair of lateral vessels; the alimentary canal behind the stomach is figured as a narrow winding tube. These were separated by Vaillant (136) as a distinct genus, *Pleurophlebs*, which Michaelsen (38, *Pleurophleps*) considered uncertain, though he has admitted it in his Indian lists (54, 58).

I have spent some time in investigating the vascular system of the two species of *Æolosoma* which occur in Lahore, and I cannot believe that in forms so closely related to the genus as these species of Schmarda's must be, there can possibly exist well-defined lateral vessels running the length of the body, at some distance from the alimentary tube, as shown in Schmarda's figures. I think there can be little doubt that the intestine of Schmarda's figure of *Æ. ternarium* is the mid-dorsal portion of the intestinal plexus or sinus, or perhaps the outline of the lumen of the intestine in a contracted condition; and that the "lateral vessels" are the optical section of the sinus on the sides of the gut in a dilated condition (the intestine is continually dilating and contracting, Stephenson, 72). With regard to the absence of oildrops, Beddard (111) has described an *Æolosoma* without oildrops, which he supposed to be Leydig's *Æ. niveum*, but which Michaelsen (38) separates as a distinct species, *Æ. beddardi*.

Neither of the distinguishing features of the genus *Pleurophleps* is therefore in reality such; the genus ought accordingly to disappear, and the inadequately-described species *ternarium* may be placed as a doubtful species of *Æolosoma*.

The sexual organs have rarely been seen in this genus; if they are seen to be present in any Indian *Æolosoma*, the worms should be carefully fixed and sectioned, and the condition fully described.

*Distribution.* Lahore; Calcutta; Ceylon. The genus has probably a world-wide distribution, and will in all likelihood be found in almost all localities in India which provide a suitable habitat.

*Key to the Indian species of* Æolosoma.

| | | |
|---|---|---|
| 1. | Oildrops orange or red ..... | *Æ. kashyapi.* |
| | Oildrops green or greenish ..... | 2. |
| 2. | Setæ not distinguishable as markedly of two lengths in each bundle; $n=7$ or 8 ..... ..... | *Æ. viride.* |
| | Setæ in each bundle of two lengths, the longer about double the length of the shorter; $n=11$ .. | *Æ. bengalense.* |

### 1. Æolosoma bengalense *Steph.*

1911. *Æolosoma bengalense*, Stephenson, Rec. Ind. Mus. vi, p. 204.

Length (preserved) 1–1·5 mm.; diameter 0·2–0·3 mm. Segments up to 16 (or possibly more); $n=11$. Prostomium not broader than succeeding segments. Setæ all straight, capillary; bundles consist as a rule of one long and several shorter, the long (about 210 $\mu$) averaging nearly twice the length of the shorter (about 110 $\mu$). Oildrops blue-green. Œsophagus sinuous, in ii–iii; stomach deep orange, in iv–viii.

*Distribution.* Calcutta (Museum Tank).

### 2. Æolosoma kashyapi, nom. nov.

1909. *Æolosoma hemprichi*, Stephenson, Mem. Ind. Mus. i, p. 277, pl. xx, figs. 53–55.
1913. *Æolosoma hemprichi*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 743, 748.

Length (maximum, extended and alive) 1·35 mm.; diameter usually about 0·06 mm. Segments of the single animal 8–11, of a chain of two about 14; $n=7$ or 8. Prostomium large, rounded, flattened, broader than the body. Setæ capillary, straight or almost so, 2–5 in a bundle, in length about equal to the diameter of the body. Oil droplets deep orange or bright brownish red. Nephridia begin usually behind the first setal bundle, sometimes one segment further back; do not occur further back than the seventh setal bundle, and may be absent from one of the intermediate segments. Cerebral ganglion markedly indented behind.

*Remarks.* I at first identified this species with *Æ. hemprichi*, but have now decided to separate it on grounds of differences in the size and setæ. *Æ. hemprichi* is of comparatively large size, 2–5 mm. (Lankester, describing a form which he calls *Æ. quaternarium* (119), but which according to both Beddard and Michaelsen is *Æ. hemprichi*, states that the largest specimens are nearly a

quarter of an inch long); Vejdovsky (138) describes it under the name *Æ. ehrenbergii* as "ein mit blossem Auge ganz deutlich sichtbares Würmchen"; while my worm was "scarcely discoverable by the naked eye in its usual surroundings, and has to be searched for with a lens."

According to Vejdovsky, *Æ. hemprichi* has 3 longer and as many shorter setæ in between the longer in each bundle; these shorter setæ are according to the figure about half the length of the longer, and alternate with them. Lankester also shows bundles of up to 9 setæ, though no regular alternation in length is visible in his figure.

The animal is very hardy in unfavourable conditions. I have used this species in a discussion on the origin of the vascular system (72), and have given a description of the vessels, of the ascending ciliary movement in the intestine, of the antiperistaltic contractions of the gut, and of the relation of the contractions of the dorsal vessel to those of the gut.

The specific name which I now assign to this form commemorates my former colleague in the Biological Department of the Government College, Lahore, Professor S. R. Kashyap.

*Distribution.* Lahore, in standing water.

### 3. Æolosoma viride *Steph.*

1907. *Æolosoma* sp., Stephenson, Rec. Ind. Mus. i, p. 233, text-fig. 1, pl. viii, figs. 1–4.
1913. *Æolosoma viride*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 743, 751.

Length (living) 3–8 mm. Segments from 10 upwards, according to length of chain; $n = 7$ or 8. Prostomium rounded, wider than the following segments. Setæ 2–6 in bundle, capillary, straight, of varying length, on the average equal in length to the diameter of the body, the longer of a bundle sometimes alternating with the shorter. Oil-globules pure green, or yellowish or brownish green. Nephridia begin behind the first setal bundle, to the number of six or seven pairs in a single animal. Cerebral ganglion transversely oval, or with a pair of rounded posterior cornua.

*Remarks.* In the original description I suggested the identity of this form with *Æ. headleyi* Bedd., but withdrew the suggestion subsequently. The points of importance are, however, not quite those which I then brought forward. The principal is the number of segments; Beddard does not state what this is in the original account of *Æ. headleyi* (109), but from his drawing it is 16 in an animal which still shows no sign of a budding zone; *Æ. viride* would show a budding zone before it reached this size. The number of nephridia is correspondingly larger in *Æ. headleyi* (10 pairs are shown). In *Æ. headleyi* $n$ is probably about 11, though we have no exact information.

Beddard in *Æ. headleyi* found colourless oil-bodies in addition to the green oildrops. There are no such bodies in the present form, though I found "smaller, less defined, somewhat refractile particles of a very faint blue colour, so faint as to be almost colourless."

I investigated the vascular system and its relations to the alimentary canal in this species in the same way as for *Æ. kashyapi* (72).

*Distribution.* Lahore, in standing water.

Species dubia *Æolosomatidarum.*

**Æolosoma ternarium** *Schmarda.*

1861. *Æolosoma ternarium*, Schmarda, Neue wirbell. Thiere, i, 2, p. 10, pl. 17, fig. 153.
1895. *Æolosoma ternarium*, Beddard, Monog. p. 182.
1900. *Pleurophleps ternaria*, Michaelsen, Tier. x, p. 16.

Length 2·5 mm.; diameter 0·5 mm. Colour yellowish grey. No oildrops in integument. Prostomium rounded, as broad as the following segments. Setæ capillary, straight, 3 per bundle, shorter than the diameter of the body; 10 seta-bearing segments.

Galle, Ceylon; in standing water.

## Family NAIDIDÆ.

Small aquatic worms, seldom exceeding an inch in length. Setæ usually in four bundles per segment, two dorsal and two ventral, dorsal bundles sometimes wanting; number of setæ per bundle indeterminate; ventral bundles without hair-setæ, composed as a rule of bifid crotchets only; dorsal bundles of varying composition, hair-setæ and single- or double-pointed needles being the commonest types. Septa usually well marked. No muscular gizzard. Transverse vascular commissures present. Cerebral ganglion separate from the integument. Testes in v, seldom in vii; ovaries in vi, seldom in viii; spermathecæ in testis segment. Male deferent apparatus well differentiated, with atrium and male pore in vi (or where testes are in vii, atrium and male pore in viii). The far more usual mode of reproduction is the asexual, by fission.

*Distribution.* The family is of world-wide distribution, and doubtless occurs throughout India wherever circumstances are favourable.

The group is an exceptionally fascinating one to study if fresh material is available. The animals are all small enough to allow of microscopic examination; they are mostly very transparent—the Chætogasters particularly so—and all the organs (except the sexual organs, *v. post.*) are visible without difficulty in the living specimen.

Preserved material, however, offers many difficulties, and it is sometimes necessary to relinquish the description or even the identification of spirit specimens; in any case the examination is certain to be tedious and trying to the eyes. This is due to the fact that the most important characters are usually the setæ. These cannot be accurately observed unless they lie flat, and unfortunately the method of flattening described in the Introduction is not applicable to preserved material. In addition, the setæ of preserved specimens can scarcely be seen if the examination is made in glycerine, because of the comparative opacity of the animal; while if the examination is made in balsam, the fine details on which so much depends are invisible, owing to the refractive indices of setæ and balsam being nearly identical.

It is quite certain that a large number of Naididæ remain to be described from the Indian region. They are not easily gathered by collectors; they are difficult to see in the mud or on the weeds where they live, and unless the collector makes these worms a special object they will escape him. In any case, the only really satisfactory way of working at them is to obtain fresh material, best done by bringing a quantity of the weeds, mud, or débris for leisurely and exhaustive examination in the laboratory; and this means that only those localities in the immediate neighbourhood of a competent microscopist can be thoroughly explored.

The student who devotes himself to this group is therefore certain to reap a rich harvest of interesting forms; for example, Lahore is probably an exceptionally unfavourable place for the Naididæ, yet 15 forms, 7 of them new, have been recorded, and the list is doubtless not yet complete. This contrasts with the list of Lahore earthworms—six species only, all of them well-known and widely-distributed forms.

At the same time it is not to be expected that the aquatic worms will yield the same interest from a zoogeographical point of view as the earthworms; most Indian genera, and many species even, are common to India and Europe—indeed, a number of genera and species are probably cosmopolitan. For this reason also it is necessary to be cautious in describing new species; it is not safe to do this until descriptions of all the species of the particular genus from whatever part of the world have been compared; access to a considerable literature is therefore essential.

No opportunity should be lost of securing sexual individuals. The sexual apparatus is still not known in the majority of the Naididæ, including some whole genera; when it becomes more fully known it will doubtless be of great use in the discrimination of species (which depends at present to an undesirably large extent on the setal characters), as well as in determining the interrelationships of the several genera. If sexual specimens are obtained, they should be fixed for histological examination—some at any rate before undertaking any examination under the microscope, in order to obviate possible death or injury. The method of longitudinal sections is the most satisfactory; it is practically impossible to obtain any useful information about the sexual

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animals in the fresh condition, as the opaque clitellum covers over the genital region, and the various organs are therefore (except in the genus *Chætogaster*) not individually visible.

The time of appearance of the sexual organs would also be interesting. In Lahore most or all of the species which have been found sexual have developed the organs in the spring of the year, or at the commencement of the hot weather; the hot weather is the unfavourable time for freshwater forms in the Punjab, and it seems possible that the ova in the cocoons are better adapted to survive it than the animals themselves. In Agra (United Provinces) the autumn appears to be the more usual time (Mehra, **94**). According to Piguet (**133**) there is no very great regularity about the time when the Swiss Naididæ become sexual.

A general diagram of the arrangement of the sexual organs is given in text-fig. 8, and will assist the comprehension of the generic and specific descriptions.

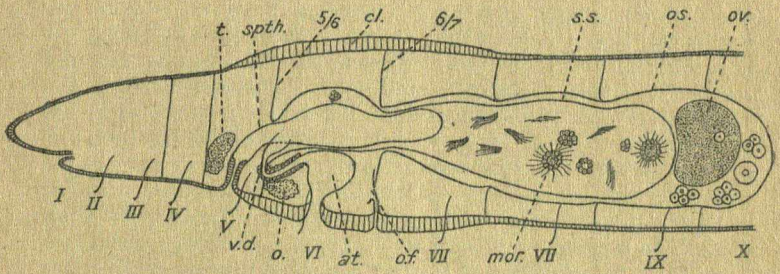


Fig. 8.—Diagram of sexual organs of one of the Naididæ. *at.*, atrium; *cl.*, clitellum; *mor.*, sperm morulæ in sperm-sac; *o.*, ovary; *o.f.*, ovarian funnel; *os.*, ovisac; *ov.*, an ovum; *spth.*, spermatheca; *s.s.*, sperm-sac; *t.*, testis; *v.d.*, vas deferens; 5/6, 6/7, the corresponding septa; i, ii, iii, etc., the several segments.

*Cephalization in the Naididæ.*—An interesting feature of the family is the frequent occurrence of cephalization—the differentiation of several segments at the anterior end of the body to form a "head." Strictly, the phenomenon occurs throughout the Oligochæta, since, in all, the first segment differs from the rest in not possessing setæ; but as a rule the condition is carried further in the Naididæ, not only the first, but also several more of the anterior segments being differentiated from those which follow. This is mainly shown in the absence of dorsal setæ; often also in a difference between the ventral setæ of the anterior segments and those behind; and sometimes by differences of pigmentation.

I have endeavoured to bring this condition into relation with the mode of asexual reproduction which characterizes the family (**68**). It is usual to find that the cephalized segments are those which have been produced in the budding zone. This is not universal however; it is not the case in *Naidium* and *Pristina*, where seven segments at the anterior end are produced in the

budding zone, but cephalization is limited to the first. In the majority of cases the rule holds—five segments are produced in the budding zone, and five are cephalized.

The development of this condition has been somewhat as follows:—In the primitive condition there was no zone of budding—the animals broke in two, and the posterior produced a new first segment and prostomium after separation. This soon gave place to a stage in which the new prostomium and first segment were produced before division; *Branchiodrilus semperi* illustrates this condition. In the next stage a few more new segments behind the first are produced, *after* separation, the younger of these being posterior; the number may vary, as in *Branchiodrilus menoni*, where it has not apparently become fixed; perhaps the degree to which these new segments are finally developed also varies in *B. menoni*. The next stage is the formation of these segments in the budding zone *before* separation, and the fixing of their number; the number has become fixed in *Slavina*, but apparently they are not always formed before separation (Stephenson, 55); in other genera, however, the full number of new segments is present before detachment. These segments are at this stage five in number, and differ from the rest in being less completely developed—they want the dorsal setæ (*Nais*, *Branchiodrilus hortensis*). A subsequent stage is that shown by some *Deros*, where the number of new segments is five, but the most posterior of these develops dorsal setæ, and ventral setæ of the type of those behind (so sometimes *B. hortensis*). Finally, in *Pristina* and *Naidium*, there is an increase of the new segments to seven, all of which (except the first) are completely developed, with dorsal setæ.

Two points must be further mentioned. The first is that this process of cephalization has taken place more than once in the family; we can see it at work in *Branchiodrilus*, where *B. semperi* shows an early stage, *B. menoni* a later, and *B. hortensis* a still later. In *Paranais*, if Michaelsen is right in uniting the various species in the one genus, we have apparently again a number of stages, evidenced by the varying degrees of completeness of development of the budded segments. *Nais*, again, is not closely related to *Branchiodrilus*, yet the same stage has been reached in *Nais* as in *B. hortensis*.

The second is the relation of the budding zone to the position of the genital organs. In the family generally these are situated in the fifth and sixth segments; and five segments are produced in the budding zone. In *Pristina* the genital segments are the seventh and eighth, and seven segments are produced in the budding zone. There seems to be some connection, but what its nature is is not so easy to determine. The testes and spermathecæ are formed in the last segment which is derived from the budding zone; if the budding zone produced only four segments, we might say that the new segments were for some reason incapable of developing sexual cells and organs; but, as it is, this will not do. The position of the genital organs differs in the

several families of Oligochæta, while the phenomena of the budding zone is confined to the Naididæ and *Æolosoma*; the differences in the position of the gonads cannot therefore in general be dependent on the occurrence and extent of a budding zone. Hence, if in the Naididæ there is any connection between the position of the organs and the extent of the budding zone, it is probably in the reverse sense—the extent of the budding zone is dependent on the position of the genital organs.

The Indian Naididæ have been the object of study (Stephenson, 72) in relation to intestinal respiration; almost all take in water by the anus, and pass it forward by means of an ascending ciliary action, which is aided by antiperistaltic movements of the alimentary wall itself. The same phenomena occur also in the Tubificidæ, but to a much more limited extent; they are common in the Polychæta. For the theoretical conclusions drawn from these phenomena the original may be consulted.

*Key to the Indian genera of* Naididæ.

| | | |
|---|---|---|
| 1. | No dorsal setæ | CHÆTOGASTER. |
| | Dorsal setæ present | 2. |
| 2. | Gill processes present | 3. |
| | No gill processes | 5. |
| 3. | Gill processes dorso-lateral, in anterior part of body | BRANCHIODRILUS. |
| | Gill processes within a branchial fossa at the anal extremity | 4. |
| 4. | In addition to gills, a pair of filiform palps present | AULOPHORUS. |
| | No palps in addition to the gills | DERO. |
| 5. | Dorsal setæ begin in segment ii | 6. |
| | Dorsal setæ begin in v or vi | 7. |
| | Dorsal setæ begin in xii–xx, or even further back | HÆMONAIS. |
| 6. | Prostomium prolonged into a long proboscis | PRISTINA. |
| | Prostomium short | NAIDIUM. |
| 7. | Prostomium prolonged into a long proboscis | STYLARIA. |
| | Prostomium short | 8. |
| 8. | Body covered with foreign particles; zones of sensory papillæ present | SLAVINA. |
| | No sheath of foreign particles or sensory papillæ | NAIS. |

## 1. Genus CHÆTOGASTER *K. Baer.*

Small worms, at most 15 mm. long, usually fairly stout, transparent and colourless, or whitish. Prostomium absent or very short, merely a rounded triangular projection of the first segment above the mouth. No dorsal setæ; ventral setæ absent from segments iii–v. Pharynx large and wide; œsophagus short, at most as long as the pharynx. One pair of transverse commissural vessels. Ventral nerve cord extensively perforated in its anterior portion, where there are no distinct ganglia. Testes and ovaries (when present as distinct organs) in v and vi respectively, spermathecæ in v. Mostly carnivorous, sometimes vegetable feeders.

For a general account of the genus the monographs of Vejdovsky (138) and Beddard (31) are useful. For remarks on the Indian species of the genus, see Stephenson (53, p. 247).

The genus occupies an isolated position in the family, from which it was separated by Vejdovsky (138) as a distinct family; but later authors have not followed him. The worms are immediately recognizable by their transparency, absence of dorsal setæ, and absence of ventral setæ on segments iii–v. The alimentary canal is more differentiated than usual in the freshwater Oligochæta; the large barrel-like pharynx is succeeded by a narrow œsophagus, and this by a dilatation which I have called the crop; a second dilatation follows, the stomach; and finally the intestine. The amœboid shape of the cells lining the crop sometimes gives the idea that in this portion of the alimentary canal intracellular digestion may take place (Stephenson, *C. spongillæ* and *C. bengalensis*, 61, 88, 93).

The absence of ascending ciliary action and antiperistalsis in the intestine (both of which are common features in the Naididæ), the reduction of the vascular system, the absence of complete dissepiments and consequently of sperm-sacs and ovisacs, the generally carnivorous habit, the thinness of the body-wall and consequent transparency, and the sometimes parasitic or semi-parasitic mode of life, have led me to argue that the whole genus was formerly parasitic, and that some members have returned to a free-living existence (72).

There are peculiar appearances in the cerebral ganglion of a number of species; granular, refractile, or pigmented particles or masses are present, the significance of which has not been elucidated; they may represent a degenerate sense organ. For an enumeration of these, *cf.* Stephenson (53 and 61.)

*Distribution*: Punjab (Lahore; Gurdaspur Dist.); Bengal (Calcutta); United Provinces (Agra); Burma (L. Inle); N.W. Frontier Province; Western Ghats; W. Himalayas (Naini Tal). The majority of Indian species are parasitic on and in freshwater snails and sponges.

The genus has probably a world-wide distribution; and having regard to the means of spreading of freshwater Oligochætes, it is not surprising to find some European species in the Indian area. The occurrence of *C. annandalei* in Burma is interesting, since the worm was originally described from Japan, and the fauna of L. Inle, its Burmese station, shows Far Eastern affinities.

*Key to the Indian species of* Chætogaster.

| | | |
|---|---|---|
| 1. | Setæ 8 or more in bundle | 2. |
| | Setæ 7 or fewer in bundle | 3. |
| 2. | Setæ 15–17 in bundle | *C. bengalensis.* |
| | Setæ 8–12 in bundle | *C. limnæi.* |
| 3. | Length more than 2 mm. | *C. orientalis.* |
| | Length less than 2 mm. | 4. |
| 4. | Œsophagus moderately long | *C. langi.* |
| | Œsophagus short or very short | 5. |
| 5. | Granular mass in cerebral ganglion | *C. spongillæ.* |
| | No such mass in cerebral ganglion | *C. annandalei.* |

1. **Chætogaster annandalei** *Steph.*

1918. *Chætogaster annandalei*, Stephenson, Rec. Ind. Mus. xiv, p. 9.

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1917. *Chætogaster annandalei*, Stephenson, Mem. As. Soc. Bengal, vi, pp. 85, 88.

Small, a single individual (preserved) 0·44 mm. long, a chain of two 0·66–0·89 mm.; diameter 0·13–0·175 mm.; $n=10$ or 11. Prostomium well marked, bluntly triangular; a constriction behind the second segment. Setæ of ii 70–90 $\mu$ in length, 4 or 5 in the bundle; those of other segments 50–60 $\mu$ long, 3 or 2 per bundle; all double-pronged, prongs very fine, the outer longer and more curved; nodulus markedly proximal. Œsophagus short. No refractile body in cerebral ganglion.

*Remarks.* The species was originally described from Japan, where it was found in a sponge.

*Distribution.* Lake Inle, S. Shan States, Burma; in a sponge, *Ephydatia fluviatilis*.

2. **Chætogaster bengalensis** *Annand.*

1905. *Chætogaster bengalensis*, Annandale, Journ. & Proc. As. Soc. Bengal, i, p. 117, text-fig., pl. iii, figs. 1–4.
1907. *Chætogaster bengalensis*, Stephenson, Rec. Ind. Mus. i, p. 248.
1918. *Chætogaster bengalensis*, Stephenson, Rec. Ind. Mus. xiv, p. 10.
1920. *Chætogaster bengalensis*, Stephenson, Mem. Ind. Mus. vii, p. 195.

Length at least 10 mm. when fully extended; in the preserved condition an animal which is preparing to divide measures 1·8 mm. or more, the first individual being 1 or 1·2 mm.; diameter up to 0·38 mm.; $n=10$ or 11. Setæ in bundles of 15–17, implanted in semicircles; in ii they are 85–120 $\mu$ long, the main portion of the shaft straight, the prongs almost equal in length and thickness, or the proximal prong slightly thicker at the base; position of nodulus varies from middle of shaft to frankly distal. In the other segments setæ shorter, 60–70 $\mu$ long, 1·7 $\mu$ in thickness; shaft here also straight for the greater part of its length, distal end hooked, proximal part gently curved, no regular difference between the prongs; nodulus varies in position, from the middle to distinctly distal. Prostomium practically absent; mouth a large circular orifice, ventro-terminal, looking obliquely forward and downward. Œsophagus short but distinct. Crop with a layer of chloragogen cells on its surface, like paving-stones, with slight intervals between them; a ring of elongated cells internally at the entrance to the crop, hanging backward into the crop, perhaps amœboid. A granular opaque mass in the cerebral ganglion.

*Remarks.* The species is commensal on several species of water-snails—*Limnæa gedrosiana* var. *rectilabrum*, *acuminata*, *chlamys*, etc.; and also in the sponges *Ephydatia fluviatilis* and *Spongilla carteri*.

*Distribution.* Calcutta; Lake Inle, Burma; Peshawar and Nowshera, N.W. Frontier Province; Gurdaspur Dist., Punjab; Satara, W. Ghats. Outside India recorded from Seistan, E. Persia.

3. **Chætogaster langi** *Bretscher.*

1907. *Chætogaster punjabensis*, Stephenson, Rec. Ind. Mus. i, p. 133, pl. v, figs. 1–11.
1915. *Chætogaster punjabensis*, Stephenson, Tr. Roy. Soc. Edin. i, pp. 740, 744.
1920. *Chætogaster punjabensis*, Mehra, P. Z. S. p. 457.

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1920. *Chætogaster punjabensis*, Stephenson, Mem. Ind. Mus. vii, p. 196.

Length 1–2 mm.; segments 8–21; $n=8$ or 9. Transparent. Prostomium short and blunt; head with a rather bulbous appearance, the pharyngeal region being rather swollen, the rest of the animal of uniform diameter, slender. Setæ 5–7 per bundle, in length equal to two-thirds of diameter of body in moderate extension; distal prong of the forked end longer than the proximal. Œsophagus in segment iii, of moderate length, half as long as pharynx. One pair of lateral commissures in iii. First nephridium in vii. Cerebral ganglion with refractile body.

*Remarks.* I noted on one occasion the presence of a few small setæ in segment iii,—an ancestral reminiscence.

After examining British specimens of what are undoubtedly *C. langi* in the living condition, I recognize the identity of my *C. punjabensis* with it.

*Distribution.* Lahore; free living. A common European form; recorded also from Seistan, E. Persia.

4. **Chætogaster limnæi** *K. Baer.*

1909. *Chætogaster limnæi*, Michaelsen, Mem. Ind. Mus. i, p. 131.
1918. *Chætogaster limnæi*?, Stephenson, Rec. Ind. Mus. xiv, p. 9.
1920. *Chætogaster limnæi*, Stephenson, Mem. Ind. Mus. vii, p. 195.

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1884. *Chætogaster limnæi*, Vejdovsky, Monog. p. 36, pl. vi, figs. 16–18.

Length of a single individual up to 2 mm., of chains up to 5 mm. Whitish in life, much less transparent than other species of the genus. Prostomium forming at most a feeble and indistinct projection. Setæ 8–12 per bundle, those of ii somewhat longer than the rest; terminal prongs almost equal and parallel. Œsophagus very short, scarcely distinct. Contractile vascular commissures of the œsophageal region dilated as hearts.

*Remarks.* Michaelsen's definition of this genus in the 'Süsswasserfauna Deutschlands' (124) is wider than that given above. He there allows a very great variation in the number and size of the setæ, "the extremes being, on the one hand, 14–20, those of ii ca. 118 $\mu$ long, and the rest ca. 79 $\mu$; and on the other hand 6–8 in bundle, length of those of ii 69 $\mu$, of the rest ca. 50 $\mu$."

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The definition would almost include *C. bengalensis*. In the Tierreich volume the same author gives the number of setæ per bundle as 8–12, as I have done above.

The identification of the worms which I examined from the Inle Lake remains doubtful, even after a comparison with an actual specimen of *C. limnæi* from Europe. The worms I examined were in a tube with *C. annandalei*, and were taken from the sponge *Ephydatia fluviatilis*. The species has not previously been recorded from a sponge.

Piguet (**134**) remarks that the much inferior transparency of this worm is due to its mode of life—parasitic on, or in the respiratory chamber of, freshwater Molluscs.

*Distribution.* Naini Tal, W. Himalayas (Dr. Annandale informs me that these specimens were found on a *Limnæa*); ? Inle Lake, Burma (on *Ephydatia fluviatilis*). This is a widely distributed European species, commensal on or parasitic in freshwater snails.

### 5. Chætogaster orientalis *Steph.*

1907. *Chætogaster pellucidus*, Stephenson, Rec. Ind. Mus. i, p. 237, text-figs. 2–6, pls. ix–x, figs. 1, 3–10.
1910. *Chætogaster orientalis*, Stephenson, Rec. Ind. Mus. v, p. 68, text-fig. 4, pl. viii, figs. 3–4.
1913. *Chætogaster orientalis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 740, 744, 754.
1920. *Chætogaster orientalis*, Mehra, P. Z. S. p. 457.
1922. *Chætogaster orientalis*, Stephenson, P. Z. S. p. 109, text-figs. 1–6.

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1909. *Chætogaster orientalis*, Stephenson, Rec. Ind. Mus. iii, p. 107.

Length of a chain 5–10 mm. or more; segments 11 upwards; $n=8$. Transparent. Prostomium vestigial, the mouth reaching to the tip of the snout. Setæ 6–7 per bundle in ii, 2–5 in the remaining segments; double-pronged, the distal prong being the longer, both equally thick at the base; setæ of ii 0·14 mm. long, of other segments about 0·11 mm. Œsophagus short, in iii. First nephridium in vii. Cerebral ganglion contains a dark granular mass. No definite gonads, sexual cells produced by proliferation of peritoneal epithelium in various parts of the body; no sperm-sacs or ovisacs; male funnel in v, vas deferens dilating to an oval atrium in vi; clitellum $\frac{1}{2}$v–$\frac{1}{2}$vii = 2. Penial setæ (text-fig. 9) shorter, stouter and fewer (3 per bundle) than the normal, with a single point, quite blunt; nodulus very large, near distal end.

*Remarks.* The species is carnivorous, devouring small Crustacea, Rotifers, small Nematodes, Ciliates such as *Paramæcium*, and other small worms; they will attempt to swallow animals much larger than themselves, *e. g.*, a dead fly.

I have described the vascular system and its relation to the gut in this species in some detail (**72**), and also the peculiar mode of origin of the sexual cells (**98**).

*Distribution.* Lahore, free living; also recorded from Tibet.

### 6. Chætogaster spongillæ *Annand.*

1906. *Chætogaster spongillæ*, Annandale, Journ. & Proc. As. Soc. Bengal, ii, p. 188, text-fig. 1 A.
1907. *Chætogaster spongillæ*, Stephenson, Rec. Ind. Mus. i, p. 248.
1911. *Chætogaster spongillæ*, Stephenson, Rec. Ind. Mus. vi, p. 205, text-fig. 1.
1920. *Chætogaster spongillæ*, Stephenson, Mem. Ind. Mus. vii, p. 195.

Length of living and not budding animal 1 mm., of chain of two, preserved, up to 0·7 mm.; diameter 0·15 mm.; segments 11 upwards; $n=8$. Transparent. Prostomium small. Setæ of ii (text-fig. 10),

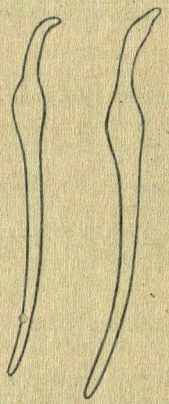

Fig. 9.—Penial setæ of *Chætogaster orientalis* Steph.



Fig. 10.—*Chætogaster spongillæ* Annand.; setæ of segment ii; × 890.

up to 6 in number, 90 $\mu$ long; of other segments 3, 4, or 5 in number, 60 $\mu$ long; prongs of setæ unequal, the distal longer and often thinner; nodulus proximal to middle of shaft. Œsophagus short; no chloragogen cells on crop. Cerebral ganglion with spherical granular mass.

*Remarks.* The animal feeds on the organic débris of the decaying parts of sponges, and is not found in the healthy growing parts; it no doubt helps in liberating the gemmules. It progresses by wriggling.

The ventral nerve cord shows more distinct ganglionic aggregations than in some other species; the appearances of the epithelium of the crop suggest intracellular digestion.

*Distribution.* Calcutta, in *Spongilla carteri* and *S. decipiens*, and on *Plumatella repens* var. *emarginata*; Khandala, W. Ghats, in *Spongilla crateriformis*.

**Chætogaster** sp.

1906. *Chætogaster* sp., Annandale, Journ. & Proc. As. Soc. Bengal, ii, p. 189, text-fig. 1 B.
1907. *Chætogaster* sp., Stephenson, Rec. Ind. Mus. i, p. 248.

Length 2–3 mm.; $n=8$ or 9. Anterior end somewhat truncated. Setæ arranged in semicircles, as in *C. bengalensis*. Buccal cavity deep, pharynx short, œsophagus short. First nephridium in vii, larger than the rest. Cerebral ganglion contains a densely pigmented mass (? eye).

A *species inquirenda*. The food consists, in part at least, of Protozoa which are abundant on the surface of the zoarium of the Polyzoon on which it was found. The eyespot is probably comparable with the refractile bodies in the cerebral ganglion in some other species; these bodies may originally have been eyes, and may have lost their pigment and become vestigial since the genus took to a parasitic or commensal life in the cavities of other animals.

Calcutta; on the surface of *Plumatella repens* var. *emarginata*.

## 2. Genus **NAIS** *Müll.*, em. *Vejd.*

Prostomium well developed, simple, rounded. Hinder end simple. Dorsal setæ beginning in vi, with moderately long hair setæ, at most twice as long as the diameter of the body, not specially elongated in any segment; and needles, with simple or bifid or rarely ctenate point. Ventral bundles of double-pronged crotchets, those of ii–v almost always longer and thinner than the rest. Clitellum including segments v–vii. Testes in v, ovaries in vi; male funnel on anterior face of 5/6, vas deferens leading to a dilated atrium in vi; male pores in vi; sperm-sac formed from septum 5/6, ovisac from 6/7, both single, the sperm-sac extending back within the ovisac; female funnels in hinder part of vi. Spermathecæ in v, consisting of ampulla and muscular duct. Penial setæ near male aperture, 2–5 in bundle.

This is perhaps the most numerous genus of the family, and will no doubt be found in most parts of India when the fresh-water fauna has been more completely investigated.

The discrimination of species rests mainly on the characters of the setæ, and in any description it is therefore necessary to examine these with the greatest care; the chief points to which attention should be directed are mentioned in the Introduction, and may be seen in the following diagnoses; especial importance attaches to the dorsal needles, the points of which should be examined with the oil immersion lens. The position of the nodulus seems in some species to vary in the several setæ of the same ventral bundle according to a definite rule (Stephenson, 77).

*Distribution.* N.-W. Frontier Province (Peshawar); Punjab (Lahore, Kasauli); United Provinces (Agra, Lucknow); Bihar (Sirsiah); Calcutta and environs; Bombay; W. Ghats (Khandala); Central India (Gwalior); Central Provinces (Saugor, Pachmarhi); Barkuda I.; Travancore (Bheemanagar); Ceylon (Kandy). Doubtless the genus exists throughout India.

A common European genus.

*Key to the Indian species of* Nais.

| | |
|---|---|
| 1. Eyes present | 2. |
| Eyes absent | 4. |
| 2. Dorsal needles 2–4 in bundle, single-pointed | *N. obtusa.* |
| Dorsal needles 1–2 in bundle, double-pointed | 3. |
| 3. Prongs of dorsal needles comparatively long, of about equal length, set at an acute angle to each other | *N. elinguis.* |
| Prongs short, inconspicuous | *N. communis* var. *punjabensis.* |
| 4. Dorsal needles pectinate | *N. pectinata.* |
| Dorsal needles double-pronged | 5. |
| 5. Stomach present; prongs of dorsal needles short and inconspicuous | *N. communis* var. *cæca.* |
| No stomach; prongs of dorsal needles fairly obvious | 6. |
| 6. Segments of the single animal few, about 13 | *N. raviensis.* |
| Segments of the single animal comparatively numerous, about 30 or more | 7. |
| 7. Inner (proximal) prong of dorsal needles the longer | *N. paraguayensis.* |
| Prongs of dorsal needles equal in length | *N. paraguayensis* var. *æqualis.* |
| Outer (distal) prong of dorsal needles the longer. | 8. |
| 8. Outer (distal) prong of anterior ventral needles (segments ii-v) nearly twice as long as the proximal | *N. paraguayensis* var. *barkudensis.* |
| Outer (distal) prong of anterior ventral needles only slightly longer than the proximal | *N. gwaliorensis.* |

Carter (2) described a form which he called *Nais fusca* from Bombay. This is included by A. G. Bourne (19) in a systematic account of the Naididæ. Michaelsen omits it altogether from his lists of Indian Oligochæta (54, 58), though he had previously included it doubtfully under *N. josinæ* in the Tierreich volume (38). The particulars given by Carter do not permit the identification of the worm; it cannot, however, be *N. josinæ*, which has bifid needles in the dorsal bundles, since *N. fusca* has only capillary setæ there.

Schmarda (3) described a *Nais caudata*, which is thought by Michaelsen (38) to be possibly a *Dero*. Schmarda however recognizes *Dero* as a separate genus, with gills, and would have referred his worm to it had there been anything to remind him of it. *Nais caudata* is probably a *Nais* with a small rapidly formed and narrow, newly budded tail. It was found at Kandy in Ceylon.

1. **Nais communis** *Piguet.*

1906. *Nais communis*, Piguet, Rev. Suisse Zool. xiv, p. 247, pl. x, fig. 9, pl. xi, figs. 14–17 and 19, pl. xii, fig. 11.

*a.* var. **punjabensis** *Steph.*

1909. *Nais variabilis* var. *punjabensis*, Stephenson, Mem. Ind. Mus. i, p. 255, text-figs. 1–3, pls. xv–xxii, figs. 1–21.
1909. *Nais communis* var. *punjabensis*, Piguet, Rev. Suisse Zool. xvii, p. 198, text-fig.
1910. *Nais variabilis* var. *punjabensis*, Stephenson, Rec. Ind. Mus. v, p. 66, pl. viii, figs. 1–2.
1910. *Nais communis* var. *punjabensis*, Stephenson, Rec. Ind. Mus. v, pp. 237, 239, 240, pl. xi, figs. 2, 4.
1913. *Nais communis* var. *punjabensis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 737, 744, 758.
1915. *Nais communis* var. *punjabensis*, Stephenson, Tr. Roy. Soc. Edin. l, p. 786.
1918. *Nais communis* var. *punjabensis*, Stephenson, Rec. Ind. Mus. xiv, p. 12.
1920. *Nais communis* var. *punjabensis*, Stephenson, Mem. Ind. Mus. vii, p. 196.
1920. *Nais communis* var. *punjabensis*, Mehra, P. Z. S. p. 457.

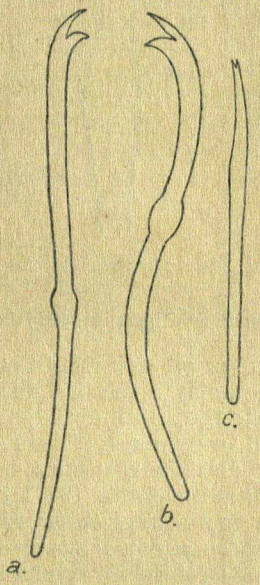


Fig. 11.—*Nais communis* var. *punjabensis*; *a*, ventral seta of an anterior bundle; *b*, ventral seta of a posterior bundle; *c*, dorsal needle.

Length 2–14 mm., average length of a single individual 5–6 mm. Colour light grey, with irregular light brown pigmentation over the most anterior segments. Segments 18–32, often about 26;

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$n = 14$–16. Eyes present. Prostomium short, rounded. Ventral setæ usually 3–5 in a bundle, extremes being 2–7; those of ii–v (text-fig. 11, *a*) in length 86–95 $\mu$, the distal prong one and a half times as long and half to two-thirds as thick at the base as the proximal, shaft thinner and less curved than in the more posterior bundles, nodulus proximal (usually only slightly so); setæ of the remaining segments (text-fig. 11, *b*) 70–80 $\mu$ long, or more in extreme cases, moderately stout, more curved than the anterior ones, distal prong slightly longer than the proximal and about half as thick at the base, nodulus distal. Dorsal bundles of 1–2 hair setæ and 1–2 needles, the length of the hairs at most equal to the diameter of the body; needles (text-fig. 11, *c*) average about 60 $\mu$ in length, are slightly sickleshaped, with a finely forked distal end (the forking may apparently rarely be absent), and an indefinite nodulus about one-third of the length from the distal end. Body-cavity with many corpuscles, which may be of two kinds, white and brown.

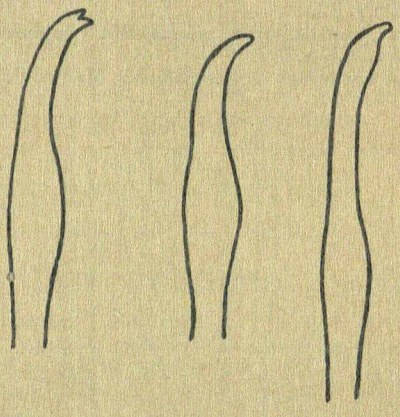

Fig. 12.—*Nais communis* Piguet var. *punjabensis*; penial setæ.

Stomach in vii or viii or vii and viii. Cerebral ganglion deeply indented behind, less deeply in front. Male funnel of fair size, turned backwards into the mouth of the sperm-sac; ectal part of vas deferens covered by "prostatic" cells, atrium approximately spherical, ejaculatory duct short, opening into a slight depression of the surface. Ovisac includes the sperm-sac. Ampulla of spermatheca at maturity a large thin-walled sac extending back into vii, contained within cavity of sperm-sac; duct not marked off externally, but lumen suddenly contracts to a fine tube with thick walls. Clitellum v–vii. Penial setæ (text-fig. 12) 90 $\mu$ long, 2–3 in bundle, stout, slightly bifid or with single blunt point.

*Remarks.* The nomenclature of this form has given some little difficulty. I at first named it *N. variabilis* var. *punjabensis*, on account of the similarity of the setæ to those of *N. variabilis*

Piguet; but an examination of the genital system by Piguet, and independently by myself, showed that the present form was closely allied to *N. communis*. See the discussion in Piguet (**56**).

The differences of this var. from the type form of the species are as follows:—In the type form the whole body is yellowish red or pale brownish; the prostomium is fairly long, twice as long as broad at the base; all the ventral setæ have a markedly longer distal prong; in the dorsal needles the forking is very easy to see (which is not at all the case in the var. *punjabensis*), and the prongs diverge almost at a right angle; the spermatheca does not appear (from the figure) to be contained in the sperm-sac in segment vi, as it is in the present form.

The thornlike projections on the dorsal hair setæ described in the original account of the worm are, as suspected by Piguet, a cryptogamic growth.

The worm has been found inhabiting tubes, probably abandoned by insect larvæ; specimens found by Annandale in Seistan were living in relatively long mucilaginous tubes, to which colonies of the Polyzoon *Lophopodella* had attached themselves.

I have used this form in an account of antiperistalsis and reversed ciliary action in aquatic Oligochætes, and have studied the relations of the contraction of the dorsal vessel and of the gut to each other (**72**). The relations of the nodulus in the setæ of the same bundle are explained in (**77**).

*Distribution.* Lahore; Peshawar; Kasauli, W. Himalayas; Agra; Khandala, W. Ghats; Bheemanagar, Travancore (in *Spongilla carteri*). Also in Seistan, E. Persia.

The type form of the species has been found as far apart as Patagonia and Switzerland.

*b.* var. **cæca** *Steph.*

1910. *Nais communis* var. *cæca*, Stephenson, Rec. Ind. Mus. v, pp. 235, 238, pl. xi, fig. 3.
1918. *Nais communis* var. *cæca*, Stephenson, Rec. Ind. Mus. xiv, p. 12.

Length about 2 mm.; segments 24–27. No eyes. Ventral setæ in bundles of two or three throughout; those of ii–v (text-fig. 13, *a*) in length 80–94 $\mu$, distal prong with slight swelling at its base and hence somewhat clawlike, one and a quarter times as long and about two-thirds as thick as the proximal; from vi onwards (text-fig. 13, *b*) 71–87 $\mu$ long, distal prong about equal to proximal in length but only about half as thick at the base. Dorsal setæ regularly one hair and one needle per bundle; the hair setæ equal to about three-quarters of the diameter of the body (preserved); the needles (text-fig. 13, *c*) 53–58 $\mu$ long, shaft straight or nearly so, prongs short, equal in length, one thicker than the other at the base.

*Remarks.* The specimens were found originally along with others of *N. communis* var. *punjabensis*, of which this is really a variety—

a variety of a variety. The essential point of difference is the absence of eyes. As the specimens were taken from a sponge, it might seem possible to correlate the absence of eyes with the absence of light; but this latter would hardly be sufficiently marked to produce such an effect, and moreover specimens of the

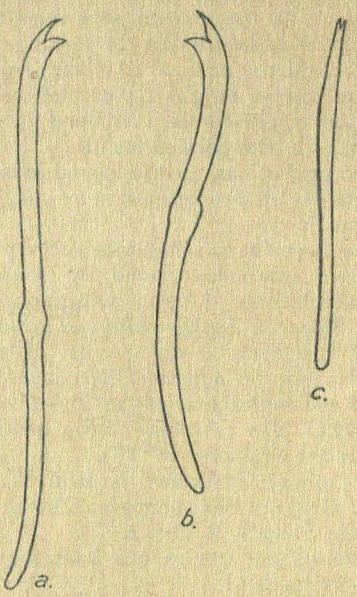


Fig. 13.—*Nais communis* Piguet var. *cæca*; *a*, ventral seta of an anterior bundle; *b*, ventral seta of a posterior bundle; *c*, dorsal needle.

more normal form, with eyes, were obtained from the same sponge. So, too, in Kasauli the two forms occur together, but here both live freely.

*Distribution.* Bheemanagar, Travancore (in *Spongilla carteri*); Kasauli, W. Himalayas.

**2. Nais elinguis** *Müll., Örst.*

1909. *Nais elinguis*, Michaelsen, Mem. Ind. Mus. i, p. 131.

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1903. *Nais elinguis*, Michaelsen, Jahrb. Hamb. wiss. Anst. xix, p. 175, fig. 4.

1906. *Nais elinguis*, Piguet, Rev. Suisse Zool. xiv, p. 241, pl. x, fig. 8, pl. xi, figs. 8–13, pl. xii, fig. 10.

Length of chains 1·2–10 mm., of single animals 2½–8 mm. Segments of a single animal 15–37; $n$=12 to 21. Colour a clear brown. Prostomium short, roundly conical. Eyes present. Ventral bundles with 2–5 bifid crotchets, distal prong longer and

thinner than the proximal; all similar in form, but those of ii–v a little longer than the rest, and with nodulus almost median, those of succeeding segments with nodulus distal. Dorsal bundles with 2–3 almost straight needles, nodulus rather more than a quarter of the distance from the distal end, tip slightly curved, ending in two fine prongs, which diverge only slightly, both fairly long, the outer or distal slightly longer; and 2–3 fairly stiff hair setæ, in length about equal to the diameter of the body, three times as long as the needles. Gut gradually widening in vii. Vascular commissures of i and ii mostly anastomosing, those of iii–v mostly independent. Male funnels turned backwards into the neck of the sperm-sac; vas deferens covered with prostatic cells; atrium rounded, with thick and muscular walls. Penial setæ 4–5 in number. Sperm-sac contained within ovisac. Ampulla of spermatheca thin-walled, duct one-third the length of ampulla, with thick walls and narrow lumen.

*Remarks.* Michaelsen records this species from Lahore; these Lahore specimens were sent by me to him; as I had never found this species in or near Lahore myself, I was inclined to believe that the specimens that actually reached Michaelsen were the ordinary *Nais* of Lahore—*N. communis* var. *punjabensis*. Dr. Annandale kindly sent all the museum specimens labelled *Nais elinguis* for me to examine; I found the specimens from Lahore to be, as I supposed, *N. communis* var. *punjabensis*, but those from Calcutta were *N. elinguis*; about those from Alipur I am very doubtful. The determination of Naididæ from spirit material is full of pitfalls; and the older diagnosis of *N. elinguis* has been shown by Piguet (**133**) to cover at least three species—*N. elinguis*, *N. variabilis*, and *N. communis*—all of which have double-pointed needles in the dorsal bundles.

*Distribution.* Calcutta, in *Spongilla carteri*; ? Alipur, near Calcutta, from colonies of *Plumatella emarginata*. Widely spread in Europe.

### 3. Nais gwaliorensis *Steph.*

1920. *Nais gwaliorensis*, Stephenson, Mem. Ind. Mus. vii, p. 198, pl. ix, figs. 3–4.

Length 2·7 mm.; diameter 0·25 mm. Segments 29 in the single animal. Prostomium bluntly triangular. No eyes. No stomachal dilatation. Dorsal bundles usually of one hair and one needle, sometimes two hairs; the hair usually rather shorter than the diameter of the body; needles (text-fig. 14, *c*) ca. 45 $\mu$ long, bent at a very obtuse angle distal to the middle, the distal section being slightly curved; length of distal section to that of proximal section :: 2 : 3; tip bifid, angle between the prongs moderately wide, outer prong slightly the longer. Ventral bundles behind segment v (text-fig. 14, *a*) 4 or 5 in bundle, 45–53 $\mu$ long and 2·5 $\mu$ thick; nodulus distal; prongs equal in length, outer only

half or two-thirds as thick as inner. In segments ii–v (text-fig. 14, *b*) the shaft is thinner and straighter, the nodulus at the

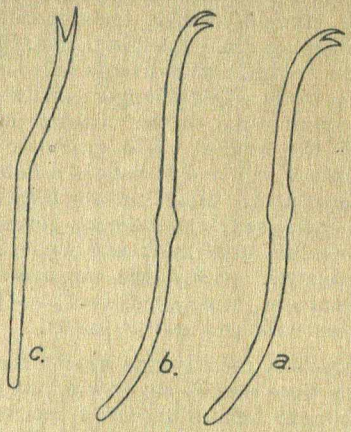


Fig. 14.— *Nais gwaliorensis* Steph.; *a*, ventral seta from a posterior segment; *b*, ventral seta from an anterior segment; *c*, dorsal needle. × 1100.

middle or slightly proximal, the outer prong is slightly longer, thinner and more hooked than the inner; 4 setæ in a bundle, length 50–56 $\mu$, thickness only 2 $\mu$.

*Distribution.* Gwalior, Central India.

4. **Nais obtusa** (*Gerv.*).

1909. *Nais obtusa*, Michaelsen, Mem. Ind. Mus. i, p. 131.

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1906. *Nais obtusa*, Piguet, Rev. Suisse Zool. xiv, p. 234, pl. x, figs. 2–4, pl. xi, fig. 5, pl. xii, fig. 8.

Length of chains 3½–6 mm., of single individuals 3–5 mm. Segments of a single animal 25–33. Colour of the anterior part yellow to brownish yellow. Prostomium fairly long. Eyes present. Ventral setæ 2–5 per bundle; those of ii–v slender, with rather longer and finer distal prong and nodulus proximal; those of the following segments shorter, about three-quarters as long as the former, thicker, more curved, prongs about equal in length but the proximal about three times as thick as the distal, nodulus distal. Dorsal bundles with 2–4 single-pointed needles with nodulus slightly distal, and 1–3 stiff hair setæ about twice as long as the needles. No vascular commissures in segment i; those of ii–iii usually with a common origin from the dorsal vessel, those of iv and v independent. Male funnel large, vas deferens covered with prostatic cells, atrium globular, ejaculatory duct narrow, male pore on rounded papilla. Penial setæ 2–3 in number. Ectal region of spermatheca with thick and muscular walls, about one-third the length of the whole (empty) organ, marked off from the ampulla by a constriction, below which it is swollen; ampulla

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when empty an elongated sac, narrower behind, when distended invades the dorsal regions of neighbouring segments.

*Distribution.* Lucknow; Calcutta, from *Plumatella fruticosa* and *P. emarginata* in a tank at the Zoological Gardens. A common European form.

### 5. Nais paraguayensis *Mich.*

1909. *Nais paraguayensis*, Michaelsen, Mem. Ind. Mus. i, p. 131.
1909. *Nais paraguayensis*, Stephenson, Mem. Ind. Mus. i, p. 263, pl. xvii, figs. 22–24.
1920. *Nais paraguayensis*, Stephenson, Mem. Ind. Mus. vii, p. 197, pl. ix, fig. 1.
1921. *Nais paraguayensis*, Stephenson, Rec. Ind. Mus. xxii, p. 750.

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1905. *Nais paraguayensis*, Michaelsen, Zoologica, xviii, Heft 44, p. 354, text-fig.

Length of single animal 3·5–14 mm. preserved; Indian specimens may be as much as 20 mm. living and extended; diameter 0·2–0·3 mm. Segments 29–106. Colour light orange. Prostomium short, rounded. Anus directed dorsally. No eyes. Ventral setal bundles with 3–6 crotchets, those of ii–v scarcely thinner than the rest, with distal prong slightly longer than the proximal, and



Fig. 15.—*Nais paraguayensis* Mich.; dorsal needle.

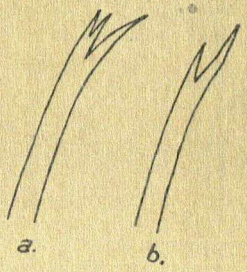


Fig. 16.—*Nais paraguayensis* Mich.; abnormally shaped dorsal needles.

both of the same thickness or the distal thinner; in the remaining segments distal prong of equal length with and thinner than the proximal. Dorsal bundles with 1–2 hair setæ and 1–2 needles; the hairs simple, their maximum length equal to diameter of body (0·3 mm.); needles (text-fig. 15) slightly sickleshaped, closely

applied to the base of the hairs, 60 $\mu$ long and 4 $\mu$ thick, with faint nodulus distal to middle, tip with two prongs of considerable size at an acute angle, proximal rather curved, almost twice as long and twice as thick as the distal which is almost straight. Cœlomic corpuscles present. No stomach. Vascular commissures plexiform.

*Remarks.* The species was found originally, as the name implies, in Paraguay; it furnishes an instance of the wide distribution, and hence valuelessness for zoogeography, of these small freshwater forms.

The Indian specimens have been much larger than the original ones from Paraguay, and have had many more segments. The hinder end of the body in these long Indian worms shows a considerable length of rapidly produced new segments. Fission has not been observed; possibly the worm fragments, without previous formation of a budding zone, and regeneration of the portions takes place subsequently (Stephenson, 96). Irregularities may occur in the shape of the dorsal needles (text-fig. 16).

*Distribution* in India:—Calcutta (Museum Tank); Sirsiah, Bihar; Lahore; Gwalior, Central India; Pachmarhi, Central Provinces.

*a*, var. æqualis *Steph.*

1920. *Nais paraguayensis* var. *æqualis*, Stephenson, Mem. Ind. Mus. vii, p. 197, pl. ix, fig. 2.



Fig. 17.—*Nais paraguayensis* Mich. var. *æqualis*; dorsal needle. × ca. 1200.



Fig. 18.—*Nais paraguayensis* Mich. var. *barkudensis*; dorsal needle. × 800.

Length 3·5 mm. (preserved); diameter 0·23 mm. Segments 34. Prostomium moderately large and long. Dorsal bundles of one hair and one needle seta; prongs of needle (text-fig. 17) equal in

length. For the rest appears to be essentially as for the type form (the material was scanty and not perfectly satisfactory).

*Distribution.* Saugor, Central Provinces.

*b.* var. **barkudensis** *Steph.*

1921. *Nais paraguayensis* var. *barkudensis*, Stephenson, Rec. Ind. Mus. xxii, p. 751, pl. xxviii, fig. 1.

Length probably about 5 mm. Anterior end rather bulbous. No eyes. No stomachal dilatation. Segments 31–33 *plus* a posterior zone of small rapidly produced segments. Dorsal setæ in bundles of two or three needles and two or three hairs; the hairs rather shorter than the diameter of the body; the needles (text-fig. 18) 94 $\mu$ long, with slight sabre-like curve, nodulus one-third of the length from distal end, tip bifid, the prongs at an acute angle to each other, the outer slightly longer. Ventral needles of segments ii–v four per bundle, 100 $\mu$ long, nodulus proximal, distal prong nearly twice as long as proximal, and of about equal thickness. In the remaining segments 4–5 per bundle, length 90 $\mu$, nodulus distal, prongs equal, the proximal one and a half times as thick as the distal.

*Remarks.* The difference of this variety from the type of the species is considerable, and it is only the existence of the var. *æqualis* as an intermediary that permits of its inclusion in the same species. Indeed the difference in length of the prongs of the anterior ventral needles may still justify its separation. The large number of rapidly produced posterior segments is, however, suggestive of a relation to the type form of the species.

*Distribution.* Barkuda Island, Chilka Lake.

6. **Nais pectinata** *Steph.*

1910. *Nais pectinata*, Stephenson, Rec. Ind. Mus. v, p. 236, pl. xi, fig. 1.

1920. *Nais pectinata*, Stephenson, Mem. Ind. Mus. vii, p. 198.

Length of single individual (preserved) about 2 mm. Segments 27–31. No eyes. Prostomium well marked, conical with rounded tip. Ventral setæ of ii–v (text-fig. 19, *a*) three per bundle, 56 $\mu$ long, thinner and less curved than those of following segments; distal prong one and a quarter times as long and about half as thick as the proximal, both prongs comparatively short, slightly swollen near their bases, nodulus proximal; those of the remaining segments (text-fig. 19, *b*) 2–5 per bundle, 51–56 $\mu$ in length, the longer ones towards the hinder end of the body, distal and proximal prongs equal in length, the proximal fully twice as thick as the distal, both with a slight swelling at the base, nodulus distal. Dorsal setæ in bundles of one hair and one needle seta; the hairs smooth, about equal in length to the diameter of the body; needles (text-fig. 19, *c*) 56 $\mu$ long, shaft slightly sickleshaped in its distal third, tip pectinate, the outer prongs on each side the strongest, the

intermediate prongs fine, 2–5 in number, nodulus indistinct, resembling a slight angle in the shaft at the junction of middle

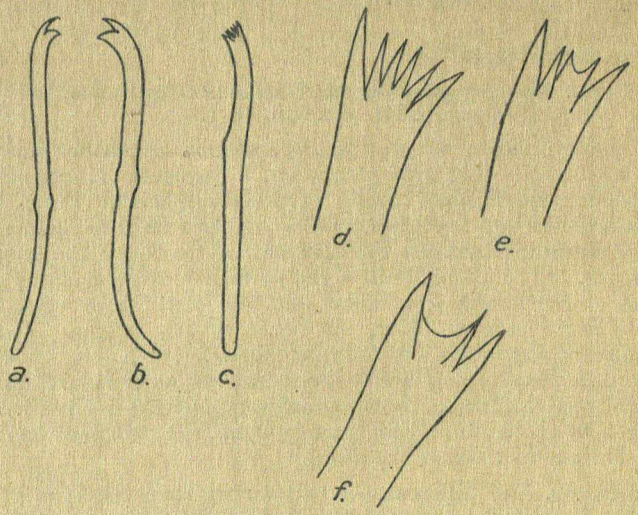


Fig. 19.—*Nais pectinata* Steph.; *a*, ventral seta from an anterior bundle; *b*, ventral seta from a posterior bundle; *c*, dorsal needle; *d*, *e*, *f*, irregular shapes of the tip of dorsal needles.

and distal thirds; occasionally irregular forms with partial webbing between the teeth (text-fig. 19, *d*, *e*, *f*). No stomach.

*Distribution.* Bheemanagar, Travancore (in *Spongilla carteri*); Gwalior, Central India.

*a.* var. **inæqualis** *Steph.*

1911. *Nais pectinata* var. *inæqualis*, Stephenson, Rec. Ind. Mus. vi, p. 208, text-fig. 2.

1920. *Nais pectinata* var. *inæqualis*, Mehra, P. Z. S. pp. 457, 458, text-figs. 1 A, 2.

Length as for type form (preserved); or 8–10 mm., even (extended) 15–18 mm. living. Segments 40–95. Ventral setæ 4–6 per bundle, ca. 100 $\mu$ long in the anterior (ii–v) segments, 90 $\mu$ in the remainder, or (in other specimens) 60–65 $\mu$ long throughout; in the anterior group distal prong one and a half times as long and two-thirds as thick as the proximal; nodulus only slightly proximal in anterior and slightly distal in posterior group. Dorsal bundles may contain one hair and two needles, or two of each, but usually one of each; dorsal hairs 300–330 $\mu$ long, or one may be more than double as long as the other—250 and 100 $\mu$; in sexual specimens begin in viii or ix; needle setæ (text-fig. 20) ca. 110 $\mu$ or (in other specimens) ca. 70 $\mu$ long, pectinate, the tooth on the inside of the slight curve at the distal end of the shaft being much thicker and longer than the others; no nodulus. Cœlomic corpuscles present. Gut somewhat swollen in vi–viii. Dorsal

vessel on left side of alimentary tube from hinder end to septum 5/6; lateral commissures 4 pairs, plexiform, in pharyngeal region (ii-v), commissures on anterior faces of septa for several segments further. Cerebral ganglion deeply indented in front and behind. Male funnels turned back into mouth of seminal vesicle; vas deferens enters atrium low down on anterior face; atrium ovoid with long axis vertical, no "prostatic" cells. Ovisac surrounds sperm-sac, may reach xvi; female funnels small, opening externally

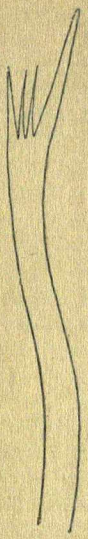

Fig. 20.—*Nais pectinata* Steph., var. *inæqualis*; dorsal needle.

about level of 6/7, apparently too small to be functional. Spermathecal ampulla ovoid, duct arises anteriorly. Clitellum occupies more than half of v, vi, vii, and viii. Penial setæ 4–6 per bundle, 100 $\mu$ long, tip hooked, not bifid as a rule, occasionally with two short prongs, blunt and of equal length. Alimentary canal degenerates in the fully mature individual; such specimens separate off the anterior portion with genital organs (=cocoon).

*Distribution.* Agra; Bheemanagar, Travancore (in *Spongilla carteri*, along with the type-form of the species).

### 7. Nais raviensis *Steph.*

1914. *Nais raviensis*, Stephenson, Rec. Ind. Mus. x, p. 324, text-figs. 1–2.
1915. *Nais raviensis*, Stephenson, Tr. Roy. Soc. Edin. l, p. 785.

Minute worms, the length of a chain of two being only 3 mm.; diameter 0·12 mm. Colour whitish. Prostomium short and blunt. No eyes. Segments in a double animal about 26, 13 in each half; $n$=13. Ventral setæ 3–4 per bundle; those of ii–v (text-fig. 21, *a*) of a maximum length of 90 $\mu$, breadth 2·2 $\mu$, prongs enclosing a narrow angle, equal in thickness, the distal considerably

longer; shaft comparatively straight, nodulus markedly proximal; those of succeeding segments (text-fig. 21, *b*) shorter, stouter, more curved, maximum length 48 $\mu$, thickness 2·5 $\mu$, prongs short, included angle wide, proximal prong slightly longer and twice as thick, nodulus distal. Dorsal setæ as a rule one hair and one needle per bundle, occasionally two needles; the hairs short and fine, 83 $\mu$ long; the needles (text-fig. 21, *c*) double-pronged,

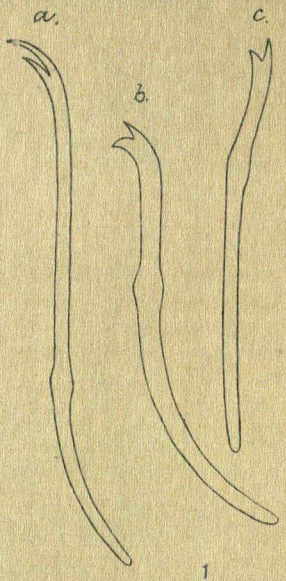


Fig. 21.—*Nais raviensis* Steph.; *a*, ventral seta from an anterior bundle; *b*, ventral seta from a posterior bundle; *c*, dorsal needle. *a* ×830; *b* ×1150; *c* ×1350.

40 $\mu$ long, shaft almost straight, slightly curved distally, the prongs short and stout, separated by a considerable angle, and of equal length, nodulus two-sevenths from the distal end. No cœlomic corpuscles. No stomach. Anus dorsal. Cerebral ganglion large, markedly bifid behind.

*Distribution.* Lahore (weeds etc. from R. Ravi).

### 3. Genus **NAIDIUM** *O. Schm.*

1884. *Naidium*, Vejdovsky, Monog. pp. 25, 31.
1895. *Pristina* (part.), Beddard, Monog. p. 289.
1901. *Naidium*, Michaelsen, Tier. x, p. 23.
1906. *Naidium*, Piguet, Rev. Suisse Zool. xiv, p. 215.
1909. *Pristina* (part.), Michaelsen, Süsswasserf. Deutsch. p. 25.
1913. *Naidium*, Piguet, Olig. Suisse, p. 24.

Prostomium rounded or pointed Ventral setal bundles composed of double-pointed crotchets; dorsal bundles beginning in ii, composed of hair setæ and double-pointed needles.

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*Relationships of the genus.*—Apart from possible differences in the genital organs, the only definite distinction from the genus *Pristina* appears to be the presence in the latter of a long proboscis—an extremely elongated prostomium. Beddard, and more recently Michaelsen, have united the two under the name *Pristina*; Piguet retains them as distinct on account of differences in the setæ, the circulation, the intestine, and the general physiognomy (what these differences are is not particularized). They resemble each other, however, in the fact that the second animal of a chain derives the first seven segments of its body from the budding zone (if we may generalize from the two Indian species—we lack information regarding others); while, so far as is known, no more than five segments are so derived in any other genus of the family. The genital organs are unfortunately not known in any species of *Naidium*, so that a comparison cannot be made with *Pristina* in this respect. A description of the genital organs in a species of *Naidium* would be valuable.

An intermediate form between the genera *Naidium* and *Nais* is perhaps seen in *Naidium* (?*Nais*) *dadayi* Michaelsen (**122**, p. 355, and see remarks by Piguet, **134**, p. 24). In this species the dorsal setæ begin sometimes in v, sometimes further forward, even in ii; it might therefore be either a *Nais* with setæ abnormally developed on the anterior segments, or a *Naidium* with setæ abnormally absent on these segments. Unfortunately none of the specimens showed a budding zone, and therefore the number of anterior segments which are derived from it is not known; this would have cleared up the uncertainty. The single-pointed needles of the dorsal bundles; the sharp division of the ventral setæ into two groups, the anterior group comprising those of segments ii–v (characteristic of most species of *Nais*); and the fact that setæ may occasionally occur in other genera where normally they are absent (*e. g.* on segment iii in *Chætogaster langi*, v. ant.), lead me to think that this species should be placed under *Nais*.

*Distribution.* In India so far only recorded from Lahore and Madras. A common European genus; no doubt it will be found widely distributed in India when the freshwater fauna is better known.

*Key to the Indian species of* Naidium.

1. Length more than 8 mm.; *n* about 22 ..... *N. breviseta.*
   Length 2 mm.; *n*=12 ..... *N. minutum.*

1. **Naidium breviseta** (*A. G. Bourne*).

1891. *Pristina breviseta*, Bourne, Quart. J. Mic. Sci. xxxii, p. 353, pl. xxvii, figs. 11–15.

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1895. *Pristina breviseta*, Beddard, Monog. p. 292.
1901. *Naidium breviseta*, Michaelsen, Tier. x, p. 23.
1906. *Naidium breviseta*, Piguet, Rev. Suisse Zool. xiv, p. 216.

Length more than 8 mm. Segments in a single animal may be

46 or more, of a chain more than 76; $n=22$ as a rule. Prostomium somewhat drawn out as a blunt, short tentacle-like proboscis. No eyes. Dorsal setæ of two kinds; hair setæ of about the same length throughout the body, except that those of ii are about half, those of iii three-quarters as long as those which follow; and needles, somewhat bayonet-shaped, bifid at the tip, prongs about equal. Ventral setæ of the ordinary crotchet form. Cœlomic corpuscles black and very noticeable. First nephridium in ix. The newly-budded head consists of seven segments.

*Remarks.* Michaelsen, in his two lists of Indian species (**54**, **58**), calls this worm *Pristina breviseta*, in consequence of his decision to unite the two genera. In any case, this species shows the first stage in the lengthening of the prostomium which leads to the characteristic tentacle of the typical Pristinas.

*Distribution.* Madras.

2. **Naidium minutum** *Steph.*

1914. *Naidium minutum*, Stephenson, Rec. Ind. Mus. x, p. 327, text-figs. 3–5.
1915. *Naidium minutum*, Stephenson, Tr. Roy. Soc. Edin. l, p. 786.

Minute worms, length of a chain of two, moderately extended, 2 mm.; thickness 0·1 mm. Seen by reflected light against a black



Fig. 22.—*Naidium minutum* Steph.; dorsal needle. × 1600.

background often marked by spots or transverse bands of a brilliant opaque white (masses of cœlomic corpuscles). Prostomium longer than its breadth at base, tip rounded. No eyes. Segments of double animal (excluding those of the budding zone) 17–19; $n=12$. First six segments all short, the rest much

longer. Dorsal bundles of one hair and one needle, the hair very slender, 80–90 $\mu$ long (rather less than the diameter of the body); needles (text-fig. 22) 35 $\mu$ long, with slight double curve, distal end forked, the prongs about equal in length, set at a fairly wide angle, a slight nodulus one-third of the length of the shaft from the distal end. Ventral setæ 3–5 per bundle, usually 3; no sharp division between anterior and posterior groups; each 30–40 $\mu$ long, nodulus usually distal; prongs equal in length or the distal slightly longer. Cœlomic corpuscles numerous, opaque as seen by the low power, by the high power seen to consist of aggregations of minute oildrops; nucleated, circular, 6–13 $\mu$ in diameter. Septal glands in iv and v, sometimes also in iii or vi. Stomach in vii. First nephridium in ix, the next in xi, and no more in the anterior animal of a chain. Cerebral ganglion slightly bifid behind, the anterior border concave. Six seta-bearing segments interpolated in the budding zone at the anterior end of the second animal.

*Distribution.* Lahore (R. Ravi).

## 4. Genus **PRISTINA** *Ehrbg.*

Prostomium prolonged into a mobile proboscis. Ventral bundles consisting of bifid crotchets. Dorsal bundles beginning in ii, consisting of hair setæ and needles with simple or bifid point. Stomach in viii. Genital apparatus occupying vii and viii (the organs being two segments further back than in the other genera of the family in which they are known). Seven segments intercalated in the budding zone at the anterior end of the second animal.

For relations to the genus *Naidium*, *v. ant.* under the latter genus. The larger number of segments added to the head of the posterior animal in the budding zone seems to be related to the more posterior position of the genital organs in the genus (*cf. ant.* p. 45).

I have used the phenomena seen in the Lahore species in a discussion on ascending ciliary action in the intestine and antiperistalsis in Annelids (72).

*Distribution.* Calcutta; Lahore; Allahabad; Agra; Bombay; Bheemanagar, Travancore. Also in Europe and N. America.

*Key to the Indian species of* Pristina.

| | | |
|---|---|---|
| 1. | Hair setæ of iii much elongated ..... | *P. longiseta.* |
| | Hair setæ of iii not longer than those of other segments ..... | 2. |
| 2. | Ventral setæ of segments ii-iv increasing in stoutness, those of iv markedly stout..... | *P. æquiseta.* |
| | Ventral setæ of ii-iv diminishing in stoutness from in front backwards ..... | *P. proboscidea.* |

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1. **Pristina longiseta** *Ehrbg.*, f. **typica.**

1909. *Pristina longiseta*, Michaelsen, Mem. Ind. Mus. i, p. 135.
1909. *Pristina longiseta*, Stephenson, Mem. Ind. Mus. i, p. 264, text-fig. 4, pl. xvii, fig. 25, pl. xviii, figs. 26–33, 38.
1909. *Pristina longiseta*, Piguet, Rev. Suisse Zool. xvii, pp. 212, 216.
1910. *Pristina longiseta*, Stephenson, Rec. Ind. Mus. v, p. 325.
1913. *Pristina longiseta*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 739, 744.
1916. *Pristina longiseta*, Stephenson, Rec. Ind. Mus. xii, p. 304.
1920. *Pristina longiseta*, Stephenson, Mem. Ind. Mus. vii, p. 199.
1920. *Pristina longiseta*, Mehra, P. Z. S. p. 457.

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1884. *Pristina longiseta*, Vejdovsky, Monog. p. 31, pl. ii, figs. 13–15.
1895. *Pristina longiseta*, Beddard, Monog. p. 290.
1906. *Pristina longiseta*, Piguet, Rev. Suisse Zool. xiv, p. 290, pl. x, figs. 22–23, pl. xii, figs. 21–25.
1913. *Pristina longiseta*, Piguet, Olig. Suisse, p. 50.

Length of single individual 3·5–5·5 mm., of chains 3–6 mm. Segments of single animal 20–33; $n$=12–22. Colour whitish. No eyes. Ventral bundles with a maximum of 9 crotchets, with distal prong longer than the proximal; those of ii and iii longer

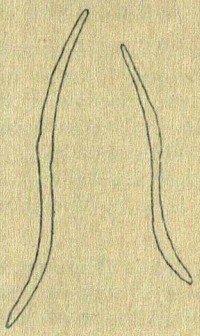

Fig. 23.—*Pristina longiseta* Ehrbg.; penial setæ.

than the rest; those of ii slenderer than those of iii, and with nodulus proximal or almost at the middle of the shaft; from iii onwards nodulus distal; from iv onwards setæ shorter and slenderer. Dorsal setæ in bundles of 2–5 straight and finely-pointed needles without nodulus, and 1–4 hair setæ about equal to the diameter of the body in length, with a fine dentation on the convex border; those of iii, however, smooth and much elongated, 3–4 times as long as those of neighbouring segments, and when turned forwards extending beyond the end of the proboscis. Cœlomic corpuscles present. Stomach in viii. Septal glands in iv–vi. Six pairs of vascular commissures in ii–vii, the first and second sometimes united by anastomosis, and the last swollen as hearts. Cerebral ganglion deeply indented in front and behind. Male funnels large, rounded, with borders slightly reflected; vas deferens with very thick walls and glandular epithelium, ascending

at first and then descending, the lumen in its downward course swollen to form an atrium; ejaculatory duct short. Spermathecæ in the form of a long sac, ending by a thickened portion which is not differentiated externally. Penial setæ (text-fig. 23) 2 per bundle, in vi. No prostatic cells; a special gland in connection with the penial setæ.

*Remarks.* The degree of serration of the dorsal setæ (of all except the elongated setæ of iii) varies; in the f. *typica*, the form found in India, it is slight or very slight, while the var. *leidyi* (*Pristina leidyi* Michaelsen, 122) has roughly serrated dorsal setæ.

The limits of *n* are apparently wider in Lahore than in Europe (12–22; European specimens 13–18).

I have ascribed a special sensory function to the elongated dorsal hairs of segment iii (55) on account of their frequent quivering movements. According to my observations the septal glands are variable in number. The nephridia commence in ix, which is probably a generic character, correlated with the fact that seven segments are added to the head of the posterior animal in the budding zone.

I believed that in one specimen (55, pl. xviii, fig. 34) I found the setæ of the fourth segment, not the sixth, modified as genital setæ; moreover, the modification was not that usually found in the setæ of vi. This Piguet (56) has shown to be a mistake, the specimen being one of *P. æquiseta*.

*Distribution.* Calcutta, in *Spongilla crassissima*, and from colonies of *Plumatella fruticosa* and *P. emarginata* (oral communication from Dr. Annandale, emending the original statement); Lahore; Bheemanagar, Travancore (on or in *Spongilla carteri*); Bombay; Gwalior, Central India. Widely distributed in Europe; found also in N. America.

2. **Pristina æquiseta** *A. G. Bourne.*

1909. *Pristina tentaculata*, Michaelsen, Mem. Ind. Mus. i, p. 134.
1909. *Pristina æquiseta*, Stephenson, Mem. Ind. Mus. i, p. 269, text-fig. 5, pl. xviii, fig. 34.
1909. *Pristina æquiseta*, Piguet, Rev. Suisse Zool. xvii, pp. 212, 216.
? 1915. *Pristina æquiseta*, Stephenson, Tr. Roy. Soc. Edin. l, p. 786.
1916. *Pristina æquiseta*, Stephenson, Rec. Ind. Mus. xii, p. 304.

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1891. *Pristina equiseta*, Bourne, Quart. J. Mic. Sci. xxxii, p. 352.
1895. *Pristina equiseta*, Beddard, Monog. p. 291.
1906. *Naidium tentaculatum*, Piguet, Rev. Suisse Zool. xiv, p. 219, pl. ix, figs. 18–20 & 26.
1913. *Pristina æquiseta*, Piguet, Olig. Suisse, p. 52.

Length of both single individuals and chains about the same, 2–3 mm. Segments of the single individual 18–23; $n$=12–15. Colour whitish. No eyes. Ventral bundles of 2–6 crotchets, those of ii 4–5 in number, straighter, slenderer, and a little longer than the rest, with distal prong strongly curved and notably

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longer than the proximal, nodulus slightly proximal; those of iii 4–5 in number, stouter, more curved, and a little shorter than those of ii, distal prong a little longer than the proximal, nodulus here and henceforward slightly distal; those of iv (text-fig. 24) or iv and v fewer in a bundle, much larger, longer, and thicker, might almost be called giant setæ, with a more or less rudimentary proximal prong; in vi and following segments setæ are similar to but rather slenderer than those of iii. Dorsal bundles with one or more rarely two fine needles, the distal end slightly curved, without nodulus, the tip bifid with the teeth very small and equal; and one or more rarely two hairs (and then one considerably

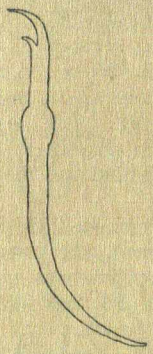

Fig. 24.—*Pristina æquiseta* A. G. Bourne; seta from ventral bundle of segment iv.

longer than the other), somewhat longer than the diameter of the body. Stomach in viii. Three pairs of septal glands in iii–v, the posterior pair sometimes wanting. Six pairs of vascular commissures in ii–vii, those of vi and especially those of vii larger than the rest.

*Remarks.* The synonymy of this form has given a good deal of trouble. It was originally described by Bourne from a *Victoria regia* tank in London in 1891. In 1896 Beddard described from Valparaiso a form which he named *Pristina proboscidea*; the account was somewhat scanty, and Michaelsen in the Tierreich volume considered it as possibly identical with Bourne's worm. In 1905, Michaelsen examined Beddard's originals on the occasion of investigating a similar worm from Paraguay and Java, and thus settled the characters of *P. proboscidea* (**121**). But Bourne's original account of *P. æquiseta* was by no means full, and Michaelsen was still in doubt as to the identity of the two forms. So too in 1909, on meeting *P. proboscidea* again, this time from India (**54**), he continued to regard *P. æquiseta* as a doubtful synonym.

Piguet had meanwhile described in Europe a form which he called *Naidium tentaculatum* (**133**); this he subsequently recognized as identical with Bourne's worm (**56**); but Michaelsen, meeting

with specimens of Piguet's species from India (**54**), preferred to retain for them the name *P. tentaculata*. In his list of Indian worms of 1910 (**58**), however, he calls the two Indian species *P. proboscidea* and *P. æquiseta*.

In 1909 (**55**) I gave an inadequate description of certain worms from Lahore under the name *P. æquiseta*; these Piguet (**56**) agrees (from the figure of the setæ of segment iv) are rightly named. Specimens which I received from Calcutta, described in 1911 (**61**), agreed with Michaelsen's revised diagnosis of *P. proboscidea*; and some which were obtained from Allahabad, which I examined in 1916 (**81**), agreed with Piguet's *N. tentaculatum*, and were therefore labelled as *P. æquiseta*.

Michaelsen thinks he has seen a fine serration on the dorsal hair setæ with the highest powers.

*Distribution.* Calcutta (in *Spongilla carteri*); Lahore; Allahabad. Also found in Europe.

### 3. Pristina proboscidea *Bedd.*, f. typica.

1909. *Pristina proboscidea* f. *typica*, Michaelsen, Mem. Ind. Mus. i, p. 133.
1911. *Pristina proboscidea* f. *typica*, Stephenson, Rec. Ind. Mus. vi, p. 211.

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1896. *Pristina proboscidea*, Beddard, Ergeb. Magalh. p. 4, fig. 18.
1905. *Pristina proboscidea* f. *typica*, Michaelsen, Zoologica, xliv, p. 359.

Length 2–5 mm.; diameter ca. 0·25 mm. Segments 18–36; $n=16$. Proboscis of varying length, from somewhat longer than the proper prostomium to nearly three times as long. No eyes. Ventral bundles with 3–5 or more, even as many as 8, bifid crotchets, those of ii much stouter than those of the middle and hinder parts of the body; in ii 3 $\mu$ thick, in iv 1·5 $\mu$ thick, in iii intermediate; distal prong of ventral setæ somewhat or much longer than the proximal, especially in ii. Dorsal bundles beginning in ii, with 1–3 or rarely 4 finely serrated hair setæ, in part somewhat longer, in part shorter than the diameter of the body; serrations in the middle of the shaft about 6 $\mu$ apart; the hair setæ of iii not specially elongated. Also in the dorsal bundles about the same number of small needle setæ, with simple pointed end. Septal glands in iii–v. First nephridium in ix.

For discussion as to synonymy, see under preceding species.

*Distribution.* Calcutta (in *Spongilla crassissima* and *S. carteri*, also living freely). Recorded also from Zanzibar, Chile (Valparaiso), Paraguay, and Java.

#### *a.* var. paraguayensis *Mich.*

1909. *Pristina proboscidea* var. *paraguayensis*, Michaelsen, Mem. Ind. Mus. i, p. 134.

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1905. *Pristina proboscidea* var. *paraguayensis*, Michaelsen, Zoologica, xliv, p. 360.

As for the f. *typica*, with the following exceptions:—Hair setæ of the dorsal bundles of very various lengths, some three times (up

to 0·55 mm.) as long as the diameter of the body, especially in the hinder segments; serrations of the hair setæ coarse, visible with comparatively low magnifications, in the middle of the seta about 11$\mu$ apart.

*Remarks.* The Indian specimens are described by Michaelsen as possessing the characters of the variety in a marked degree, some of the hair setæ being nearly four times the diameter of the body in length, and the serrations being very distinct.

There are transitions between the ordinary degree of serration and that characteristic of the variety (Michaelsen, **121, 122**).

*Distribution.* Calcutta (from colonies of *Plumatella fruticosa* and *P. emarginata*). Also in Paraguay.

### 5. Genus **BRANCHIODRILUS** *Mich.*

1890. *Chætobranchus*, Bourne, Quart. J. Mic. Sci. xxxi, p. 83.
1891. *Chætobranchus*, Bourne, Quart. J. Mic. Sci. xxxii, p. 355.
1895. *Chætobranchus*, Beddard, Monog. p. 301.
1909. *Branchiodrilus*, Michaelsen, Tier. x, p. 23.
1910. *Lahoria*, Stephenson, Rec. Ind. Mus. v, p. 59.
1912. *Lahoria*, Stephenson, Tr. Roy. Soc. Edin. xlviii, p. 285.
1912. *Brachiodrilus* (laps.), Stephenson, Rec. Ind. Mus. vii, p. 228.

Prostomium rounded. A pair of dorso-laterally placed branchial processes on many or most of the body segments, beginning immediately or at a short distance behind the mouth. Dorsal setæ beginning in the same segment as the gills, of two kinds, capillary and needles; the former, in a number of the anterior segments, enclosed in the gills. Ventral setæ crotchet-shaped, forked distally.

The genus has so far been found only in India. It is one of the few genera of Oligochætes which possess gills; the relation of the gills to the hair setæ of the dorsal bundles is quite peculiar.

The three species show stages in the origin of cephalization, and I have used them in a discussion of this phenomenon (**68**, pp. 229 *seq.*). *B. semperi* may be considered as the primitive member of the genus; there is no budding zone, and the dorsal setæ begin in segment ii; with the production of a budding zone before the two animals separate there comes into existence at the anterior end of the second animal a region of newly-formed segments in which dorsal setæ do not develop, though ventral setæ do; this region is of variable extent in *B. menoni*, while in *B. hortensis* its extent and characters have become fixed. It is evident that the condition of cephalization has been produced in *Branchiodrilus* independently of the other genera of Naididæ.

Before *B. menoni* was known, the presence of cephalization in *B. hortensis* and its absence in *B. semperi* seemed to warrant generic separation; and hence the former was given the generic name *Lahoria*. But with the discovery of *B. menoni*, an intermediate form which bridges over the gap in regard to this character, it became necessary to unite all three in the same genus.

I have recently recorded the genus from Lucknow (**93**), but have not identified the species; and from Burhanpur in the Central Provinces (**96**), the fragment being specifically indeterminable.

*Distribution.* Madras; Lahore; Lucknow; Burhanpur, C.P.

*Key to the Species of* Branchiodrilus.

| | |
|---|---|
| 1. No zone of budding; dorsal setæ begin in segment ii. . | *B. semperi.* |
| Budding zone slight or absent; a varying number of setal bundles ventrally (up to four pairs) in front of the first dorsal setæ ..... | *B. menoni.* |
| Budding zone well marked; dorsal setæ begin on segment vi (occasionally v) ..... | *B. hortensis.* |

1. **Branchiodrilus semperi** (*A. G. Bourne*).

1890. *Chætobranchus semperi*, Bourne, Quart. J. Mic. Sci. xxxi, p. 83, pl. xli.
1895. *Chætobranchus semperi*, Beddard, Monog. p. 302.
1900. *Branchiodrilus semperi*, Michaelsen, Tier. x, p. 24.
1912. *Branchiodrilus semperi*, Stephenson, Rec. Ind. Mus. vii, p. 228.

Length ca. 37–50 mm., diameter 0·5 mm. Segments ca. 130. Anterior end a little thinner, slightly pigmented in transverse bands segmentally arranged. No eyes. Branchial processes dorso-lateral, one pair on each of the anterior segments, commencing with the second; 60–70 pairs, the first five or six a little shorter than the next, diminishing in size after the first ten or twelve until they become mere warts; the longest several times as long as the diameter of the body. The processes are hollow projections of the body-wall, ciliated, with a loop of the lateral vessel of the segment in each of the first 50 or so. Dorsal setæ within the branchial processes, all in the more anterior, some only in the hinder segments; begin in ii; of two kinds, hair and needle setæ; two or three of each kind in each bundle as a rule, but the sickle-shaped needles absent from the more anterior dorsal bundles; hairs very long in the anterior segments. Ventral setæ crotchet-shaped, nodulus rather distal; 4–6 per bundle; in anterior segments outer prong twice as long as inner, behind this the inner twice as long as outer, and the angle between the two wider. Cœlomic corpuscles rounded, with olive-green granules. Lateral commissures a pair to each segment. No stomachal dilatation. Asexual division without the production of a budding zone.

*Remarks.* The worm does not secrete any glutinous material in the form of a tube, but it makes for itself long tracks in the mud, and each appears to reside in its own burrow, which, unless disturbed in some way, remains as a permanent structure.

*Distribution.* Madras, in mud from a tank.

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**2. Branchiodrilus menoni** *Steph.*

1912. *Branchiodrilus menoni*, Stephenson, Rec. Ind. Mus. vii, pp. 219, 229, text-figs. 1–3, pl. xi, figs. 1–6.
1921. *Branchiodrilus menoni*, Stephenson, Rec. Ind. Mus. xxii, p. 752.

Length (preserved) 8–15 mm.; segments up to 130. Prostomium short, rounded; no eyes. Anterior part of body pigmented dorsally and laterally, irregularly in front of gills, then in segmental bands for a few segments, soon disappearing. A short prebranchial region between first gills and mouth, which may or may not present a series of ventral setal bundles (up to four pairs). Gills diminishing in size behind, and ending some distance in front of posterior end; longest gills two and a half times the length of the diameter of the body. Dorsal setæ of two kinds, capillary and needles; capillary alone in the most anterior segments, one or two per bundle, beginning with and enclosed in the gills, slenderer than those behind; capillary setæ cease to be enclosed in gills at some point in front of segment xxx, thence projecting freely, stouter, from this point usually one per bundle. Needles (text-fig. 25) begin from the point where hair setæ cease



Fig. 25.– *Branchiodrilus menoni* Steph.; dorsal needle seta, × ca. 375.

to be enclosed in the gills; one per bundle, length 0·1 mm., usually bayonet-shaped, finely pointed, supporting the base of the hair seta, projecting from the surface only slightly. Ventral setæ usually three per bundle, of three types; in prebranchial region 77–87$\mu$ long, remarkably slender, with delicate prongs, nodulus proximal to middle of shaft; in anterior branchial region 100–116$\mu$ long, slender, distal prong one and a half times as long as proximal, nodulus at middle or somewhat proximal; behind this the shaft relatively stout, 110–140$\mu$ long, prongs equal or distal slightly longer, nodulus distal; in all setæ the distal prong is only about half as thick as the proximal. No stomach. Dorsal vessel on left side of gut. Asexual reproduction without or almost without previous formation of a budding zone.

*Distribution.* Madras.

### 3. Branchiodrilus hortensis (*Steph.*). (Text-fig. 26.)

1910. *Lahoria hortensis*, Stephenson, Rec. Ind. Mus. v, p. 59, text-figs. 1–3, pl. vii, figs. 1–3.
1912. *Branchiodrilus hortensis*, Stephenson, Rec. Ind. Mus. vii, p. 229.
1913. *Branchiodrilus hortensis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 738, 744, 760.
1920. *Branchiodrilus hortensis*, Mehra, P. Z. S. pp. 457, 458, 463, text-figs. 1 B, 3.

Length 16–25 mm.; diameter 0·5–0·75 mm. Segments of a single animal 90–120; of a chain of two may be 170. Prostomium

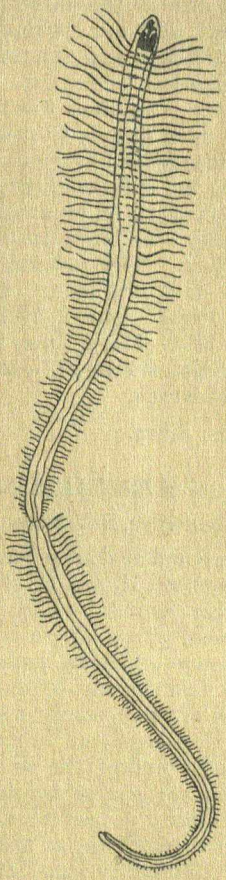

Fig. 26.—*Branchiodrilus hortensis* (Steph.); whole animal. × 10.

bluntly conical, well marked. No eyes. Anterior part of body pigmented, irregularly on dorsal surface of first few segments, then in transverse bands as far as about segment xx, where it dies away; pigmentation less marked and less regular ventrally.

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Surface of body as well as of gills ciliated. Gills and dorsal setæ begin on vi (occasionally on v); longest gills equal to three times the diameter of the body (1·6 mm.); gills diminish in length posteriorly, and end just in front of hinder end of body. Dorsal setal bundles of capillary and needle setæ, not more than two of each per bundle; capillary setæ contained within the gills for first 40–50 segments, some being almost as long as the gills within which they are contained; behind this one capillary seta free from the gill, one, shorter than the free seta, still contained within it. Needle setæ short pointed rods, scarcely projecting on the surface of the body. Ventral bundles of 4–5 setæ, distal prong slightly longer than proximal and thinner at the base; nodulus slightly distal; length 0·15 mm. in front, 0·13 mm. behind; no difference of type between those of the first few and the remaining segments. No stomach. Dorsal vessel on left side of gut. A budding zone formed during asexual division. Clitellum comprising v–viii. Sperm-sac may reach back to xxvi, usually to xviii; male funnels within sperm-sac at some distance behind its mouth, outer margin of funnel attached to wall of sac; vas deferens first passes forwards in neck of sperm-sac, then upwards to enter atrium on its anterior face much above its middle. A large mass of "prostatic" cells covering ejaculatory duct. Spermathecal ampulla heart-shaped, notched below where duct originates; aperture some distance behind groove 4/5. Penial setæ 2–3 in a bundle, somewhat hooked distally, not bifid, 132 $\mu$ long, distal portion narrow, 36 $\mu$ long; proximal portion stouter, 96 $\mu$ long, no distinct nodulus, distal portion bent backwards.

*Distribution.* Lahore; Agra.

### 6. Genus **HÆMONAIS** *Bretscher.*

1900. *Hæmonais*, Bretscher, Rev. Suisse Zool. viii, p. 16.

Ventral bundles composed of double-pronged crotchets. Dorsal bundles commencing between xii and xx, or sometimes still further back, of hairs and double-pointed needles. Vascular system complicated, the dorsal vessel giving origin in the anterior segments to a system of commissures which are connected among themselves by longitudinal vessels, and may also communicate with the ventral vessel. Vascular loops of the posterior segments form a capillary cutaneous network. Five segments intercalated in the budding zone to form the anterior end of the second animal of a chain. Testes in v, ovaries in vi; sperm-sac single, its posterior part contained within the ovisac; vas deferens, atrium, and male pore in vi; spermathecæ in v, consisting of ampulla and duct. Penial setæ at male pore. Alimentary canal degenerates in the fully sexual animal.

The genus is at present known only from one locality in Switzerland and from Lahore and Agra.

The genital system is similar to that of *Nais*, and it is probable that this is the nearest relative of *Hæmonais*; *Nais pectinata* var.

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*inæqualis* has some characters of an intermediary—commencing loss of dorsal setæ and degeneration of the alimentary canal in the sexual animal.

*Distribution.* Lahore; Agra. Outside India only known from Switzerland.

1. **Hæmonais laurentii** *Steph.*

1915. *Hæmonais laurentii*, Stephenson, Tr. Roy. Soc. Edin. 1, p. 769, text-figs. 1–5, pl. lxxix, figs. 1–6; pp. 785, 793.
1920. *Hæmonais laurentii*, Mehra, P. Z. S. pp. 457, 458.

Length, maximum extended, 20 mm. *N*=31–36. Prostomium triangular with rounded tip. No eyes. Ventral setæ 2–4 in bundle; in anterior part of body (text-fig. 27, *a*) 80–104 $\mu$ long, comparatively slender (3$\mu$), distal prong slightly longer than proximal and

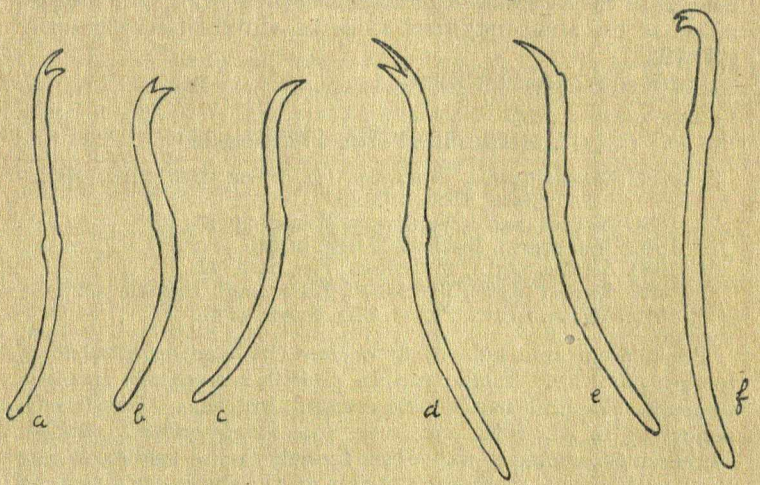


Fig. 27.—*Hæmonais laurentii* Steph.; various setæ, ×540. *a*, anterior ventral; *b*, posterior ventral; *c*, single-pointed ventral; *d*, dorsal needle; *e*, single-pointed dorsal needle; *f*, penial seta.

half as thick at base, nodulus usually proximal but variable in position; no sudden change in characters of setæ on passing backwards, but behind xv the type has changed (text-fig. 27, *b*), length 80–96$\mu$, thickness 4–4·5$\mu$, prongs equal in length or proximal slightly longer, proximal more than twice as thick at base as distal, nodulus distal. Dorsal bundles of one hair and one needle seta, beginning in xviii–xx; hair setæ about 150 $\mu$ long; needles (text-fig. 27, *d*) of double-curved and double-pronged type, about 105$\mu$ in length and 4·5$\mu$ in thickness, prongs longer than those of ventral setæ, angle between prongs narrower, distal prong longer and sometimes thinner than proximal, nodulus distal, whole seta largest in posterior part of body, where length may reach 115$\mu$. In both dorsal and ventral bundles single-pointed needles may occur (text-fig. 27, *c*, *e*). Dorsal setæ in anterior segments are shed

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at an early period; traces of their occurrence are found as far forwards as segment vi. Cœlomic corpuscles present. Chloragogen pigment extends to anterior end of animal (into prostomium). No stomach. Dorsal vessel on left side of intestine as far forwards as vi. Cerebral ganglion bifid in front and behind. Clitellum includes half segment v and anterior part of viii (= almost 3). Male funnels in anterior part of sperm-sac; vas deferens short and stout, entering atrium on upper surface of latter; atrium small, ovoid; spermathecal duct narrow and short, opening at middle of segment v, ampulla ovoid with long diameter vertical (only seen in empty state). Penial setæ (text-fig. 27, *f*) in vi, 1–3 in bundle, 110 $\mu$ long, stout (4 $\mu$), distal end strongly hooked and bifid, nodulus very markedly distal to middle of shaft.

*Remarks.* I have investigated in this species the position of the nodulus in the several setæ of the same bundle (77). The degeneration of the alimentary tract at sexual maturity is noteworthy (76, 78).

*Distribution.* Lahore; Agra.

### 7. Genus **SLAVINA** *Vejd.*, emend.

1883. *Slavina* (part), Vejdovsky, Sb. Böhm. Ges. Prag, Math.-Nat. Classe, 1883, p. 219.
1884. *Slavina* (part.), Vejdovsky, Monog. pp. 25, 30.
1895. *Nais* (part.), Beddard, Monog. p. 281.
1900. *Slavina* (part.), Michaelsen, Tier., x, p. 32.
1909. *Slavina* (part.), Michaelsen, Süsswasserf. Deutsch. p. 13.
1913. *Slavina* (part.), Piguet, Olig. Suisse, p. 47.

Prostomium rounded. Body covered with an investment of foreign particles. Tactile papillæ present, segmentally arranged in zones. Ventral setæ double-pronged crotchets. Dorsal setæ beginning in vi, with hair setæ and single-pointed needles. Clitellum embracing v–vii. Male funnels facing backwards into the mouth of the sperm-sac; atrium in vi; sperm-sac single, its hinder part included within the ovisac; spermatheca with duct and ampulla distinct. Penial setæ present.

The genus *Slavina* was established for the *Nais appendiculata* of d'Udekem by Vejdovsky in 1883; the diagnosis is in Czech. In the same author's monograph of the following year the characters are:—Presence of capillary setæ, which begin on segment vi, absence of gills and proboscis, the capillary setæ of the first pair of bundles being much longer than those of subsequent segments.

Beddard in 1895 does not recognize the genus, and places the only species under *Nais*. Michaelsen in 1900 defines the genus thus:—"Prostomium rounded. Integument often furnished with small non-retractile papillæ. Ventral bundles with forked crotchets; dorsal bundles beginning in vi, with capillary setæ only, those of vi with one or several elongated hair setæ." Two species are included, *S. appendiculata*, with foreign matter on the integument and integumental papillæ, and *S. gracilis*, without either

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(*S. gracilis* is the *Nais gracilis* of Leidy; the absence of foreign matter is implied by its not being mentioned, as in the case of *S. appendiculata*).

In Michaelsen's volume on the Oligochæta in the 'Süsswasserfauna Deutschlands' the elongated hair setæ of segment vi are the diagnostic mark of the genus in the key; the full diagnosis runs:—"Prostomium well developed, simple, rounded. Dorsal bundles of setæ begin on vi, with capillary setæ, those of vi with enormously elongated hair setæ, several times as long as the diameter of the body."

Finally Piguet in 1913 diagnoses *Slavina* as follows:—"Prostomium rounded. Ventral bundles of double-pronged crotchets. Dorsal bundles commencing in vi, and, at least in the European species, accompanied by needles with simple point. Reproductive apparatus not known."—Though thus neither the sheath of extraneous particles nor the elongated hair setæ of segment vi are found in the formal diagnosis of the genus, both features, as well as the circles of integumental papillæ, come into the key (the work, however, deals only with Swiss forms). The diagnosis in the body of the work would not, however, distinguish the genus from *Nais*, of which certain species have single-pointed needles along with hair setæ in the dorsal bundles.

Four species altogether have been referred to this genus,—one American, one European, and two Indian; but I now recognize my *S. punjabensis* as identical with *S. appendiculata* (as suspected by Michaelsen in 1913). Of the three species which seem valid, two (*appendiculata* and *gracilis*) agree in possessing the elongated setæ, and two (*appendiculata* and *montana*) in having the sheath of foreign particles and circles of tactile papillæ.

Now specially elongated hair setæ are not necessarily—perhaps not at any time—of generic importance; compare the genus *Pristina*, where one species has such setæ and the others have not. The second group of characters, papillæ and extraneous covering, are of at least equal value, and immediately give a distinct physiognomy to the animals possessing them. I propose, therefore, to group together the two species with these features, *appendiculata* and *montana*, and to reserve the name *Slavina* for these; *S. gracilis* will then go where it was placed by its discoverer Leidy, in the genus *Nais*, where its relation to the other species of the genus will be the same as that of *Pristina longiseta* to the other species of *Pristina* (I do not forget that *Ophidonais serpentina* has, according to Piguet, a sheath of fine foreign particles, and also circles of sensory papillæ; but that genus is characterized by the entire absence of hair setæ from the dorsal bundles, a good generic character).

*Key to the Indian species of* Slavina.

1. Eyes present; dorsal hair setæ of vi much elongated ..... *S. appendiculata.*
   No eyes; dorsal hair setæ of vi not specially elongated ..... *S. montana.*

## 1. Slavina appendiculata (*Udek.*).

1909. *Slavina appendiculata*, Michaelsen, Mem. Ind. Mus. i, p. 132.
1909. *Slavina punjabensis*, Stephenson, Mem. Ind. Mus. i, p. 272, pl. xviii, figs. 35–37, pl. xix, figs. 41–45, pl. xx, figs. 50–52.
1913. *Slavina punjabensis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 737, 744, 757.
1913. *Slavina appendiculata*, Michaelsen, Mem. Soc. Neuchatel, v, p. 207.
1915. *Slavina punjabensis*, Stephenson, Tr. Roy. Soc. Edin. l, p. 793, pl. lxxx, figs. 4, 5.
1916. *Slavina punjabensis*, Stephenson, Rec. Ind. Mus. xii, p. 302.

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1855. *Nais appendiculata*, d'Udekem, Bull. Ac. Belgique, xxii, p. 552, fig. 3.
1884. *Slavina appendiculata*, Vejdovsky, Monog. p. 30, pl. iii, figs. 17–26.
1895. *Nais appendiculata*, Beddard, Monog. p. 287.
1903. *Slavina appendiculata*, Michaelsen, Jahrb. Hamb. wiss. Anst. xix, p. 185.
1906. *Slavina appendiculata*, Piguet, Rev. Suisse Zool. xiv, p. 282, pl. xii, fig. 20.

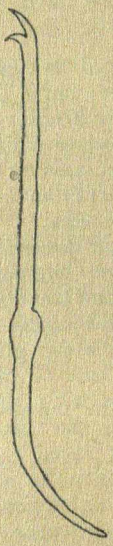

Fig. 28.—*Slavina appendiculata* (Udek.); ventral seta (the proximal prong of the fork shown slightly too short).



Fig. 29.—*Slavina appendiculata* (Udek.); penial seta. × 550.

Length of single individual 2–8 mm., of chains 4–20 mm. Segments of single animal 20–46; $n$=19–25. Colour light brown; body opaque, due to an investment of extraneous particles.

Prostomium rounded, short. Eyes present. Integument with zones of non-retractile tactile papillæ, bearing a few sensory bristles; one such principal zone at the level of the setæ; and from vi onwards a second, less important, often absent, more posteriorly in the segment. Ventral bundles with 2–5 crotchets (text-fig. 28), the distal tooth a little longer and considerably thinner than the proximal, nodulus proximal to middle of shaft; setæ of ii–v slenderer and longer than the rest. Dorsal bundles with one or sometimes two hair setæ, equal to or sensibly longer than diameter of body, those of vi much longer than the others, sometimes reaching four times the diameter of the body; and one or two needles, single-pointed, suddenly tapering towards the distal end. Alimentary canal dilates in viii. Cœlomic corpuscles present. Vas deferens forming a loop with its convexity downwards, ascending limb short, entering atrium below middle point of its height; atrium large, subspherical, taking up whole length of vi; "prostate" represented only by peritoneal cells in small clusters over the atrium. Spermathecal ampulla of two portions, an ental, thin-walled, variable in size and shape, and an ectal, a small rounded chamber fairly constant in size; duct vertical, invaginated upwards into cavity of ampulla. Penial setæ (text-fig. 29) 1–3 in number, ending in a single well-marked hook; no distinct nodulus.

*Remarks.* I now accept Michaelsen's identification of my *S. punjabensis* with the common form. My separation of the Lahore specimens was based on the diagnosis in the Tierreich volume—partly on the statement there made that there are two kinds of papillæ in *S. appendiculata*, one kind numerous, scattered, and minute, the other comparatively large sensory projections. Of these I only found the latter; and indeed, as I have since discovered, the former are not mentioned or figured by d'Udekem in the original description, nor by Vejdovsky (**138**), Beddard (**31**), Bousfield (**116**), Piguet (**133**), nor by Michaelsen himself in a recent diagnosis (**124**). I found the vascular commissures to be plexiform; Michaelsen has explained that the contrary statement in the Tierreich volume rests on inference only.

The second row of papillæ was absent in the Lahore specimens, and the one which was present appeared to be less regular than in the European worms. But the second row is variable at best—indeed, Vejdovsky figures only one row. The papillæ were absent over the ventral surface; this had been previously noticed by Bousfield in *Nais lurida* (a synonym of *S. appendiculata*).

I was able to study the sexual organs of this species, which had not before been seen, in mature specimens obtained in March at Lahore. I have also investigated the phenomena of antiperistalsis and reversed ciliary action in this species.

*Distribution.* Alipur, near Calcutta, from colonies of *Plumatella emarginata*; Lahore, free-living. A common European species.

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2. **Slavina montana**, nom. nov.

1916. *Slavina* sp., Stephenson, Rec. Ind. Mus. xii, p. 301, pl. xxx, fig. 1.

Length ca. 5 mm.; diameter 0·25 mm.; segments 47 or 48. Prostomium blunt. No eyes. Foreign particles adhering to surface. Body-wall contains pigment grains. Sensory papillæ apparently in a single zone rather behind middle of segment, often at the level of the setæ. Ventral setæ (text-fig. 30) up to 4 in bundle in most anterior segments, 3 in the rest; in segments ii–v length 135 $\mu$, thickness 3 $\mu$, proximal prong almost equal in



Fig. 30.—*Slavina montana* Steph.; ventral seta. × 500.

length to the distal and twice as thick, on the whole much the more massive of the two, distal prong slightly claw-like, nodulus proximal; in other segments length rather less, 125 $\mu$, but no other constant distinction. Dorsal bundles of one hair and one needle; the hairs equal to the diameter of the body in length, none specially lengthened; the needles straight, tapering to a single point, 50–60 $\mu$ long. Stomach in viii (not always).

*Remarks.* I at first refused to name this species, since I thought it possible that the specially elongated setæ which characterized the then known species of *Slavina* might have dropped out. As however there were two undamaged specimens available for examination, the chances of this having happened on both sides of both specimens seem to me to be slight, and I have therefore decided to distinguish it as *S. montana*. There is really no reason why a *Slavina* should have specially elongated setæ—one species of *Pristina* has and others have not; and I think now that the description is probably trustworthy on this point. The absence of eyes in the present species is also a distinction.

*Distribution.* Bhim Tal, Kumaon Dist., W. Himalayas.

## 8. Genus **STYLARIA**, *Lmk.*

Prostomium prolonged into a long filiform proboscis. Ventral bundles of double-pointed crotchets. Dorsal bundles beginning in vi, with hair setæ not specially elongated in any particular segment, and single-pointed needle setæ.

The genus is best known by the species *S. lacustris*, which has a wide distribution in Europe, and is also recorded from N. America and Siberia.

*Distribution.* In India recorded from Calcutta ; Lahore ; and Bhim Tal, in the W. Himalayas.

*Key to the Indian species of* Stylaria.

| | |
|---|---|
| 1. Eyes present ..... | *S. lacustris.* |
| Eyes absent ..... | *S. kempi.* |

### 1. Stylaria lacustris (*L.*).

1909. *Stylaria lacustris*, Stephenson, Mem. Ind. Mus. i, p. 276, pl. xix, figs. 46–48.
1911. *Stylaria lacustris*, Stephenson, Rec. Ind. Mus. vi, p. 209, text-fig. 3.
1913. *Stylaria lacustris*, Stephenson, Tr. Roy. Soc. Edin. xlix p. 739, 744.

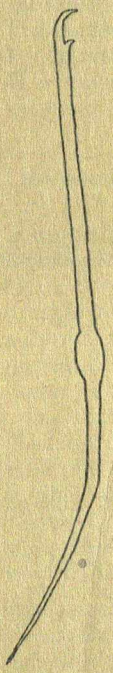

Fig. 31.—*Stylaria lacustris* (L.); ventral seta.

Length of single individuals 3–10 mm.; segments 23–60 ; chains 5·5–18 mm. long ; $n$=15–35. Colour to the naked eye a clear

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reddish brown. Proboscis of variable length. Eyes present. Ventral bundles of slender crotchets (text-fig. 31), nodulus proximal, distal prong very large and much curved, proximal very small, almost rudimentary. Dorsal bundles commencing in vi, of long hair setæ alternating with very short straight needles, single-pointed, without nodulus. Stomach in viii or vii and viii. Behind vi the gut is surrounded in each segment immediately behind the septum by a ring of blackish pigment, sometimes well marked and visible to the naked eye, at others hardly present. First nephridium in vii, viii, or ix. Vas deferens without "prostatic" investment, opening into the upper part of a pear-shaped atrium; penial setæ present.

*Remarks.* The length of the hair setæ is variable; in my Calcutta specimens it was double the diameter of the body, in the Lahore specimens equal to the diameter only. The ventral setæ in the Calcutta specimens were 6–9 per bundle, in those from Lahore 5–6.

The peculiarity of the process of asexual division consists in the fact that the second zone of budding is established one segment in front of the first, so that the animal of which this segment forms the middle part has only one segment of the parent, the rest having been produced by the budding zones; similarly the third such zone is produced one segment in front of the second.

Some individuals become sexual in Calcutta in January.

*Distribution.* Lahore; Calcutta. It has also been found in Seistan, E. Persia, and is a common European species.

## 2. Stylaria kempi *Steph.*

1916. *Stylaria kempi*, Stephenson, Rec. Ind. Mus. xii, p. 303, pl. xxx, fig. 2.

Length 2¼–4 mm. Prostomium a long narrow proboscis, in length equal to three times the diameter of the body. No eyes. $N=25$. Ventral setæ all with slight kinking forwards of the shaft at the nodulus; those of segments ii–iv (text-fig. 32) six or fewer in bundle, 120 $\mu$ long, terminal prongs very unequal, the distal large, the proximal small, nodulus markedly proximal, distal curve of shaft slight; those of more posterior segments 6–7 in bundle, 96–100 $\mu$ long, proximal prong remarkably small, nodulus proximal, but not so markedly so as in the more anterior segments. Dorsal bundles with one long hair seta, 0·46–0·6 mm. long, twice or three times as long as the diameter of the body; and shorter hairs, equal to diameter of body or less, 200 $\mu$ down to 80 $\mu$; also two or three single-pointed needles, 40 $\mu$ in length. No septal glands. Stomach slightly or well marked, in viii and ix.

*Remarks.* The chief difference between this and the widely-distributed *S. lacustris* is the absence of eyes in the present form; perhaps also the greater length of the single long hair seta of the dorsal bundles. Michaelsen (**120**) refuses to consider certain eyeless worms described by Floericke as distinct from the common

*S. lacustris.* These worms, which Floericke (**118**) put in a separate genus *Cœcaria*, and divided among three species, are stated to be characterized by (besides the absence of eyes) the shortness of the proboscis, and the shortness of the hair setæ of the anterior segments. Michaelsen points out quite rightly that these are all signs of an incompletely developed anterior end, and that the

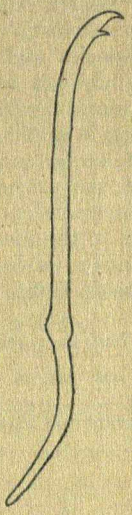

Fig. 32.—*Stylaria kempi* Steph.; ventral seta of segment ii. × 550.

animals are therefore probably ordinary Stylarias which have become detached abnormally early. It does not appear that there are any such marks in the two specimens on which the present species is founded.

*Distribution.* Bhim Tal, Kumaon Dist., W. Himalayas.

## 9. Genus **DERO**, *Oken.*

1887. *Dero* (part.), Bousfield, J. Linn. Soc., xx, p. 91.
1895. *Dero* (part.), Beddard, Monog. p. 297.
1900. *Dero* (part.), Michaelsen, Tier. x, p. 26.

Prostomium well marked, rounded. No eyes. Ventral bundles of segments ii–iv or ii–v longer than the others. Dorsal bundles beginning in v or vi, with hair setæ and bifid needles. Hinder end with branchial fossa, with gills but no palps. Genital organs in general resemble those of *Nais*; sperm-sac single, its hinder part contained within the ovisac; spermathecæ in v, do not enter sperm-sac, but (in *D. limosa*) rather bulge forwards. Alimentary canal degenerates in some species in the fully mature (sexual) animal.

For an account of the curious degeneration of the alimentary canal in this genus (in *D. limosa* and another unnamed species), *v.* Stephenson (**78**). The same phenomenon occurs in *Hæmonais*;

it occurs in Polychætes also, but not, so far as is yet known, in Oligochætes beyond those just mentioned.

The dorsal vessel is ventral in position and on the right side of the ventral vessel in *D. zeylanica*; its position has not been stated for *D. limosa*. In *Hæmonais* the dorsal vessel is on the left side of the gut; in some Tubificids (*Branchiura* and *Limnodrilus socialis*), the dorsal vessel is ventral and on the left side of the ventral vessel; in *Aulophorus*, closely related to *Dero*, it has the normal position in some species and the abnormal (ventral or ventro-lateral, side apparently not stated) in others. If the statement that the dorsal vessel in *D. zeylanica* is on the right side of the ventral is correct, it would seem to be an exception to the usual run of these cases, so far as known.

True gills, in this genus, are projections, usually longer than broad, from the floor of the branchial fossa; secondary gills are projections from the margin of the fossa.

*Distribution.* Lahore; Kandy, Ceylon; Agra. The genus has a world-wide distribution outside India.

*Key to the Indian species of* Dero.

| | |
|---|---|
| 1. Gills of the usual type, one pair of secondary and two pairs of true gills | *D. limosa.* |
| Gills as ridges of wall of branchial fossa, free in only part of their extent | *D. zeylanica.* |

**1. Dero limosa** *Leidy.*

1914. *Dero limosa*, Stephenson, Rec. Ind. Mus. x, p. 330, text-fig. 6.
1914. *Dero limosa*, Stephenson, Tr. Roy. Soc. Edin. l, pp. 785, 789, pl. lxxx, figs. 1, 3.
1920. *Dero limosa*, Mehra, P. Z. S. pp. 457, 458.

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1887. *Dero limosa*, Bousfield, J. Linn. Soc. xx, p. 105, pl. v, figs. 11–16.
1895. *Dero limosa*, Beddard, Monog. p. 298.
1900. *Dero limosa*, Michaelsen, Tier. x, p. 28.

Length of single animal about 6 mm., of chains about 12 mm. Segments of single animal about 48, of chains about the same. Transparent. Ventral bundles of segments ii–v with 4 or 5 forked crotchets, longer than those of other segments, nodulus proximal, curve of shaft slight, shaft thinner than in those behind, prongs with a very narrow angle between them, distal one and a half times as long as proximal; in middle of body bundles have 3 or 4 crotchets, shorter than those in front, more curved, nodulus distal, distal prong very slightly longer and half as thick as proximal, included angle moderately wide. Dorsal bundles beginning in vi, with one hair seta and one needle seta, the latter bifid, with a slight sickle-shaped curve. Branchial fossa with rounded ventro-posterior border, the dorsal (anterior) border bearing a pair of secondary gills; true gills two pairs, leaf-shaped, somewhat longer than broad. No cœlomic corpuscles. Stomach in ix and x, or x. Four vascular loops in vii–x. Clitellum includes nearly

the whole of v, with vi and vii. Male funnels face forwards in v, are cup-shaped; vas deferens forms a downward loop and enters atrium on its dorsal aspect; atrium large, globular; no "prostatic" cells on vas or atrium; ejaculatory duct slightly invaginated upwards into atrial chamber. Spermathecæ large ovoid thin-walled sacs, duct narrows downwards. No genital setæ; setæ of vi disappear in the sexual animal. Alimentary canal degenerates at sexual maturity.

*Remarks.* The Lahore specimens showed a number of segmentally arranged bright orange-coloured spots, at the level of the setæ below the insertion of the dorsal setal bundles; the dorsal margin of the branchial fossa was more cut up than usual, apparently, and gave the appearance of two pairs of secondary gills.

The setæ of the ventral bundles vary, I find (77), in the position of the nodulus; as in some other species, there is a regular change in its position on the shaft from the outer to the inner seta of a bundle.

*Distribution.* Lahore; Agra. Widely distributed, *e. g.* in England, N. America, Philippines.

2. **Dero zeylanica** *Steph.*

1913. *Dero zeylanica*, Stephenson, Spol. Zeyl. viii, p. 252, pl. i, figs. 1–4.



Fig. 33.—*Dero zeylanica* Steph.; dorsal needle.

Length of single animal 7·5 mm.; chains not observed; maximum diameter 0·35 mm. Segments 43–60. Prostomium short, rounded. No eyes. Ventral setæ of ii–v with only a

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slight curve, longer than those of other segments, ca. 125 $\mu$, prongs with narrow included angle, distal nearly twice as long as proximal and of same thickness, nodulus at or near middle, number in bundle 4 or 5; in other segments length 87-98 $\mu$, distal prong only slightly longer than proximal and half or two-thirds as thick at base, nodulus distal, number in bundle 2-5, the larger numbers in the more anterior segments, the smaller near the hinder end. Dorsal setæ begin in vi, the anterior segments having 3 hair and 3 needle setæ, further back two of each kind per bundle, and further back still one only; the hairs do not exceed the diameter of the body; the needles (text-fig. 33) are nearly straight, with a slight sickleshaped curve and finely bifid point, and a slight nodulus distal to middle. Intestine opens into floor of branchial fossa, which extends forwards dorsal to hinder end of the gut as a pocket; four pairs of gills as ridges of the wall of the branchial fossa and forwardly-directed pocket, the ridges being free in part of their extent, either in their middle or at their hinder ends (in the latter case they point forwards, not backwards as in most species of the genus).

*Remarks.* The curious arrangement and form of the gills is distinctive.

*Distribution.* Kandy, Ceylon.

### 10. Genus **AULOPHORUS** *Schmarda.*

1861. *Aulophorus*, Schmarda, Neue wirbell. Thiere, i, 2, p. 9.
1887. *Dero* (part.), Bousfield, J. Linn. Soc. xx, p. 103.
1895. *Dero* (part.), Beddard, Monog. p. 297.
1900. *Dero* (part.), Michaelsen, Tier. x, p. 26.
1905. *Aulophorus*, Michaelsen, Z. wiss. Zool. lxxxii, p. 307.

Prostomium well developed, rounded. Ventral setæ beginning in ii, composed of double-pronged crotchets. Dorsal setæ beginning in v or vi, bundles composed of hair setæ and forked or palmate needles. Hinder end forms a branchial fossa with paired gills, the border of the fossa prolonged behind into a pair of long filiform appendages (palps) diverging in the form of a swallow's tail.

The distinction from the genus *Dero* consists in the possession, in addition to the gills, of a pair of long non-retractile and non-vascular palps at the hinder end. Schmarda in defining *Aulophorus* took the presence of palps, the absence of gills (which apparently he failed to observe in his two species), and the manufacture of a tube as the distinguishing characters. Most writers for some time afterwards, however, merged the genus in *Dero*; but Michaelsen in 1905 re-defined it and separated it again, and he has been followed by later authors.

The dorsal vessel is ventral in position for the greater part of its extent in *A. tonkinensis*, and ventro-lateral in *A. michaelseni*; it has the normal position in *A. furcatus*.

*Distribution.* Calcutta; Lucknow; Bhim Tal, W. Himalayas; Lahore; Bombay; Khed, Poona Dist.; Kandy, Galle, and elsewhere in Ceylon. It has a world-wide distribution outside India.

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*Key to the Indian species of* Aulophorus.

1. Dorsal needles palmate ..... *A. tonkinensis.*
   Dorsal needles double-pointed ..... 2.
2. Gills two or three pairs of true and one of accessory, or three pairs of true gills only ..... *A. furcatus.*
   Four pairs of true gills ..... *A. michaelseni.*

*A. oxycephalus* Schmarda, (3), from Galle and also from the interior of Ceylon, is placed by Michaelsen in the Tierreich as a doubtful species; he has since suggested (54) that it may be identical with *A. tonkinensis*; it is not *A. michaelseni*, since found at Kandy.

## 1. Aulophorus tonkinensis (*Vejd.*).

1909. *Aulophorus tonkinensis*, Michaelsen, Mem. Ind. Mus. i, p. 132.
1911. *Aulophorus tonkinensis*, Stephenson, Rec. Ind. Mus. vi, p. 212.
1913. *Aulophorus tonkinensis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 738, 744, 757.

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1894. *Dero tonkinensis*, Vejdovsky, Mem. Soc. Zool. Fr. vii, p. 244, text-fig.
1900. *Dero tonkinensis*, Michaelsen, Tier. x, p. 30.
1905. *Dero tonkinensis*, Michaelsen, Zoologica, xliv, p. 353.

Length of chain of two animals 3·5 mm.; maximum thickness 0·28 mm.; segments 26–29; $n=17$ or 18; 5 segments added in budding zone to form head of second animal. Prostomium small, short, rounded; pharyngeal region swollen, the prostomium appearing like a nose on its end. Ventral bundles with 4–7 crotchets, the prongs short, setæ of ii–v the same thickness (3 $\mu$), but longer (90 $\mu$) than those of other segments (70 $\mu$). Dorsal bundles beginning in vi, with one hair seta 0·16 mm. long and 3 $\mu$ thick, the prongs diverging to a width of 7 $\mu$, and connected by a web which may appear ribbed. Hinder end cylindrical, not expanded, with an oblique funnel-shaped depression, from which two pairs of long cylindrical gills with conical extremities (the shape of a lead-pencil) project, the dorsal pair longer and thicker than the ventral; ventral border prolonged into a pair of palps, cylindrical, with distal end slightly swollen and rounded, somewhat longer and thicker than the dorsal gills. Cœlomic corpuscles present. Stomach in ix. Dorsal vessel has a ventral position throughout the greater part of its extent; contractile commissures in vii and viii.

*Remarks.* Michaelsen considers this species as possibly identical with Schmarda's *A. oxycephalus* from Galle, Ceylon (3).

Annandale *apud* Michaelsen, (54), gives an account of the behaviour of the worm; it moves about in a case of foreign particles; extending the anterior part of its body, it uses its

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protrusible pharynx as a sucker by which to pull itself along; the palps protrude from the hinder end of the case as it moves; *cf.* also Stephenson (61, p. 213).

*Distribution.* Calcutta; Lucknow; Bhim Tal, Kumaon Dist., W. Himalayas. Also from Tonkin, China.

2. **Aulophorus furcatus** (*Oken*).

1910. *Dero* sp., Stephenson, Rec. Ind. Mus. v, p. 71, text-figs. 5-8, pl. vii, figs. 4-6, pl. viii, figs. 5-7.
1912. *Aulophorus stephensoni*, Michaelsen, Arch. f. Naturgesch. lxxviii, Abt. A, Heft 9, p. 116.
1914. *Aulophorus furcatus*, Stephenson, Rec. Ind. Mus. x, p. 332.
1915. *Aulophorus furcatus*, Stephenson, Tr. Roy. Soc. Edin. l, p. 784.
1916. *Aulophorus furcatus*, Stephenson, Rec. Ind. Mus. xii, p. 306, pl. xxx, fig. 3.

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1887. *Dero furcata* (part.), Bousfield, J. Linn. Soc. xx, p. 105, pl. v, figs. 17, 18.
1895. *Dero furcata*, Beddard, Monog. p. 299.
1900. *Dero furcata*, Michaelsen, Tier. x, p. 29.

Length of chains about 6–16 mm.; diameter 0·2 mm. Segments of single individual about 35–40 or more, of chains up to 48; $n$=18–25; 5 segments added to head of second animal in budding zone. Prostomium rounded. Ventral crotchets 4–5 in bundle, fewer posteriorly; those of ii–iv a little longer, with

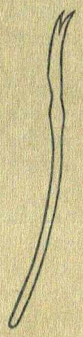

Fig. 34.—*Aulophorus furcatus* (Oken); dorsal needle.

longer prongs, the distal longer than the proximal, equal in thickness or the proximal thicker at the base; from v onwards the crotchets are more curved, shorter, and thicker, with shorter teeth, the distal a little longer than or equal to the proximal, which is a little or considerably thicker. Dorsal bundles beginning in v, containing one double-pointed needle (text-fig. 34)

with a slight sickleshaped curve, and one hair seta which does not attain a length equal to the diameter of the body. Branchial fossa funnel-shaped, with two pairs of true gills and one pair of accessory gills, or three pairs of true gills, or three pairs true and one pair accessory gills. The posterior margin of the fossa prolonged into a pair of long narrow palps, diverging behind. Four or five pairs of vascular commissures, in vi–ix or vi–x, or even six pairs in v–x; dorsal vessel on intestine. No stomach. Cœlomic corpuscles present or absent. First nephridium in vii (rarely viii). Clitellum v–½vii=2½. Male funnels cup-shaped, close together, looking upwards and backwards, in mouth of sperm-sac; vas deferens running downwards on septum 5/6, entering anterior face of atrium; atrium small, subspherical, no covering of "prostatic" cells; ejaculatory duct short, somewhat invaginated upwards into the atrium. Ovisac encloses sperm-sac. Spermathecæ ovoid sacs confined to v, duct narrow and straight.

*Remarks.* I have shown that all intermediate conditions exist between the typical *A. furcatus* with two pairs of true and one pair of accessory gills, and the form at first described as *Dero* sp. and afterwards named *A. stephensoni* by Michaelsen, with three pairs of true and one pair of accessory gills. The species must therefore be united, and the diagnosis widened accordingly. If thought necessary, the typical form with two pairs of true and one pair of accessory gills may be distinguished as f. *typica*, and the other extreme of the series as f. *stephensoni* (Mich.), with the proviso, however, that intermediate forms occur.

*Distribution.* Lahore; Bombay; Khed, Poona Dist., in a hot spring. Widely distributed in Europe; perhaps in Africa and America also.

3. **Aulophorus michaelseni**, nom. nov.

1913. *Aulophorus palustris*, Stephenson, Spol. Zeyl. viii, p. 255, pl. i, fig. 5.
1916. *Aulophorus palustris*, Stephenson, Rec. Ind. Mus. xii, pp. 305, 306.

Length of single animal (preserved) 3–4·5 mm.; diameter 0·3 mm. Segments max. 52; $n$=22. Prostomium short and rounded. In preserved specimens the anterior end is somewhat swollen, thickest at iv, vi–vii being contracted and having the appearance of a neck. No eyes. Hinder end with palps, gently tapering in thickness from 60 $\mu$ proximally to 16 $\mu$ at distal end, and four pairs of gills, all true (inserted within the margin of the funnel), the most anteriorly placed being the shortest. Ventral setæ of ii–iv (text-fig. 35, *b*) 4–5 per bundle, 76–84 $\mu$ long, distal prong twice as long as proximal, but only two-thirds as thick at base, nodulus markedly proximal; those of the other segments (text-fig. 35, *c*) 4 per bundle, or 3 or 2 posteriorly, prongs equal

in length but distal only half as thick as proximal, nodulus markedly distal, setæ shorter than those of the anterior group (68 $\mu$), and more curved. Dorsal bundles begin in v, consist of one hair seta not exceeding in length the diameter of the body, and one needle (text-fig. 35, *a*), 51–55 $\mu$ long, sickleshaped,

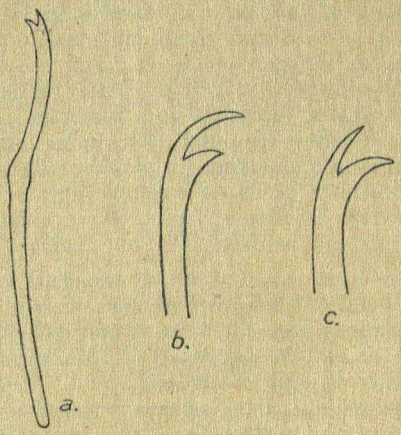


Fig. 35.—*Aulophorus michaelseni* Steph.; *a*, dorsal needle; *b*, anterior ventral seta; *c*, posterior ventral seta (*b* and *c* more magnified than *a*).

forked, with slight nodulus at junction of curved with straight portion of the shaft. Septal glands in iv and v. No stomach. Dorsal vessel has a ventro-lateral position on the gut for the greater part of its course.

*Remarks.* I have come to the conclusion that the present species must be separated from *A. palustris* Mich. (121), with which I at first united it. So far as I know, the only description of *A. palustris* that we possess is merely a short preliminary diagnosis; but even so, the mention of crotchets (Hakenborsten) in the dorsal bundles is, I now think, sufficient to distinguish it from the present form; the dorsal needles of this form cannot be called Hakenborsten, and I therefore give it a new name.

I considered in 1916 that this species might ultimately have to be merged in *A. furcatus*, through the discovery of intermediate conditions of the gills, as it has been necessary to merge *A. stephensoni*. But the position of the dorsal vessel seems to be a well-marked distinction.

*Distribution.* Kandy, Ceylon.

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# Family TUBIFICIDÆ.

Small aquatic worms, usually reddish in colour, up to 200 mm. in length, of slender build. Setæ in four bundles per segment, usually with an indeterminate number of setæ per bundle. Ventral bundles contain only bifid or more rarely single-pointed crotchets; dorsal bundles consist of bifid or pectinate crotchets only, or of bifid or single-pointed crotchets with hair setæ; both dorsal and ventral series begin in ii. No muscular gizzard. Testes and ovaries in x and xi respectively; vasa deferentia open each into an atrium, or both into a common atrium; atrium opens on xi. Spermathecæ may be absent; when present they open on x. Asexual reproduction by fission as in the Naididæ does not occur.

The above diagnosis does not apply fully to the aberrant genus *Aulodrilus*.

This family is very common in Europe, but hitherto only eight species, belonging to six genera, have been found in India. This poverty is partly apparent, partly real. The difficulties in the way of the exact study of this family are much the same as those mentioned for the Naididæ; though being on the whole larger worms than the Naididæ one would expect them to be collected oftener; that this does not happen is an indication that the family is really somewhat scantily represented in India; and the same applies to the Enchytræidæ. Two of the eight Tubificids, however, *Limnodrilus socialis* and *Branchiura sowerbyi*, seem to be fairly common forms.

The disproportions in numbers between the Indian Naididæ and Tubificidæ are brought out by the following table:—

| | Naididæ. | Tubificidæ. |
|---|---|---|
| Germany (Michaelsen, Süsswasserf. Deutsch. 1909) | 39 | 19 |
| Switzerland (Piguet, Olig. Suisse, 1913) | 33–34 | 15 |
| India | 31 | 8 |

*Distribution.* Kashmir; Lahore, Punjab; Lucknow and Agra, United Provinces; Burhanpur, Central Provinces; Calcutta and Belgatchia; Kurseong, E. Himalayas; Manipur, Assam; Inle Lake, Burma; Barkuda Island, Chilka Lake, E. Coast; Madras; Nilgiris; Kandy, Ceylon.

*Key to the Indian genera of* Tubificidæ.

1. Gills present in dorsal and ventral series .... Branchiura.
   No gills. .... 2.
2. Outer prong of crotchets throughout shorter than inner .... Aulodrilus.
   Outer prong of crotchets mostly equal to or longer than inner .... 3.

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| | |
|---|---|
| 3. No spermathecæ; spermatophores affixed to surface of animal | Bothrioneurum. |
| Spermatheca single | Monopylephorus. |
| Spermatheca paired | 4. |
| 4. No hair setæ in dorsal bundles; all dorsal needles bifid | Limnodrilus. |
| Hair setæ present; anterior dorsal needles ctenate | Tubifex. |

## 1. Genus **LIMNODRILUS** *Clap.*

Dorsal and ventral bundles with bifid crotchets, of the same form in both; no hair setæ. Lateral pulsatile hearts in viii, or more usually in viii and ix; vascular cutaneous network in the posterior part of the body. Testes in x, ovaries in xi; vas deferens long, atrium with a bulky solid prostate, ending by a true penis (*i.e.*, one the folds of which are not capable of being smoothed out) with usually a strong chitinous tube. Spermathecæ in testis segment, containing spermatophores after copulation.

The common species is *L. socialis*; specimens of the genus, species indeterminable, have been obtained from Sona Sar, a small lake in Kashmir, at a height of 12,500 ft. (*Limnodrilus* sp., Stephenson, Rec. Ind. Mus. xii, p. 307).

*Distribution.* Lahore; Calcutta and Belgatchia; Kandy, Ceylon; Kashmir. The genus is common in Europe, and is found also in N. America, Japan, and Tibet.

### 1. Limnodrilus socialis *Steph.*

1912. *Limnodrilus socialis*, Stephenson, Tr. Roy. Soc. Edin. xlviii, p. 294, pl. ii, figs. 9–16.
1912. *Limnodrilus socialis*, Stephenson, Rec. Ind. Mus. vii, p. 237, text-fig. 4.
1913. *Limnodrilus socialis*, Stephenson, Spol. Zeyl. viii, p. 260.
1913. *Limnodrilus socialis*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 740, 744, 762.

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1917. *Limnodrilus socialis*, Stephenson, Mem. As. Soc. Bengal, vi, p. 93, pl. iv, figs. 6, 7.

Colour pale reddish brown, deeper anteriorly. Length up to 75 mm. extended; thickness less than 1 mm. Segments ca. 110; a double annulation in the first few. Prostomium bluntly conical. Setæ (text-fig. 36) with proximal prong of fork shorter and stouter than the distal; nodulus distal; length in anterior part of body 115 $\mu$, diminishing to about 80 $\mu$ behind; 6–8 per bundle anteriorly, diminishing to 3 or 4 posteriorly. Paired gland-like masses of cells ventro-laterally to œsophagus in vi and vii, and smaller aggregations in v and viii. Dorsal vessel situated ventrally, to the left of the ventral vessel for the greater part of its course; no subintestinal vessel; a supra-intestinal present in segments v–ix; hearts a single pair in viii, and in the sexual

animal in addition a pair of long sinuous loops to the genital organs. Cutaneous plexus in the posterior half of the body formed by four chief capillary vessels on each side in each segment, which branch freely and anastomose. Nephridia of vii and viii (the most anterior pairs) surrounded by large pear-shaped cells; then a hiatus till xiii; nephridia not present in every segment after xiii. Cerebral ganglion cleft both anteriorly and posteriorly.



Fig. 36.—*Limnodrilus socialis* Steph.; seta; × 750.

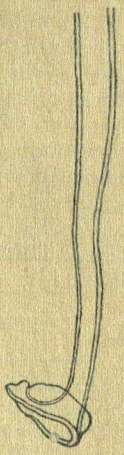

Fig. 37.—*Limnodrilus socialis* Steph.; chitinous penial tube; × 115.

Clitellum embraces xi–xii. Vas deferens wider in its first portion; atrium elongated, pear-shaped, the first part the broader; prostate continuous with first part of atrium; penis sheath (text-fig. 37) circular in cross-section, narrowing somewhat to its termination, about 10–11 times as long as broad at its upper end (520 $\mu$ and 49 $\mu$), termination expanded in form of a trumpet and its anterior lip strongly everted. Vesiculæ seminales paired in ix, single in xi, the latter reaching back through a number of segments. No spermatophores.

*Remarks.* The worms may occur in great abundance, forming tangled masses of several pounds in weight; their heads are downwards in the mud, their tails freely waving; on any interference the animals contract themselves with extraordinary rapidity, and there may be no sign of life where a moment before there was a large animated mass.

I found that in March at Lahore a large proportion of the worms were headless; the worms had been found sexually mature in December and also in February, and I am inclined to suppose that the deposition of the large eggs causes so much damage to the anterior segments that these are thrown off; the oviduct appears to be such a small passage that it does not seem possible, with every allowance for distension, to suppose that the ova can escape through it. It is thus possible that, though the worms live for some time after losing the anterior segments, the whole generation perishes every year.

I have found the worm in material from Kyoto, Japan, collected by Annandale; it is sold as food for goldfish, and is thus one of the few Oligochæta that are of commercial importance.

The same species has been described by Nomura (**132**) as *L. gotoi* (for a discussion on the identity of these *cf.* **84**, where also the question of nomenclature is argued).

This species appears to differ from others of the genus in not having spermatophores.

Both antiperistalsis and ascending ciliary action occur in the intestine, as in the Naididæ.

*Distribution.* Lahore; Calcutta and Belgatchia; Kandy, Ceylon. Also in Japan.

## 2. Genus **BRANCHIURA** *Bedd.*

1892. *Branchiura*, Beddard, Quart. J. Mic. Sci. xxxiii, p. 325.
1895. *Branchiura*, Beddard, Monog. p. 270.
1900. *Branchiura* (part.), Michaelsen, Tier. x, p. 39.
1908. *Braychiura*, Michaelsen, Arch. f. Naturgesch. lxxiv, 1, pp. 140, 152.

Dorsal bundles with hair setæ, along with single-pointed or forked crotchets. Segments of the hinder part of the body with a dorsal and a ventral gill. Atrium with a blindly ending appendage (paratrium); terminal portion of atrium eversible as a penis; no penial setæ. No spermatophores; spermathecæ filled in copulation with amorphous masses of spermatozoa. A special cœlomic sac encloses the ectal portion of the male efferent apparatus.

This interesting genus has been the subject of much discussion since the description of *B. sowerbyi* by Beddard in 1892. For a *résumé* of the limits ascribed to the genus at various times *cf.* Stephenson (**84**); at present it is held to comprise only the one species.

The relationships of the genus are discussed in the paper just mentioned, and in the others there referred to. The closest relative of *Branchiura*, however, is the recently discovered *Kawamuria* (Stephenson, **84**). Notable in both genera is the cœlomic sac which encloses the terminal portion of the male efferent apparatus; the function of this sac, which has muscular walls, is by its contraction to evert a portion of the atrial wall as a penis. A similar sac has been found in some species of

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*Phreodrilus* (Beddard, **110**; Benham, **114**), where its function is apparently similar; these authors suppose the sac to have been formed in *Phreodrilus* by a splitting off from the surface of the atrium.

*Distribution.* Lahore; Calcutta; Madras; Lucknow and Agra, United Provinces; Manipur, Assam; Inle Lake, Burma; and Kaung-daing, Yawng-hwe State. Also recorded from London, Dublin, France, Germany, Japan, and China.

1. **Branchiura sowerbyi** *Bedd.*

1912. *Branchiura sowerbyi*, Stephenson, Tr. Roy. Soc. Edin. xlviii, p. 285, pls. i, ii, figs. 1–8.
1912. *Branchiura sowerbyi*, Stephenson, Rec. Ind. Mus. vii, p. 234, pl. xii, figs. 1–5.
1913. *Branchiura sowerbyi*, Stephenson, Tr. Roy. Soc. Edin. xlix, pp. 741, 744, 763.
1918. *Branchiura sowerbyi*, Stephenson, Rec. Ind. Mus. xiv, p. 12, text-figs. 1–3.
1920. *Branchiura sowerbyi*, Stephenson, Mem. Ind. Mus. vii, p. 200.
1920. *Branchiura sowerbyi*, Mehra, P. Z. S. pp. 457, 458.
1921. *Branchiura sowerbyi*, Stephenson, Rec. Ind. Mus. xxii, p. 752.

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1892. *Branchiura sowerbyi*, Beddard, Quart. J. Mic. Sci. xxxiii, p. 325, pl. 19.
1895. *Branchiura sowerbii*, Beddard, Monog. p. 271.
1900. *Branchiura sowerbyi*, Michaelsen, Tier. x, p. 40.
1908. *Branchiura sowerbyi*, Michaelsen, Arch. f. Naturgesch. lxxiv, (1), p. 134, pl. iii, figs. 1–6.
1913. *Branchiura sowerbyi*, Keyl, Z. wiss. Zool. cvii, p. 199, pl. ix, figs. 2, 5–7, 9, pl. x, figs. 10–15, pl. xi, figs. 16, 17; text-figs. 1, 2, 17–19, 28–30, 36–56.
1917. *Branchiura sowerbyi*, Stephenson, Mem. As. Soc. Bengal, vi, p. 89.

Length ordinarily 20–50 mm., exceptionally up to 185 mm.; thickness 1 mm. or more; fairly stout, very contractile. Colour pinkish grey, with whiter and more translucent margins. Segments 74–270. Prostomium bluntly conical. Ventral bundles with single- and double-pointed needles (text-fig. 38), up to 6 or 8 in a bundle, about 120 $\mu$ in length, with double curve, nodulus distal; the double-pointed variety, in which the outer point is the smaller, predominant in the anterior part of the body, the single-pointed in the hinder part. Dorsal bundles in the anterior part of the body composed of 1–3 hairs and 5–8 needles; the hairs short, 130–164 $\mu$, not much longer than the needles, and absent from the whole of the gill region; the needles of the same form as those of the ventral bundles, mostly forked in the anterior part, single-pointed in the hinder part of the body. The gills are cylindrical projections segmentally arranged in the posterior part of the body, occupying the hindmost sixth to two-fifths of the body, one dorsal and one ventral in each segment; there are from 50 to 140 pairs; in length they are commonly about equal to the

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diameter of the body, shorter in front, where before disappearing they become mere tubercles; they are not ciliated; the cavity of the gill-process is shut off from the cœlom, and contains a vascular loop. Dorsal vessel situated ventro-laterally for the greater part of its extent; supraintestinal present from vi to xii; hearts two pairs, in ix and x, the first pair originating above from the supraintestinal, the second from the dorsal vessel; non-contractile loops in ii–viii. Cerebral ganglion deeply indented in

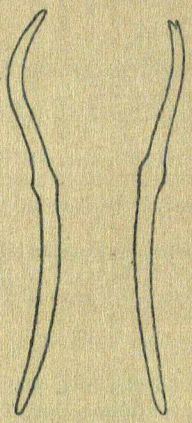

Fig. 38.—*Branchiura sowerbyi* Bedd.; single- and double-pointed setæ; × 450.

front, less markedly behind; large giant fibres in ventral nerve cord, of which one is specially enormous (up to 70 $\mu$ in diameter). Clitellum x–xii. Male pore at site of missing ventral setæ of xi. Spermathecal pore behind ventral setæ of x. Testes in x; vas deferens fairly short, joining the atrium some distance from its ental end, and thence running in the atrial wall to ental end of the latter; atrium long, joining the paratrium about the middle of its length; paratrium also much elongated, at its ectal end running with the (here narrowed) atrium for some distance before the two lumina unite; ectal portion of atrium (below union with paratrium) partially eversible as a somewhat bladder-like penis (not often seen everted); both paratrium and ental portion of atrium covered with a massive investment of "prostatic" cells (text-fig 39). Spermathecæ with almost circular ampulla and sharply distinct thick tubular duct.

*Remarks.* Many interesting and curious points have been brought out recently by the considerable amount of work which has been done on the anatomy of this species. The genital organs in particular have received attention (Michaelsen, 1908 *sup.*; Keyl, 1913; Stephenson, **68, 88**). I have shown, on the basis of the Lake Inle specimens, that the variations in size, and in the number of the gills, as well as in the length of the latter, are very considerable; but I have been unable to correlate these variations with

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the conditions of life, except in some degree with the nature of the bottom on which the animals happen to be living. Keyl has published a detailed study of much of the anatomy, in which he devotes special attention to the histology of the nervous system and to a comparative account of the giant fibres in the Annelida, to the elements of the lateral line, and to the genital system, and adds observations on the mode of life and powers of resistance.

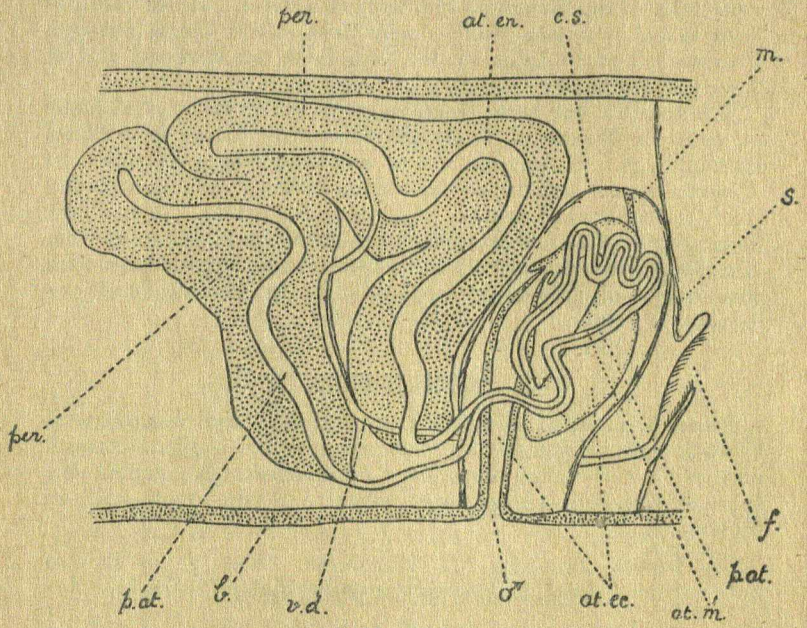


Fig. 39.—*Branchiura sowerbyi* Bedd.; male genital organs (diagrammatic). *At. ec.*, *at. en.*, *at. m.*, the ectal, ental, and middle parts of the atrium respectively; *b.*, body-wall; c.s., cœlomic sac; *f.*, male funnel; *m.*, muscular band; *p.at.*, paratrium; *per.*, peritoneal cells; *s.*, septum; *v.d.*, vas deferens; ♂, male aperture.

Antiperistalsis occurs in the intestine, and water may be taken in at the anus by "gulping movements"; but ascending ciliary action apparently does not occur in the intestine (Stephenson, 72).

Keyl states that the needle setæ are more or less plainly bifid in all bundles.

A curious point in relation to its occurrence is its association with *Limnodrilus socialis*. The two were found together in Lahore; they were found similarly in Calcutta; and they occur living together in Tokyo also.

*Distribution.* Coincides with that of the genus as given above.

The species was first found by Beddard in the mud of the *Victoria regia* tank in the Royal Botanical Society's Garden in London; Michaelsen afterwards found it in a warm water tank of

the Botanical Gardens at Hamburg; Perrier then found specimens in the Rhone; it was then recorded from several places in India, first from Lahore, where it was living freely in the open, then from Calcutta, in the Museum compound, and Madras, in the *Victoria regia* tank in the Agri-Horticultural Society's Gardens; Keyl mentions that it has been found in warm water houses in Göttingen and Frankfort; Southern records it from the *Victoria regia* tank in the Botanical Gardens in Dublin. It has recently been taken in Japan (ditches near Tokyo), and China (Kiangsu Province); and in India in the Inle Lake, at Manipur, and at Agra and Lucknow.

The question has been discussed as to where its original home is, since in Europe it is almost constantly found in artificial surroundings. S. America was at one time suggested, since the *Victoria regia* is a native of that region; when it was found living freely in India, that country also seemed possible. It has now been shown to be widely scattered in Asia; and its descent from *Kawamuria*, which is hardly to be doubted (84, 88), indicates with some degree of probability Japan or some Far Eastern locality as its place of origin.

### 3. Genus **BOTHRIONEURUM** *Štolc.*

Prostomium with a sensory pit. Dorsal and ventral setal bundles with bifid crotchets; no hair setæ. No gills. Atrium with a blindly ending appendage (paratrium). No penis. No spermathecæ. Spermatophores affixed to the body-wall in copulation.

*Distribution.* Kurseong, E. Himalayas. The genus is also known from Europe, N. America, and the Malay Peninsula.

#### 1. Bothrioneurum iris *Bedd.*

1909. *Bothrioneurum iris*, Michaelsen, Mem. Ind. Mus. i, p. 135.
1910. *Bothrioneurum iris*, Stephenson, Rec. Ind. Mus. v, p. 241, text-figs. 1, 2.

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1901. *Bothrioneuron iris*, Beddard, P. Z. S. i, p. 81, text-figs. 8–10.

Moderately stout, about 25 mm. in maximum length. Segments about 64. Prostomium semicircular. Prongs of setæ at a wide angle, the distal usually the longer, the proximal the thicker; number per bundle 3–6 in the anterior part of the body, regularly 2 in the posterior. No ventral setæ in the segment of the male pore. Masses of gland cells in connection with the alimentary tube in iii, iv, and v. No cutaneous capillaries. Clitellum on segments of male pore and succeeding segment. No penial setæ. Position of genital organs varies, male aperture being on xi or xii. Vas deferens divisible into two regions, invested by a thick layer of peritoneal cells; first part of atrium fusiform in shape, next portion irregular, with a number of folds or small diverticula; paratrium small, egg-shaped, without a cap of peritoneal cells, with

hardly distinguishable lumen, its mouth invaginated into second part of atrium ; terminal portion of atrium unites with its fellow underneath ventral nerve cord, the male aperture being median

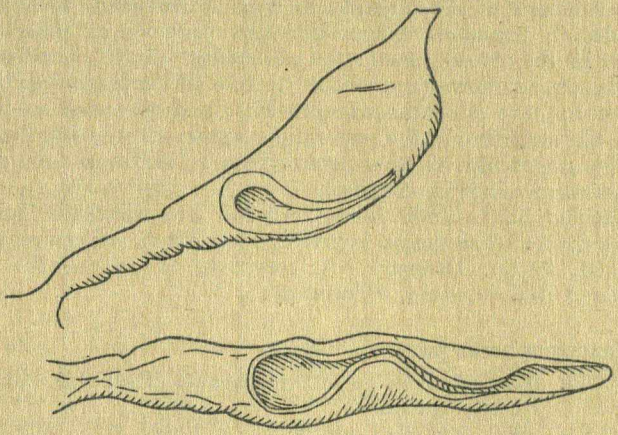

Fig. 40.—*Bothrioneurum iris* Bedd. ; empty spermatophores.

and single. Spermatophores (text-fig. 40) of somewhat fusiform or irregular shape, attached by a solid stalk to the clitellar segments, one to five in number. Female apertures paired, in groove behind male aperture.

*Distribution.* Kurseong, E. Himalayas. The species is also known from Siamese Malaya, whence it was first described.

### 4. Genus **MONOPYLEPHORUS** *Levinsen.*

1892. *Vermiculus*, Goodrich, Zool. Anz. xv, p. 474.
1895. *Vermiculus*, Beddard, Monog. p. 271.
1900. *Vermiculus*, Michaelsen, Tier. x, p. 40.
1900. *Rhizodrilus*, Fr. Smith, Bull. Illinois Lab. v, p. 444.
1900. *Rhizodrilus*, Michaelsen, Tier. x, p. 522.
1904. *Monopylephorus*, Ditlevsen, Z. wiss. Zool. lxxvii, p. 423.
1905. *Monopylephorus*, Moore, P. Ac. Philad. lvii, pt. 2, pp. 375, 376.
1909. *Rhizodrilus*, Benham, Olig. Subantarctic Is., p. 260.
1913. *Monopylephorus*, Michaelsen, Zoologica, xxvi, Heft 67, Teil 1, p. 141.
1914. *Rhizodrilus*, Benham, Tr. N. Zealand Inst. xlvii, p. 183.
1915. *Monopylephorus*, Nomura, J. Coll. Sci. Tokyo, xxxv, Art. 9, p. 44.
1917. *Monopylephorus*, Stephenson, Mem. Ind. Mus. v, p. 439.

Ventral and dorsal setal bundles with forked crotchets only. Male pore, unpaired, in xi. Spermathecal pore or pores in x. Female pores paired, in 11/12. Hearts in x, and often also in some of the preceding segments. Testes in x, vasa deferentia short, opening by means of a common simple atrium. Ovaries in xi.

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The above is taken from Michaelsen's Tierreich volume. In addition, the nephridia appear to be peculiarly constituted, having their coils closely united as in the Enchytræidæ. Nomura gives as distinctions of *Monopylephorus* from *Rhizodrilus* (both being included in the above diagnosis):—the presence of unicellular valves in the dorsal vessel; the absence of direct commissural vessels between dorsal and ventral trunks (the commissures being broken up into a cutaneous network); and the presence of a flame-like structure in the nephridium, apparently the lengthening of the upper lip of the nephrostome; besides a few other characters of minor importance.

*Distribution.* In India only recorded from Barkuda Island, Chilka Lake. The genus is widely distributed, being found in England, Japan, Denmark, N. America, the Kermadec and Auckland Islands, and the Transvaal.

1. **Monopylephorus parvus** *Ditlevsen.*

1917. *Monopylephorus parvus*, Stephenson, Mem. Ind. Mus. v, p. 485, text-fig. 1.

Maximum length 8–15 mm.; diameter ca. 0·4 mm. Segments 38–64. Colour pink in life. Prostomium large, prominent, triangular with rounded tip. Setæ of two forms, single- and

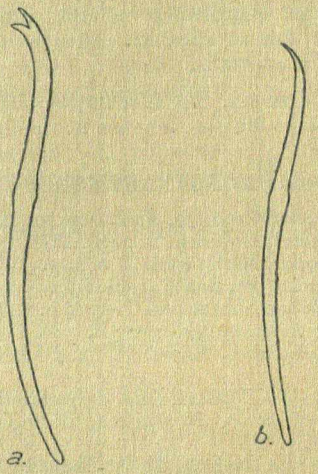


Fig. 41.—*Monopylephorus parvus* Ditlevsen; *a*, double-pointed seta from an anterior dorsal bundle; *b*, single-pointed seta from a ventral bundle behind the middle; × 760.

double-pointed crotchets (text-fig. 41); no hair setæ. Double-pointed setæ 80 $\mu$ long, 3 $\mu$ thick, nodulus somewhat distal, prongs equal in length, both comparatively short, of about equal thickness or, especially posteriorly, the outer thinner than the inner. Single-pointed setæ ca. 70 $\mu$ long, 3 $\mu$ thick, distal curve more marked than the proximal, tip sharp, nodulus slightly distal.

Some setæ with intermediate characters, the outer prong being small. Ventral setæ absent in xi, usually three per bundle, but may be more in the anterior segments, and only two posteriorly; in the anterior part the bundles consist of double-pointed setæ only, behind the middle single-pointed also occur. Dorsal setæ begin in ii, 3 per segment, or 4 or 5 in the anterior segments; anteriorly only double-pointed setæ are present, single-pointed make their appearance not far from the anterior end, and soon entirely replace the double-pointed. A sucker-like "pharynx" resembling that of Enchytræids; pharyngeal gland-cells arranged in four cords dorsally and dorso-laterally. Body-cavity corpuscles up to 10 $\mu$ in diameter. Dorsal vessel laterally or ventro-laterally situated on the left side throughout the greater part of the body, only fully dorsal at the anterior end. Supra- and sub-intestinal vessels absent. Parietal plexus within muscular layer of body-wall. Nephridia of "enchytræid" character; upper lip of funnel very long. Testes and funnels in x. Vas deferens covered almost from the beginning with high peritoneal cells, passes back in xi, and then rises towards the dorsal body-wall; loses high peritoneal investment and bends downwards; dilates to form an atrial chamber of elongated pear-shape, the narrower end below. The atria converge and unite to open on a papilla on the roof of a median depression on the ventral surface of the animal (spermiducal chamber). Sperm-sacs two, an anterior in ix, and a posterior extending backwards from septum 10/11 through several segments. Spermatheca single, in x, aperture median in 9/10, the organ being, however, on the left side; it is a somewhat twisted cylinder narrowing towards the external aperture to form a short duct. Spermatophores not formed.

*Distribution.* Barkuda Island, Chilka Lake. The species has previously been found in a littoral habitat in N. America; and a worm which may be identical has been described from Denmark.

### 5. Genus **TUBIFEX** *Lm.*

1895. *Tubifex* + *Ilyodrilus* + *Heterochæta* + *Peloscolex* + *Psammoryctes* + *Hemitubifex* + *Spirosperma* + *Embolocephalus*, Beddard, Monog. pp. 242, 257–262, 264, 272.
1900. *Tubifex*+*Ilyodrilus*, Michaelsen, Tier. x, pp. 47, 48–53, 524–525.
1909. *Tubifex*, Michaelsen, Süsswasserf. Deutsch. p. 34.
1913. *Tubifex*, Piguet, Olig. Suisse, p. 61.

Ventral bundles of bifid crotchets. Dorsal bundles of bifid crotchets, and, at least in the anterior segments, hair setæ also. Ventral crotchets differing in form from the dorsal, the latter often pectinate, or more or less incompletely pectinate (with small teeth intermediate between the two prongs). Atrium with a solid prostate, terminating in a penis. Spermatophores in the spermathecæ.

The characters which distinguish the subgenus *Tubifex* from

the others are:—Surface of the body without papillæ, smooth. Vas deferens longer than the atrium.

*Distribution.* Nilgiris, S. India. Outside India is widely distributed in Europe and N. America, and has been found in N. Africa. Apparently there is only the one record from Asia.

1. **Tubifex (Tubifex) tubifex** (*Müll.*).

1921. *Tubifex (Tubifex) tubifex*, Steph. Rec. Ind. Mus. xxii, p. 753.

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1895. *Tubifex rivulorum*, Beddard, Monog. p. 244.
1900. *Tubifex tubifex*, Michaelsen, Tier. x, pp. 48, 525.
1909. *Tubifex (Tubifex) tubifex*, Michaelsen, Süsswasserf. Deutsch. p. 37, text-fig. 73.
1913. *Tubifex (Tubifex) tubifex*, Piguet, Olig. Suisse, p. 63.

Length 30–40 mm. Segments 60–100. Reddish; rolling up into a ball on attempts to seize it. Ventral bundles with up to 5 bifid crotchets with upper tooth longer than the lower. Dorsal bundles with up to 5 crotchets which in the anterior segments present one or several small intermediate teeth but lack these posteriorly, and up to 6 hair setæ rather shorter than the diameter of the body. Hearts in viii. Spermathecæ with sac-like ampullæ; duct long, narrow, thin, and a little swollen ectally. Vas deferens long; atrium irregularly pyriform-reniform, the ental extremity thicker, but not separated as an atrial chamber from the rather narrower middle portion. Prostate large, shortly stalked; penis protractile, short, rounded in front. No penial setæ.

*Remarks.* My own specimens differed from the above description only in the ventral setæ, in which the prongs were about equal in length.

*Distribution.* In India only so far found below Coonoor in the Nilgiris. Outside India it is widely spread in Europe and has been found in N. America.

## 6. Genus **AULODRILUS** *Bretscher.*

1899. *Aulodrilus*, Bretscher, Rev. Suisse Zool. vi, p. 388.
1900. *Aulodrilus*, Michaelsen, Tier. x, p. 55.
1913. *Aulodrilus*, Piguet, Olig. Suisse, p. 57.

Crotchets numerous, with upper prong shorter and thinner than the lower. In the dorsal bundles the crotchets are accompanied or not, according to the species, by short capillary setæ. Alimentary canal much dilated from viii onwards. Hearts in vi or viii; in ii–v anastomosing lateral loops; from vii or ix onwards a pair of loops in each segment. Male pore and penial setæ on vii or x; clitellum on vii–viii or x–xi; a small atrium, followed by a long atrial duct enclosed in a muscular cœlomic sac; terminal portion of atrial duct evaginable as a pseudopenis; spermathecæ in vi or ix.

The genus is represented by two species in Europe. *A. limnobius*

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and *A. pluriseta*; in addition, a worm from the S. of France, as yet undescribed, is stated to belong to this genus, and to have retractile penes in front of the ventral setæ of segment vii.

Some species, perhaps all, form tubes. Probably in all species the hinder end of the body acts as a gill; it is highly vascularised, and the anus can dilate, forming in this way what Piguet calls a branchial fossa. The terminal part of the body is unsegmented, the posterior zone of production of new segments being situated some little distance in front of the hinder end of the animal.*

1. **Aulodrilus remex** *Steph.*

1921. *Aulodrilus remex*, Stephenson, Rec. Ind. Mus. xxii, p. 753, pl. xxviii, figs. 2–6.

Length 12 mm.; diameter 0·43 mm. anteriorly, 0·25 mm. posteriorly. Segments 49 *plus* a region where new segments are being differentiated, and behind this again a short unsegmented

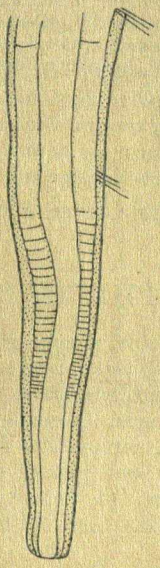

Fig. 42.—*Aulodrilus remex* Steph.; hinder end; × ca. 70.

region at the hinder end (text-fig. 42). No eyes. Dorsal setæ anteriorly in bundles of about 7 needles and 1–4 hairs; the hairs short, with a bayonet curve (text-fig. 43); needles half as long as the hairs, some singly pointed, others double-pointed with the outer prong much shorter and less conspicuous than the inner.

* As this work is passing through the press a paper by H. R. Mehra has appeared (P. Z. S. 1922, p. 943) describing two new species from Benares,—*A. kashi* and *A. stephensoni* (see Appendix). Our knowledge of the sexual organs in the genus is derived entirely from this paper.

Further back the needles are oar-shaped, with flattened distal end (text-fig. 44); number in a bundle 5 needles and 2 or 3 hairs. Ventral setæ singly or doubly pointed needles (text-fig. 45), 9 or fewer in the anterior, and 6 or 7 in the posterior segments; singly pointed needles confined to a few of the most anterior



Fig. 43.—*Aulodrilus remex* Steph.; dorsal hair seta. × 230.




Fig. 44.—*Aulodrilus remex* Steph.; distal end of dorsal oar-shaped setæ; *a*, usual form; *b*, exceptional form.



Fig. 45.—*Aulodrilus remex* Steph.; tip of double-pointed ventral seta. × ca. 1200.

segments. Œsophagus narrow, giving place to the much dilated intestine in viii. Dorsal vessel ventral in position and on the left side as far forwards as segment vii. Large parietal vessels, in complicated loops, in the hinder segments.

*Distribution.* Burhanpur, Central Provinces.

## Family PHREODRILIDÆ.

Ventral setæ 2 per bundle, single- or double-pointed crotchets; dorsal bundles with single-pointed needles or hair setæ only. Male pores on xii, spermathecal pores on xiii. Œsophagus without gizzard or appendages. Meganephridial. Central nervous system well developed, completely free from the integument. One pair of testes in xi, one pair of ovaries in xii; one pair of male funnels in front of septum 11/12; vasa deferentia debouching through atria. Asexual reproduction by fission not observed.

The family was established by Beddard in 1891, but withdrawn by him in his Monograph of 1895, where the genera *Phreodrilus* and *Hesperodrilus* were ranked under the Tubificidæ. Michaelsen adopted the same procedure in the Tierreich volume; in 1903, however, he united the two genera as *Phreodrilus*, and revived Beddard's family Phreodrilidæ; since he is of opinion that the genus shows no nearer affinities to the Tubificidæ than to other families, and regards it as a phylogenetically ancient group, with reminiscences of various families.

In the only Indian species of the family the spermathecæ open on segment xiv.

## 1. Genus **PHREODRILUS** *Bedd.*

1891. *Phreodrilus*, Beddard, Ann. Mag. N. H. (6) vii, p. 92.
1891. *Phreodrilus*, Beddard, Tr. Roy. Soc. Edin. xxxvi, p. 291.
1894. *Hesperodrilus*, Beddard, Ann. Mag. N. H. (6) xiii, p. 206.
1895. *Phreodrilus* + *Hesperodrilus*, Beddard, Monog. pp. 227, 255, 273.
1900. *Phreodrilus* + *Hesperodrilus*, Michaelsen, Tier. x, pp. 37, 38.
1903. *Phreodrilus*, Michaelsen, Olig. Tiefsee Exp. p. 134.

Cerebral ganglion bilobed, deeply cleft behind. Vas deferens ending in the middle part of the tubular atrium; no special prostate glands. Spermathecæ without diverticula; spermatozoa stored in the ampulla, no spermatophores formed. Freshwater.

*Distribution.* Nuwara Eliya, Ceylon. Also widely distributed in the S. Hemisphere.

### 1. **Phreodrilus zeylanicus** (*Steph.*).

1913. *Hesperodrilus zeylanicus*, Stephenson, Spol. Zeyl. viii, p. 257, pl. i, fig. 6.

Length ca. 8 mm., maximum diameter, 0·6 mm. Segments 34. Prostomium short, bluntly conical. Ventral setæ as a rule 2

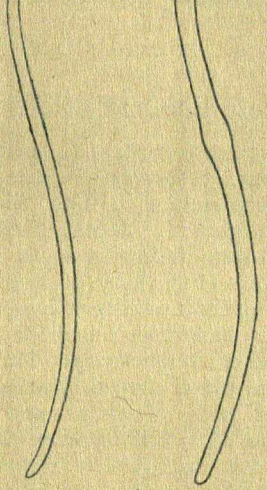

Fig. 46.—*Phreodrilus zeylanicus* Steph.; ventral setæ (the distal end of the single-pointed seta is uppermost); × 600.

per bundle, one a single- and one a double-pointed crotchet (text-fig. 46), both about 120 $\mu$ long, the shaft of the single-pointed being considerably thinner than that of the other; the

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outer prong of the forked seta is only half as long and one-third as thick at the base as the other, and has a slight nodulus which is markedly distal to the middle of the shaft. Dorsal setæ begin in iii, all capillary, up to 5 per bundle, some thicker than others, the longest equal to about the diameter of the body. Œsophagus passes without sharp demarcation into intestine in viii; no stomach. A number of large deeply staining cells on both sides of septa 4/5, 5/6, and 6/7, and a few on 7/8. Clitellum includes one-fifth of xii and all xiii. Setæ absent ventrally on xii, where are the male pores. Sperm morulæ in x and xi, not enclosed in sperm-sacs; vas deferens joins ental end of atrium; the latter vertically elongated, glandular, narrower towards its lower end and bending forwards to male aperture. Spermathecæ are ovoid sacs in xiv and xvi, dorsally situated, both however opening ventrally on xiv; ducts long and narrow.

*Remarks.* Only one specimen came under observation, and therefore some of the peculiarities mentioned above may be individual only—*e.g.*, possibly the position of the spermathecæ, and their opening on xiv (instead of on xiii, as usually in the genus).

The presence of a muscular sac in some species of the genus (*cf.* Beddard, **110**, **112**, and Benham, **114**) is paralleled in *Branchiura*. Its function is recognized by Benham, who considers it to be a part of the atrial wall separated off.

*Distribution.* Nuwara Eliya, Ceylon.

## Family ENCHYTRÆIDÆ.

Small worms, aquatic or terrestrial in habit, whitish or in some genera pinkish in colour. Setæ mostly in four bundles per segment; dorsal and ventral setæ similar in form, single-pointed, without distinct nodulus. No gizzard. Septal glands present, connected with septum 4/5 and some following septa. Dorsal vessel exists only in the anterior part of the body, at its hinder end joining the intestinal plexus. Nephridia usually of compact form, a solid mass within which the tube undergoes a number of windings. Testes and ovaries in xi and xii respectively. Male funnels as a rule elongated, more or less barrel-shaped, composed of large glandular cells; deferent canal with glandular and muscular terminal apparatus, ending on xii. Spermathecæ in v, opening in or behind groove 4/5, not infrequently communicating with the œsophagus. (Occasionally the male and female organs are displaced 3 or 4 segments forwards, the spermathecæ keeping their typical position.)

This family is extremely common in Europe, where a very large number of species have been described in recent years. The family, like the Tubificidæ, is apparently rare in India; and, as with the Tubificidæ, and for the same reasons, the rarity is

probably in part apparent only. But it is likely that the family is in reality much less well represented than in the N. Temperate zone. Thus 85 species are recorded from Switzerland alone, as against some half dozen from India (it should be stated, however, that the Swiss species may not all turn out to be separate in reality, when the fauna has been more thoroughly investigated).

The two genera which are all that are known with certainty from India (*Fridericia* and *Enchytræus*) are easily distinguished by the presence or absence of the characters mentioned under the genus *Fridericia*.

Michaelsen (Tier. x, p. 105) puts *Nais albida* (Carter, Ann. Mag. N. H. ser. 3, vol. ii, p. 22, pl. iii, figs. 47, 48) as doubtfully an *Enchytræus*. It was found at Bombay.

## 1. Genus **FRIDERICIA** *Mich.*

Mostly terrestrial. Setæ in four bundles per segment, of the *Enchytræus*-type, straight except for a proximal curve; in each bundle the setæ are disposed in pairs, the shorter being intercalated in between the longer, the shortest being thus in the middle of the bundle; sometimes only one pair of setæ in a bundle. Head-pore mostly small, between prostomium and first segment; dorsal pores exist mostly from vii backwards, sometimes from vi. Peptonephridia present. Œsophagus passes gradually into intestine. Chyle cells, with a canal in their interior, the canal opening into the lumen of the gut, and ciliated in part of its extent at least, are a general feature of some part of the anterior alimentary tract. Dorsal vessel usually originates behind the clitellum. Blood colourless. Nephridia mostly with large anteseptal portion, in which the tube undergoes some windings. Vasa deferentia long. Spermathecæ usually communicating with the gut, simple or with diverticula.

The genus is easy of recognition, the disposition of the setæ, the dorsal pores, and the chyle cells being distinctive. The position of the chyle cells may be used as a specific distinction.

*Distribution.* Wagah, near Lahore; Darjiling Dist.; Purneah Dist., Bihar (an unidentified species, Stephenson, 1917, Rec. Ind. Mus., xiii, p. 364). Has a wide—almost world-wide—distribution outside India.

*Key to the Indian species of* Fridericia.

1. Peptonephridia long tubes, male funnels comparatively small ..... *F. bulbosa.*
   Peptonephridia small, solid, club-shaped; male funnels extremely large ..... *F. carmichaeli.*

### 1. Fridericia bulbosa (*Rosa*).

1914. *Fridericia bulbosa*, Stephenson, Rec. Ind. Mus. x, p. 334.

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1895. *Fridericia bulbosa*, Beddard, Monog. p. 343.
1900. *Fridericia bulbosa*, Michaelsen, Tier. x, p. 96.

Length 4–15 mm.; segments 30–46; pale greyish in colour, transparent. Setæ in bundles of 4 in anterior, of 2 in posterior

part of body. Peptonephridia as simple or feebly ramified tubes, sometimes merely bifurcated. Dorsal vessel post-clitellar in origin. Nephridia with large urn-shaped anteseptal portion, postseptal 2–3 times as long, duct springing from the hinder end. Cerebral ganglion somewhat longer than broad. Male funnels 2–3 times as long as broad, with narrow everted margin. Spermathecæ communicating with the œsophagus, without diverticulum, ampulla bulbous or of an inverted pear-shape, duct narrow, without glands, or surrounded by small gland-cells at its termination.

*Remarks.* The above is the diagnosis as it applies to European specimens. The worms found near Lahore do not correspond exactly, and the following notes are therefore appended.

Prostomium short, rounded; the setæ are not so regular as the above diagnosis would lead one to suppose; thus the lateral setæ are usually two per bundle throughout the body (though there may be three in front of the clitellum); the ventral bundles in front of the clitellum may have only three setæ in certain segments, or indeed only two. Dorsal pores from vii onwards. Septal glands in connection with septa 4/5, 5/6, and 6/7; stomach a marked dilatation in x and xi; intestine begins in xiv. Lymph corpuscles nucleated, the largest 22–27 $\mu$ long. Nephridia small, anteseptal portion nearly as large as postseptal, the septum causing a marked constriction. Clitellum xii–xiii. No everted margin was seen in the male funnel, which was not more than twice as long as broad.

Thus there is no very exact correspondence; the worms may really belong to a different species.

*Distribution.* Wagah, near Lahore.

2. **Fridericia carmichaeli** *Steph.*

1915. *Fridericia carmichaeli*, Stephenson, Mem. Ind. Mus. vi, p. 47, pl. vi, figs. 3–5.

Length ca. 15 mm.; diameter 0·4 mm. Segments ca. 64. Prostomium rounded, semicircular. Setæ usually 2 per bundle throughout; there may be three in the ventral bundles in front of the clitellum. Head-pore present; dorsal pores from vi onwards. Cœlomic corpuscles large, oval, nucleated, glandular, especially aggregated in vii, viii, and ix, surrounding setal fragments. Peptonephridia small, solid, club-shaped; septal glands in iv, v, and vi; œsophagus passes gradually into intestine; chyle cells in xiv–xviii. Dorsal vessel extends backwards to xv; a small aggregate of cells in its interior in ix. Nephridia with relatively large anteseptal portion, one-third as long as the postseptal from which the duct originates ventrally at its hinder end. Cerebral ganglion a little longer than broad, rounded behind, concave in front. Clitellum slightly marked, xii–xiii. Male pores on conical papillæ. Male funnel with collar of

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cubical cells, main mass very large, lumen excentric; vas deferens very fine, much coiled; penial body small, compact, ovoid, on inner side of penial lumen. Ampullæ of spermathecæ ovoid, dorsally situated, continuous with œsophagus; origin of duct from upper end of ampulla, invaginated into cavity of latter, its termination about the mid-lateral line, without gland cells.

*Remarks.* The presence of setal fragments in the body cavity may be compared with what happens in *Enchytræus harurami*; on the significance of this, as indicating a possibly excretory importance of the setæ, and parallels elsewhere, see Stephenson (80, Introduction).

*Distribution.* Rungneet Tea Estate, Darjiling Dist. (4000–5000 ft.).

## 2. Genus **ENCHYTRÆUS** *Henle.*

For the most part terrestrial (but all the Indian species so far described are aquatic). Setæ straight, except at their proximal ends, where they are curved through an arc of a circle; singly pointed distally; all of a bundle of approximately equal length. No dorsal pores. Œsophagus without any sharp delimitation from the intestine. Dorsal vessel originating behind the clitellum; no cardiac body. Spermathecæ without diverticulum, and communicating with the œsophagus. Vasa deferentia long.

It will be seen from the description of *E. harurami* that one or two of the above characters are not applicable there; the vasa deferentia are there comparatively short, and no communication between spermathecæ and œsophagus was observed.

*Distribution.* Lahore; Bombay; Chilka Lake; Ennur, near Madras. Outside India it is very widely distributed—almost world-wide.

*Key to the Indian species of* Enchytræus.

| | | |
|---|---|---|
| 1. | Testes and sperm-morulæ free ..... | *E. indicus.* |
| | Testes and sperm-morulæ enclosed in sacs ..... | 2. |
| 2. | Male funnels resembling a thistle-funnel ..... | *E. harurami.* |
| | Male funnels two or three times as long as broad .. | *E. barkudensis.* |

### 1. Enchytræus barkudensis *Steph.*

1915. *Enchytræus barkudensis*, Stephenson, Mem. Ind. Mus. v, p. 142, pl. x, figs. 1–4.
1915. *Enchytræus barkudensis*, Stephenson, Mem. Ind. Mus. vi, pp. 40, 43, 45, pl. vi, figs. 1, 2.

Length (preserved) 6–15 mm.; diameter 0·3 mm., filiform. Colour light brown (preserved); practically colourless in life. Segments 46–67. Prostomium rounded, very short. Setæ 3 per bundle in both dorsal and ventral bundles in ii–xi, 2 thenceforward, except that there are none ventrally in xii. Cœlomic corpuscles numerous in the anterior part of the animal, nucleated

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and flattened plates, oval or broadly spindle-shaped, 28 $\mu$ in average length. Intestine begins in xi, xiii, xv, or xvi. Peptonephridia club-shaped, small, inconspicuous. Septal glands in iv, v, and vi. Dorsal vessel very variable in place of origin—from xii to xxii. Nephridia with short anteseptal portion, one quarter the length of the postseptal, which is narrow and elongated, giving off the duct from its under surface one-third of its length from its hinder end. Lateral vascular commissures four pairs, in ii–v. Clitellum not distinct. Testes in testis-sacs, which also contain sperm-morulæ; funnels 2 or 3 times as long as broad; vas deferens long and coiled, the penial body a small hemispherical mass of cells round its termination. Ampulla of spermathecæ small, ovoid, communicating with œsophagus, duct narrow, long, with a few slight bends in its course, no glands round its termination.

*Remarks.* The worm lives in brackish water, the saline content of which varies considerably at different times of the year; it is found below the surface of the sand, in company with *Pontodrilus bermudensis* (in both places).

The sperm-sacs have the same form as those of *E. harurami*. The nephridia appear to be of variable form, and are sometimes pyramidal in shape. On the pharynx, and a possible sensory function of the pharynx in Enchytræids generally, see **80**, p. 40.

*Distribution.* Barkuda Island, Chilka Lake; Ennur backwater, near Madras.

## 2. Enchytræus harurami *Steph.*

1914. *Enchytræus harurami*, Stephenson, Rec. Ind. Mus. x, p. 335, text-fig. 7, pl. xxxvi, fig. 1.
1915. *Enchytræus harurami*, Stephenson, Mem. Ind. Mus. vi, pp. 41, 43.

Length 4 mm. Colour opaque white. Segments 35. Prostomium rounded; no head-pore or dorsal pores. Anterior end narrower than the posterior, gently tapering. Setæ 2 per bundle throughout, both in dorsal and ventral bundles, about 53 $\mu$ long in the posterior, 40–46 $\mu$ in the anterior part of the body. Cœlomic corpuscles numerous, nucleated, in length 10–15 $\mu$, oval, pear-shaped, or spindleshaped. Septal glands in iv–vi as a connected lobulated mass on each side; peptonephridia in iv, extending into v; intestine begins in xiii. Dorsal vessel begins in xii. Nephridia in vii–x, and again from xiv onwards; anteseptal portion short, a quarter the length of the postseptal, duct one-third to a quarter as long as the postseptal. Cerebral ganglion large, slightly indented behind. Clitellum not conspicuous, xii–xiii. Sperm-sacs enclose testes and sperm-morulæ; funnels relatively small, with a well-marked rim succeeded by a globular body, the whole resembling a thistle-funnel; vas deferens straight, bending dorsalwards to enter upper surface of penial body, the latter a small spherical mass of tightly packed cells. Ampulla of spermathecæ spherical, small, marked off from the duct, no

opening into œsophagus, duct twice as long as ampulla, no diverticulum.

*Remarks.* The sperm-sacs appear not to correspond to those of the Naididæ, which are produced by the backward bulging of certain septa; these rather appear to be due to the delamination of a superficial layer from the testis itself. Into this sac the sperm-morulæ fall off; but how the spermatozoa when ripe make their way to the funnels is not exactly known (cf. **79**, **80**).

Concerning "excretory setæ" in the body-cavity, cf. **80**.

*Distribution.* Lahore (pond in Zoological Gardens).

### 3. Enchytræus indicus *Steph.*

1912. *Enchytræus indicus*, Stephenson, Rec. Ind. Mus. vii, p. 238, pl. xii, fig. 6.

Length (preserved) 4 mm. Colour brownish. Segments 31. Prostomium short, bluntly conical. Head-pore between prostomium and first segment. Setæ about 50 $\mu$ long; in ventral bundles 3 per bundle in ii–xi, absent in xii, 2 per bundle behind; dorsal setæ 2 per bundle throughout. Septal glands in iv, v, and vi; peptonephridia in iv; intestine begins in xiv. Dorsal vessel originating in xiv. Nephridia with small anteseptal portion, and pear-shaped postseptal twice as long as anteseptal, its broad end anterior; duct half as long as postseptal. Cerebral ganglion not indented behind. Clitellum xii–xiii, absent midventrally. Male funnels small; vas deferens coiled in the anterior part of xii, straight behind; penial body spherical. No sperm-sacs. Ova in segments viii–xii. Ampulla of spermathecæ small, spherical or ovoid, (probably) communicating with the œsophagus; duct several times as long as ampulla, bent once or twice in its course.

*Remarks.* The worms were found in the egg-membranes of the pond-snail *Ampullaria*.

The occurrence of the penial body, a compact mass of glandular cells surrounding the end of the vas deferens, is noteworthy, since this structure has been supposed not to occur in the genus (cf. **68**, p. 240). The seminal funnel also has here a form which is not very different from that found in other families—an intermediate condition between that and the "barrelshaped" funnel usual in the Enchytræidæ.

*Distribution.* Bombay.

## Species inquirenda Enchytræidarum.

### Henlea (?) lefroyi *Bedd.*

1905. *Henlea lefroyi*, Beddard, P. Z. S. p. 562.

Length 3–4 mm. Segments 27. Colour white. No dorsal pores detected. Setæ "of the usual Enchytræid form," curved; 2 in the lateral bundles (exceptionally 3), and 3 in the ventral. Septal glands in iv, v, and vi, of equal size in the three segments.

Peptonephridia present but very short. Œsophagus not demarcated from intestine; no cæca or pouches on gut. Dorsal vessel anteclitellar (segment xi) in origin; no cardiac body; no dorsal diverticulum as in *Buchholzia*. Orifices of atria conspicuous on xii, in line with ventral setæ, which are absent here. No penial setæ. Sperm funnels of the usual type, but details cannot be given. Spermathecæ open into œsophagus in v; external openings in 4/5; no diverticulum.

Lefroy found that the worms attacked and destroyed the eggs of a locust of the genus *Acridium*, when the ground in which these are deposited is moist.

Michaelsen (Mem. Ind. Mus. i, 1909, p. 115) considers the genus to which the worm belongs uncertain; it may be a *Marionina* or *Lumbricillus*. Welch (Bull. Illinois Lab. x, 1914, p. 126) also criticizes the ascription of the worm to the genus *Henlea*.

## Family MONILIGASTRIDÆ.

1900. Moniligastridæ, Michaelsen, Tier. x, p. 109.
1919. Moniligastridæ, Smith and Green, Proc. U.S. Nat. Mus. lv, p. 145.
1922. Moniligastridæ, Stephenson, P.Z.S. pp. 134, 135, 136, 142, 147.

Setæ simple, pointed, sigmoid, four pairs per segment. Clitellum extending over 3 to 6 segments, including those bearing the genital pores. Male pores one or two pairs, in or near grooves 10/11, 11/12 or 12/13. Female pores one pair, in 11/12 or on xiii or xiv. Spermathecal pores one or two pairs, in 7/8 or 8/9, or 7/8 and 8/9. Œsophagus with two gizzards anterior to x, or two to ten gizzards at beginning of intestine. Last heart two segments in front of ovarian segment. Meganephridial. Testes and funnels one or two pairs, enclosed in one or two pairs of testis sacs; vasa deferentia opening into prostate glands, or independently of them. One pair of ovaries in the segment immediately in front of the groove or segment on which the female pores are situated; one pair of ovisacs extending backwards from the ovarian segment. One or two pairs of spermathecæ, with long tubular ducts.

The above definition is slightly modified from that current until recently, on account of the discovery of the new genus *Syngenodrilus* in British E. Africa. This worm is different in many respects from those previously known, and its discovery has necessitated the division of the family into two subfamilies, one of which contains *Syngenodrilus* only (Syngenodrilinæ), the other all the forms previously known (Moniligastrinæ).

I have recently (98) discussed the phylogenetic history of the family, and of the individual genera, at some length. I consider the testis sacs of the Moniligastridæ, which differ in essential respects from those of other Oligochæta, as the morphological

equivalents of segments. The ancestor of the family probably possessed three pairs of testes, in segments x, xi, and xii; three pairs of funnels, prostates, and male pores, the latter in furrows 11/12, 12/13, and 13/14; two pairs of ovaries, in segments xiii and xiv; and three pairs of spermathecæ, opening in furrows 6/7, 7/8, and 8/9.

*Syngenodrilus* is derived from the above form by a contraction, or huddling together, of the testis segments in such a way that the middle one is almost squeezed out of existence and the other two become testis sacs; by a corresponding reduction of the number of spermathecæ to two pairs opening in 7/8 and 8/9; and by the disappearance of the anterior pair of ovaries with their funnels and ducts.

*Desmogaster* is derived from the common ancestor by the contraction of the segments of the first and third pairs of testes to form testis sacs, and the disappearance of the middle pairs of male organs; by a corresponding diminution in the number of spermathecæ, the remaining pairs opening in 6/7 and 7/8; and by the disappearance, as in *Syngenodrilus*, of the anterior ovary with its funnel and duct.

*Eupolygaster* came into existence by the further disappearance of the posterior pair of male organs and the anterior pair of spermathecæ of *Desmogaster*.

*Drawida* and *Moniligaster* originated from a form similar to *Desmogaster* by a contraction or huddling together of the testis segments like that in *Syngenodrilus*, but carried further, so that the testis sacs fuse, extinguishing the intervening segment; the spermathecæ are again reduced to one pair.

*Distribution.* The Moniligastrinæ are mainly found in S. India; also in Ceylon, Burma, Bengal, the E. Himalayas, and the other localities under *Drawida*; outside India in the Malay Archipelago, Philippine Islands, Japan, China, Caroline Islands, Bahamas. The Syngenodrilinæ have been found only in British E. Africa.

## Subfamily MONILIGASTRINÆ.

1890. Moniligastridæ, Rosa, Ann. Mus. Genova, (2) ix, pp. 368, 380, 391.
1895. Moniligastridæ, Beddard, Monog. p. 192.
1900. Moniligastridæ, Michaelsen, Tier. x, p. 109.
1909. Moniligastridæ, Michaelsen, Mem. Ind. Mus. i, p. 117.
1910. Moniligastridæ, Michaelsen, Abh. Ver. Hamburg, xix, p. 20.
1914. Moniligastridæ, Stephenson, Rec. Ind. Mus. viii, p. 367.
1919. Moniligastrinæ, Smith and Green, Proc. U.S. Nat. Mus. lv, p. 145.

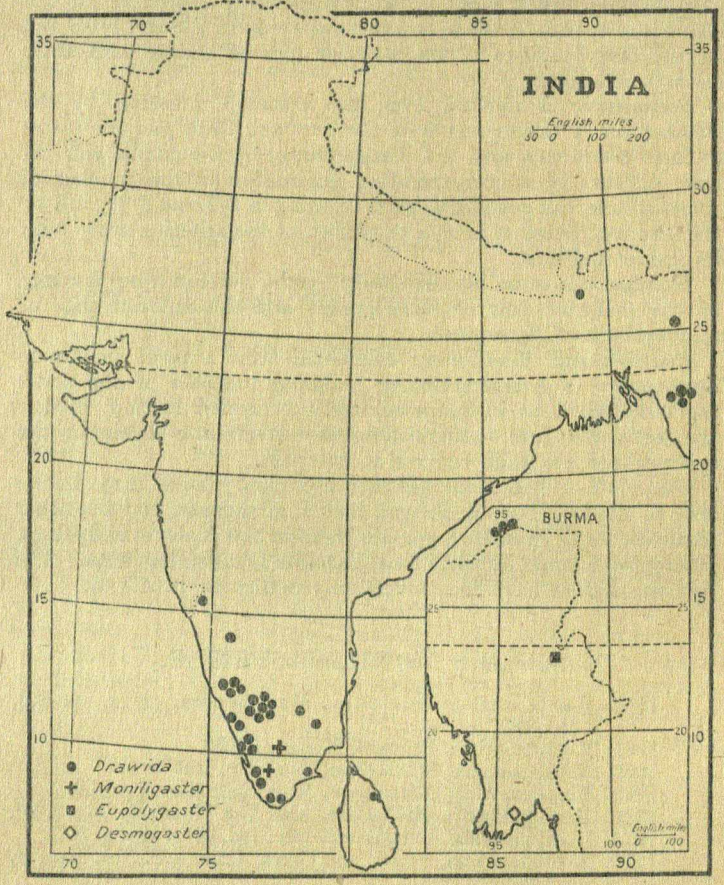
Male pores one or two pairs, in 10/11, or 11/12 and 12/13. Œsophagus with a number (2–10) of gizzards at the beginning of the intestine. Vasa deferentia enter each a prostate.

The subfamily contains all the forms that have been accounted to the family until recent times, and coincides with the Moniligastridæ of previous authors up to 1919. The features which

distinguish the subfamily from the genus *Syngenodrilus*, which constitutes the subfamily Syngenodrilinæ, are (1) the position of the gizzards—in front of segment x in *Syngenodrilus*, at the beginning of the intestine in the Moniligastrinæ; (2) the

CHART I.

*Distribution of endemic species of Moniligastridæ in India.*




presence in *Syngenodrilus* of prostate glands independent of the sperm-ducts; the so-called "prostates" of the Moniligastrinæ are modifications of the terminal portions of the ducts themselves.

*Distribution.* As for the family, excluding British E. Africa. For a graphic representation of the Indian distribution of the subfamily cf. Chart 1.

*Key to the genera of* Moniligastrinæ.

| | |
|---|---|
| 1. Two pairs of male pores | DESMOGASTER. |
| One pair of male pores | 2. |
| 2. A stalked glandular mass, usually double, associated with the spermathecæ | MONILIGASTER. |
| Spermathecæ without a stalked glandular mass in association | 3. |
| 3. Female pores in 11/12 | DRAWIDA. |
| Female pores anteriorly on xiii | EUPOLYGASTER. |

## 1. Genus **DESMOGASTER** *Rosa.*

1890. *Desmogaster* (typ. *D. doriæ*), Rosa, Ann. Mus. Genova, (2) ix, p. 369.
1895. *Desmogaster*, Beddard, Monog. p. 205.
1900. *Desmogaster*, Michaelsen, Tier. x, p. 110.
1922. *Desmogaster*, Stephenson, P.Z.S. pp. 136, 138, 144.

Two pairs of male pores, in 11/12 and 12/13; female pores anteriorly on xiv; spermathecal pores one or two pairs, in 7/8 or 8/9, or 7/8 and 8/9. Gizzards 7–10, at the beginning of the intestine. Last heart in xi. Two pairs of testes and funnels, enclosed in sacs, on septa 10/11 and 11/12. Two pairs of much elongated prostates. Ovaries in xiii; ovisacs extending back from septum 13/14. Spermathecæ without atrial dilatation or stalked glands at ectal end.

*Distribution.* Burma. Outside India in Sumatra and Borneo.

### 1. **Desmogaster doriæ** *Rosa.*

1890. *Desmogaster doriæ*, Rosa, Ann. Mus. Genova, (2) ix, p. 369, pl. xii, figs. 2–11.
1895. *Desmogaster doriæ*, Beddard, Monog. p. 205.
1900. *Desmogaster doriæ*, Michaelsen, Tier. x, p. 111.

Length 500 mm.; maximum diameter 12 mm. Segments 240–330. Colour yellowish brown, lighter ventrally. Prostomium prolobous. Setæ closely paired; no setæ visible on the most anterior segments; $aa=2bc$. No dorsal pores. Nephridiopores just above *b*. Clitellum ? Male pores in *cd*. Female pores in *ab*. Spermathecal pores in *cd*, eyelike.

Septa 6/7–9/10 much thickened; a number of septa behind 8/9 are displaced backwards, especially dorsally. Gizzards 10, in xx–xxix, each occupying the anterior part only of its segment. The last two hearts larger than the rest, in x and xi; beneath these two pairs are other pairs close to the œsophagus, joining the lateral longitudinal vessels on the body-wall. Testis sacs suspended on 10/11 and 11/12, projecting forwards and backwards. Vas deferens long, joining ental end of prostate. Prostates about 7 mm. long, tubular, slightly curved in S-shape, surface smooth; multicellular pear-shaped glands contained within

the wall, peritoneal covering outside. Ovaries elongated, cylindrical, wavy. Ovisacs elongated, in xiv and xv, extremity irregularly lobed, but surface not mammillary in appearance. Spermathecal ampulla of a flattened heart-shape, duct long and fine.

*Distribution.* Meteleo, Cheba or Biapo Dist., Burma.

## 2. Genus **EUPOLYGASTER** *Mich.*

1900. *Eupolygaster*, Michaelsen, Tier. x, p. 112.
1909. *Eupolygaster*, Michaelsen, Mem. Ind. Mus. i, pp. 117, 141.
1922. *Eupolygaster*, Stephenson, P. Z. S. pp. 136, 144.

Clitellum xii–xv (=4) (?). Male pores in 10/11; female pores on the anterior part of xiii; spermathecal pores in 7/8. Gizzards 4–7. Last heart in x. One pair of testes and funnels, enclosed in testis sacs on septum 9/10. Prostates long, sausage-shaped. Ovaries in xii; ovisacs extending backwards from 12/13. Spermathecæ without atrial dilatation or stalked glands at ectal end.

The name was introduced by Michaelsen in the Tierreich to replace *Polygaster* Horst, previously occupied. The relationships of the genus are discussed by Michaelsen and Stephenson.

*Distribution.* Burma. Outside India the genus occurs in Sumatra and Borneo.

### 1. Eupolygaster browni *Mich.*

1907. *Eupolygaster browni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 143.
1909. *Eupolygaster browni*, Michaelsen, Mem. Ind. Mus. i, p. 139.

Length 150 mm.; diameter 4–6 mm. Segments 293. Colour brownish. Prostomium broad, prolobous. First segment with a secondary furrow, exactly resembling an intersegmental groove. Setæ very small, especially in the anterior part of the body, inconspicuous or missing in the first 8 segments, closely paired; all ventral, $aa = 2\frac{1}{3}bc$ anteriorly, $= 1\frac{1}{2}bc$ posteriorly; $dd$ = ca. $\frac{2}{3}u$. Clitellum ? Male pores just medial from *c*. Female pores ? Spermathecal pores in similar position to the male pores.

Septa 4/5–8/9 thickened; 9/10 displaced backwards dorsally, as also some of the following. Gizzards 6, well developed, in xix–xxiv; a vestigial gizzard in xviii. Testis sacs rather small, not stalked, depending into x. Vas deferens long, irregularly undulating but not coiled, on hinder surface of 9/10, enters ental end of prostate. Prostate tubular, bent in the form of a **U**, long and thick, smooth, with muscular shimmer, ectal end a little enlarged. No ovarian chamber noted; ovisacs moderately long, somewhat undulating, extending back through several segments. Spermathecæ with irregularly pear-shaped ampulla, and long duct not sharply marked off from ampulla, lying against hinder face of 7/8, irregularly winding. No atrial dilatation.

*Remarks.* If the groove on segment i is really an intersegmental

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groove, the numbering of the segments in this species will have to be increased by one, and it will differ from the other species of the genus.

*Distribution.* Lashio, N. Shan Hills, Burma.

### 3. Genus **MONILIGASTER** *E. Perr.*

1872. *Moniligaster* (type *M. deshayesi*), E. Perrier, N. Arch. Mus. Paris, viii, p. 130.
1895. *Moniligaster* (part.), Beddard, Monog. p. 196.
1900. *Moniligaster*, Michaelsen, Tier. x, p. 112.
1909. *Moniligaster*, Michaelsen, Mem. Ind. Mus. i, p. 140.
1922. *Moniligaster*, Stephenson, P. Z. S. pp. 141, 144.

One pair of male pores in 10/11, one pair of female pores in 11/12, one pair of spermathecal pores in 7/8. Gizzards 4 or 5, in front of the intestine. Last pair of hearts in ix. One pair of testis sacs on septum 9/10. Prostates with duct distinguishable from glandular part. Ovaries in xi. Ovisacs extending backwards from 11/12. Spermathecæ with a bifid muscular atrial chamber, each horn of which bears a lobulated glandular mass.

Michaelsen subjected the type-specimens of the genus to re-examination, and on the basis of this and of the examination of a second species the characters of the genus are now definitely determined.

The difference between this genus and *Drawida* is small, and consists only in the possession by *Moniligaster* of a pair of branched tubes opening into the two horns of the atrial chamber, or, as I should prefer to say, a pair of glands discharging each by its own canal into a common duct (*cf.* my description of *M. deshayesi*, **80**), and the absence of such an apparatus in *Drawida*. Michaelsen considers that it might be allowable to unite the two as *Moniligaster* s. l., or to consider them as subgenera of a larger genus *Moniligaster* s. l. (**54**). Compare, on the relationships of the genus, Stephenson (**98**).

*Distribution.* Cochin State; Travancore; Palni Hills; ? Ceylon.

*Key to the species of* Moniligaster.

Prostates elongated backwards, at least as far as xiii.... *M. deshayesi.*
Prostates confined to xi ..... *M. perrieri.*

#### 1. **Moniligaster deshayesi** *E. Perr.*

1872. *Moniligaster deshayesi*, E. Perrier, N. Arch. Mus. Paris, viii p. 130, pl. iv, figs. 77–84.
1895. *Moniligaster deshayesi*, Beddard, Monog. p. 199.
1900. *Moniligaster deshayesi*, Michaelsen, Tier. x, p. 112.
1909. *Moniligaster deshayesi*, Michaelsen, Mem. Ind. Mus. i, p. 149.
1910. *Moniligaster deshayesi*, Michaelsen, Abh. Ver. Hamburg, xix, p. 54.
1915. *Moniligaster deshayesi*, Stephenson, Mem. Ind. Mus. vi, p. 57.

Length 150 mm.; diameter 6·5 mm. Colour a medium olive ventrally, darker dorsally with a bluish tinge. Segments ca.

184. Prostomium indistinct. Slightly thickened regions laterally in each segment. No dorsal pores. Setæ closely paired, minute; *aa*=*bc*; *dd* slightly more than half circumference. Nephridiopores in *ab* or *cd*, no regular alternation. Clitellum not well marked, x–xiii (=4). Male apertures small, between *b* and *c*, nearer *b*. Female pores indistinct, in *b*. Spermathecal pores minute, just below *c*, or in *cd*.

Septa 4/5 and 5/6 fused at their peripheral attachment; 6/7–8/9 much thickened. Gizzards four, in xv–xviii or xvi–xix. Testis sacs large, on posterior face of 9/10, may extend back into xii; funnel fused with wall of sac. Vas deferens very long, with numerous loops which are bunched together, one bunch projecting into ix, another into x. Prostates very large, sausage-shaped, pearly white, extending back through several segments; vas passes back along it, fusing with it some little distance from its ental end; terminal part of prostate narrower, more shining, duct-like, rather twisted. Ovarian chamber present; ovisacs large, extending back through several segments. Spermatheca with broadly ovoid ampulla and coiled duct, which joins bifurcation of atrial appendage; glandular appendage in vii, large, bifid, each half compact and rounded, with a yellowish mammillated surface, the whole bound down to the ventral parietes and to septum 7/8 by areolar tissue; the stalks of the two halves unite to form a common duct, which is not dilated.

*Distribution.* Parambikulam, Cochin State; Anachardie and Neduvangad, Travancore; ? Ceylon. (Michaelsen doubts the statement that Perrier's original specimen came from Ceylon.)

*a.* var. **minor** *Mich.*

1913. *Moniligaster deshayesi* var. *minor*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 78.

Length 110 mm.; maximum diameter 4 mm. Segments ca. 200. Colour reddish grey with greenish iridescence. Prostomium prolobous. Setæ very fine and very closely paired; *aa* is about equal to *bc*. Clitellum x-xiii, ring-shaped, but less distinct ventrally in x and xiii. Male pores about midway between *b* and *c*, surrounded by small somewhat lighter areas. Five gizzards, the first small but not rudimentary. Testis sacs may extend back as far as xiv, after the manner of *Drawida ghatensis*. Prostates extend two or three segments backwards, duct not sharply delimited, smooth, spirally curved, half the length of the whole; glandular portion wavy in its course, chalky white, of glandular appearance, vas deferens entering its ental end. Ovisacs extend back to about xiv.

*Remarks.* The atrial appendages appear to be essentially as in the type-form; the setæ, too, seem to be arranged similarly. The smaller size, the number of gizzards, and the smaller extent of the prostates distinguish the two.

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*b.* var. **gravelyi** *Steph.*

1915. *Moniligaster deshayesi* var. *gravelyi*, Stephenson, Mem. Ind. Mus. vi, p. 59.

Length 130 mm.; diameter 5 mm. Dorsal surface a bluish grey, ventral surface lighter than dorsal; lateral regions thickened, lighter in colour than either dorsal or ventral regions. Prostomium absent (or invisible). $Aa = bc$ approximately; $dd = \frac{1}{2}$ circumference in middle of body. Nephridiopores in *ab* or *cd*, no regular alternation. Male pores about midway between *b* and *c*.

Vas deferens enters prostate at its ental end. Prostate extends back to xiii, its surface presenting shallow depressions marking out ill-defined lobes. Atrial gland single, a short moderately stout duct being given off from its under surface; spermathecal duct joins atrial gland on its upper border.

*Remarks.* The distinguishing feature is the single character of the atrial gland. A specimen of the type-form which came under my examination showed a gland which was only indistinctly bifid, and so presented a transition to this variety.

*Distribution.* Trichur, Cochin State.

2. **Moniligaster perrieri** *Mich.*

1907. *Moniligaster perrieri*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 146.
1909. *Moniligaster perrieri*, Michaelsen, Mem. Ind. Mus. i, p. 150.
1913. *Moniligaster perrieri*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 78.

Length 210 mm.; maximum diameter 5 mm. Segments ca. 175. Colour bluish grey, darker dorsally than ventrally. Prostomium prolobous or indistinctly zygolobous. Setæ very small, very closely paired; $aa = bc$; $dd$ = ca. $\frac{1}{2}$ circumference. Dorsal pores apparently absent. Nephridiopores in *cd*. Clitellum ring-shaped, occupying $\frac{1}{3}$ix–xiv ($= 5\frac{1}{3}$), less marked at the two ends. Male pores a little lateral from *b*, in hexagonal depressions the inner borders of which touch the lines of *b*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 6/7–8/9 moderately strong; 9/10 attenuated, pushed back very far. Five gizzards in xvii–xxi; the fourth strongest, thenceforward diminishingly strong as far as the first, the fifth the weakest of all, almost rudimentary. Testis sacs large, ovoid, depending backwards. Vas deferens enormously long, presenting a bunch of long narrow loops projecting forwards into ix. Prostates confined to xi, glandular part twice as long as thick, bent, surface mammillated, vas enters ental end, which is directed forwards; duct from under surface, a little thinner than glandular part, about as long as thick, nacreous in appearance. Ovisacs very large, thick, extending backwards through a number of segments, it may be as far as xx. Spermatheca resembles that of the previous species in all principal points except that the muscular atrial chamber and its horns are here shorter and thicker, and not so distinctly tubular.

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*Distribution.* Kodaikanal and Tiger Shola, Palni Hills; Ponmudi and Bonaccord, Travancore. In both the Travancore localities it was found in water.

## 4. Genus **DRAWIDA** *Mich.*

1895. *Moniligaster* (part.), Beddard, Monog. p. 196.
1900. *Drawida*, Michaelsen, Tier. x, p. 114.
1909. *Drawida*, Michaelsen, Mem. Ind. Mus. i, pp. 117, 137.
1922. *Drawida*, Stephenson, P. Z. S. pp. 141, 144.

Clitellum including the whole or the greater part of x–xiii. One pair of male pores in 10/11; female pores in 11/12; spermathecal pores in 7/8. Two to eight gizzards at beginning of intestine. Last heart in ix. One pair of testes and funnels, enclosed within testis sacs which project from septum 9/10 into segment x or segments ix and x. Prostates of various form. Ovaries in xi; this segment may be reduced to a special ovarian chamber of characteristic form; one pair of ovisacs projecting backwards from septum 11/12. Spermathecæ with or without atrium-like dilatation at ectal end, without stalked glands.

*Distribution.* Southern India, also Ceylon; the Himalayas, especially the Eastern; Bengal; Burma; also rarely in Central India; the Andaman Islands. Outside India an endemic (?) species has been found in Borneo (**131**), and peregrine species have been found in the Caroline Islands, Sumatra, the Sunda Islands, the Philippine Islands, Japan, China, and the Bahamas.

This is one of the large Indian genera; only one species is known which does not occur in British India,—the one in Borneo. The genus presents many peculiarities.

The external features of the living worms have not often been recorded, except by Bourne (**28**), who gives beautiful coloured figures of a number of his species. The colours are very various, but change in spirit, and are then less distinctive; while some species are deeply pigmented, others are pale, almost or quite without pigment.

The genus is remarkable in having, as a rule, no dorsal pores (v. Introduction, Bionomics, p. 34); *D. barwelli* is an exception, and pores are found in a vestigial condition in *D. nepalensis* and *D. rosea.*

In a few species rings of minute papillæ have been noticed, which, when well marked, resemble the small projections which bear the setæ in Perichætine worms. They are visible only under a dissecting microscope, and occur most markedly in the anterior part of the body; they are also seen in the genus *Moniligaster*, and I have suggested that they are probably sensory. They have not, however, been investigated histologically.

There is sometimes to be seen a thickening of the lateral regions of the body (also found in *Moniligaster*); in these cases the body-wall seems to be slightly swollen along each side in

about the middle third of the half circumference, and the inter-segmental grooves are deeper as they pass over this tract.

The setæ are almost always very small and closely paired; they may be absent in segment ii, or even further back, in either the lateral or ventral bundles, or both; even when present, those of the most anterior segments may be very difficult to see. It is possible that this condition of the setæ, like the absence of dorsal pores, may be related to a former aquatic habit; setæ of the usual type would be of little use in locomotion in water or mud, and the worm would have to depend on wriggling movements only. Penial and copulatory setæ are never found.

Genital markings are found comparatively rarely.

Septa 5/6–8/9 are nearly invariably thickened, sometimes to a remarkable degree; occasionally the thickening begins with 6/7. The remainder are thin; a few of the succeeding septa may be displaced somewhat backwards.

The number of gizzards, and their position, are not constant within the various species; a difference of one or two in the number, and of one or two segments in their position, is not uncommon. The smallest number of gizzards is two, the largest eight; three to five are the commonest numbers; they are specially far back in *D. nilamburensis* (some segments on each side of the thirtieth). All the gizzards may not reach the same degree of thickening; those at the anterior end of the series may be more feebly developed, and it is sometimes difficult to say where exactly the muscular development justifies the name of gizzard, the œsophagus becoming gradually more muscular over several segments. In some cases again the muscular thickening is continuous from segment to segment, and there is but little constriction at the septa; while in others the segmental thickenings are separated from each other by soft rings where the alimentary wall is unmodified and thin. There is no evidence that the peculiar development of the œsophagus is related to a harder nutriment—rather the reverse.

The last heart is always in segment ix.

The nephridia are meganephridia of a rather distinctive type, which I have described (98) in *D. japonica*. They do not appear to be of importance from a systematic point of view, and the above reference will therefore be sufficient.

Testes, male funnels, and developing sperm-morulæ are contained in special sacs connected with septum 9/10—suspended on the septum and projecting backwards into segment x or more commonly forwards and backwards into both ix and x; in the latter case they may be more or less constricted by the septum. I have argued (98) that the sacs represent a segment, the anterior and posterior walls of which have fused together for the most part, only remaining separate at the position of the sacs. This receives confirmation from the condition of the ovarian segment, where we see a similar contraction going forward, though without having reached the same degree.

Thus in some species there is nothing unusual about segment

xi, the ovarian segment. In other cases it is narrow from front to back, and the anterior and posterior walls meet above, where they are inserted together into the dorsal parietes. In still other species septa 10/11 and 11/12 fuse dorsally for some distance downwards, so that on opening the animal the contents of the segment, which may now be called the ovarian chamber, are not at first displayed, and a segment appears to be missing. There are other peculiarities also in the cases of fully developed ovarian chamber, which I have described in the paper referred to above; septa 10/11 and 11/12 fuse together above and at the sides of the œsophagus, which is thus excluded from the chamber; and both are missing below, so that segment x communicates directly with xii.

The prostate is the terminal part of the male deferent apparatus. Its form varies considerably; it may be an elongated cylinder, the thin vas deferens joining it at its ental end or at some point in its extent; or it may be a short cylinder, with the vas deferens joining it at its ental or sometimes apparently at its ectal end; or it may be reduced to a cushion-like circular or oval pad on the inner surface of the body-wall. Essentially it seems to be the thickened terminal part of the duct, the lumen widened and surrounded by a firm muscular coat, with a thick layer of large peritoneal cells on the surface; the narrow vas deferens thus enters normally at the ental end. In certain cases the vas deferens, although appearing to join the prostate lower down, can be separated from it and shown to become continuous with it at its ental end; in other cases this cannot be demonstrated by dissection, but sections show that in *D. japonica* the condition is the same, as doubtless it is in other species also. The cushion-like form is thus to be looked on as a secondary shortening of the primitive cylindrical form.

The investment of peritoneal ("glandular") cells varies; in some cases it appears as a number of pear-shaped aggregations, in others as a mammillated covering, while in others the peritoneum seems to have its more usual characters, and the muscular coat of the prostate appears with the characteristic shimmer. The glandular cells do not appear to communicate with the lumen of the prostate (Stephenson, **98**). The presence or absence of these glandular cells has some systematic importance; thus Michaelsen (**58**) establishes a closely related group of forms (the *pellucida* group) of which a smooth muscular prostate is one of the characters.

The spermathecæ have a characteristic form. They begin in an ovoid or pear-shaped ampulla, which is attached to the posterior face of septum 7/8 by a mesentery, usually within the arch of the nephridium, and not far from the middle line; from the lower end of the ampulla passes the duct, long, fine, and coiled, also attached by mesentery to the septum; on reaching the ventro-lateral body-wall the duct ends in one of several ways:—either it may immediately pass to the exterior without undergoing any

dilatation, or with only a slight dilatation which is concealed within the body-wall; or its terminal part may be expanded, the expansion being larger or smaller, simple or bifid,—the expansion being the continuation of the duct; or from the somewhat dilated terminal part of the duct a diverticulum may arise, sometimes of considerable size, narrow and elongated or broad and sac-like. The whole of this terminal apparatus is contained in segment vii, except that one horn of the bifid atrium may be situated on the posterior side of the septum.

Michaelsen (54) compares the several parts of this whole apparatus with the parts of the spermathecæ of the Megascolecidæ. In the Megascolecidæ the spermatozoa are contained in the diverticula, the main pouch being apparently glandular in function; the opposite is the case in the Moniligastridæ. Still it does not seem possible to homologize the ampulla of the Moniligastridæ with the diverticulum of the Megascolecidæ and *vice versa*; the invariable part of the Megascolecid apparatus is the main pouch, and so it is in the Moniligastridæ; these are therefore homologous with each other, and with the simpler organs of the lower families. The diverticula of the Megascolecidæ and the atrial sacs or branched glands of the Moniligastridæ (*Drawida* and *Moniligaster*) have been evolved independently, and so are not to be considered as homologous.

For the relationship of *Drawida* to *Moniligaster*, and the mode of derivation of the several genera of Moniligastrinæ from the common ancestor, see Michaelsen (54), and Stephenson (98).

In describing species of *Drawida* the important characters are the following:—Pigmentation; closeness of pairing of the setæ and relative extent of the intersetal intervals; the positions of the male, female, and spermathecal pores with reference to the setal lines; genital markings; number and position of gizzards; shape and position of testis sacs; shape of prostate and condition of its surface; presence or absence of an ovarian chamber; description of atrium—its size, and presence or absence of sac-like appendage.

*Key to the Indian species of the genus* Drawida.

| | | |
|---|---|---|
| 1. | Two gizzards | 2. |
| | More than two gizzards | 7. |
| 2. | Genital papillæ present | 3. |
| | Genital papillæ absent | 5. |
| 3. | Prostates two pairs | *D. scandens.* |
| | Prostates one pair | 4. |
| 4. | Spermathecal atrium small, pear-shaped | *D. japonica* (part.). |
| | Spermathecal atrium absent | *D. modesta.* |
| 5. | Setal interval *aa* less than *bc*...? | *D. travancorensis.* |
| | Setal interval *aa* equal to or greater than *bc*. | 6. |
| 6. | Atrium a bilobed widening of end of spermathecal duct | *D. minuta* (part.). |
| | Atrium a simple ovoid sac, duct entering its ectal end | *D. willsi.* |

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|---|---|---|
| 7. | Spermathecal atrium absent | 8. |
| | Spermathecal atrium present | 16. |
| 8. | Setal interval *aa* equal to or greater than *bc*. | 9. |
| | Setal interval *aa* less than *bc* | 14. |
| 9. | Spermathecal pores in or near *c* or *cd* | 10. |
| | Spermathecal pores between *b* and *c*, but nearer *b* | *D. fakir*. |
| 10. | Dorsal pores present | *D. barwelli*. |
| | Dorsal pores absent | 11. |
| 11. | Male pores midway between *b* and *c* | *D. barwelli* var. *impertusa* (part.). |
| | Male pores between *b* and *c*, but nearer to *b*. | *D. pellucida* (part.), 12. |
| | Male pores between *b* and *c*, but nearer to *c* (just below *c*) | *D. kempi* (part.). |
| 12. | Genital marking as a ridge on ix | var. *stewarti*. |
| | No genital ridge | 13. |
| 13. | Non-pigmented | f. *typica* (part.). |
| | Heavily pigmented | var. *bournei*. |
| 14. | Setal interval *aa* in middle of body equal to half *bc* | *D. friderici*. |
| | Setal interval *aa* in middle of body greater than half *bc* | 15. |
| 15. | Complete ovarian chamber; indefinite genital papillæ on segment x | *D. barwelli* var. *impertusa* (part.). |
| | Complete ovarian chamber; genital papillæ on segment ix | *D. rotungana*. |
| | Ovarian chamber incomplete or absent; no genital papillæ | *D. pellucida* var. *pallida* (part.). |
| 16. | Atrium bilobed | 17. |
| | Atrium not bilobed | 21. |
| 17. | Testis sacs much elongated backwards | 18. |
| | Testis sacs with the usual relations | 19. |
| 18. | Each prostate composed of two finger-shaped structures side by side | *D. somavarpatana*. |
| | Each prostate a single ovoid or pear-shaped mass | *D. ghatensis*. |
| 19. | Male and spermathecal pores in *ab* | *D. minuta* (part.). |
| | Male pores between *b* and *c*, spermathecal pores in *cd* | *D. robusta*, 20. |
| 20. | Setal interval *aa* greater than *bc* | var. *typica*. |
| | Setal interval *aa* not greater than *bc* | var. *ophidioides*. |
| 21. | Setal interval *aa* in middle of body equal to or greater than *bc* | 22. |
| | Setal interval *aa* less than *bc* | 34. |
| 22. | Spermathecal atrium not separated off from end of spermathecal duct, of which it is a dilatation | 23. |
| | Atrium a sac or projection independent of ectal end of spermathecal duct | 29. |
| 23. | Worm of large size, over 500 mm. long | *D. nilamburensis* |
| | Worm less than 250 mm. long | 24. |
| 24. | Prostate elongated or teat-like | 25. |
| | Prostate hemispherical, hemiovoidal, or cuboid | 26. |
| 25. | Ovarian chamber present | *D. elegans*. |
| | No ovarian chamber | *D. uniqua*. |

| | |
|---|---|
| 26. Surface of prostate soft and glandular .... | 27. |
| Surface of prostate smooth and muscular.. | 28. |
| 27. No genital markings ..... | *D. kempi* (part.). |
| Genital markings as seminal grooves leading backwards from near male pores.... | *D. sulcata.* |
| Genital markings as oval thickenings on xi. | *D. kanarensis* (part.). |
| 28. Accessory glands in spermathecal region.. | *D. shunkarai.* |
| No accessory glands in spermathecal region. | *D. pellucida* f. *typica* (part.). |
| 29. Genital markings present ..... | 30. |
| Genital markings absent..... | 31. |
| 30. Genital markings as discrete papillæ .... | *D. japonica* (part.). |
| Genital markings as large transversely oval areas ..... | *D. chalakudiana.* |
| 31. Gizzards about eight ..... | *D. decourcyi.* |
| Gizzards about three or four ..... | 32. |
| 32. Atrium small or moderate in size ..... | 33. |
| Atrium a large or very large sac..... | 48. |
| 33. Atrium teat-like; *dd* equal to half circumference ..... | *D. parambikulamana.* |
| Atrium small, pear-shaped; *dd* greater than half circumference ..... | *D. parva.* |
| 34. Atrium a dilatation of the end of the spermathecal duct ..... | 35. |
| Atrium an independent sac ..... | 40. |
| 35. Prostates smooth ..... | 36. |
| Prostates glandular..... | 38. |
| 36. Length 500 mm. or more ..... | *D. grandis.* |
| Length less than 200 mm. ..... | 37. |
| 37. Seminal grooves and ridges leading backwards from male pores ..... | *D. matthaii.* |
| No seminal grooves and ridges ..... | *D. pellucida* var. *pallida* (part.). |
| 38. Length about 500 mm. ..... | *D. naduvatamensis.* |
| Length less than 200 mm..... | 39. |
| 39. Ovarian chamber present; male pores midway between *b* and *c* ..... | *D. sapphirinaoides.* |
| No or incomplete ovarian chamber; male pores nearer *c* than *b* ..... | *D. chlorina.* |
| No or incomplete ovarian chamber; male pores nearer *b* than *c*; thickened patches on xi ..... | *D. kanarensis* (part.). |
| 40. Body flattened vertically; colour almost black ..... | *D. brunnea.* |
| Shape and colour otherwise ..... | 41. |
| 41. Atrium sac-like or pear-shaped..... | 42. |
| Atrium narrow and elongated, finger- or club-shaped ..... | 45. |
| 42. Setal interval *dd* equal to half circumference. | 43. |
| Setal interval *dd* greater than half circumference ..... | 44. |
| 43. Genital marking as a transverse oval area on x and xi ..... | *D. annandalei.* |
| Genital markings, if present, as small papillæ on vii, x, and xi ..... | *D. papillifer.* |
| 44. Male and spermathecal pores in *b*..... | *D. ramnadana.* |

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| | | |
|---|---|---|
| | Male pores midway between *b* and *c*, spermathecal pores just below *c*; no genital papillæ on xi | *D. nepalensis.* |
| | Male pores immediately outside *b*, spermathecal pores between *b* and *c*; genital papillæ on xi | *D. rosea.* |
| 45. | Length less than 50 mm. | 46. |
| | Length 100 mm. or more | 47. |
| 46. | No genital markings | *D. affinis.* |
| | Genital papillæ on vii | *D. jalpaigurensis.* |
| 47. | Prostate smooth; *dd* greater than half circumference | *D. hodgarti.* |
| | Prostate glandular; *dd* greater than half circumference | *D. rangamatiana.* |
| 48. | Prostates thickly tubular | *D. burchardi.* |
| | Prostates flattened from side to side | *D. paradoxa.* |

The preparation of the above key has presented difficulties; and where the comparatively few characters that have to be relied on do not chance to have been noted, or vary, or are described in ambiguous terms, it has been necessary to enter a species more than once in the key. Thus the number of gizzards is variable within a species; the relative extent of the intersetal intervals *aa* and *bc* may perhaps vary according to the state of contraction of the body-wall at the time of fixation, or may be stated ambiguously; e. g., "*aa* equal to or slightly less than *bc*"; and, where all degrees exist, there is obviously room for difference of opinion in cases of very slight dilatation of the end of the spermathecal duct—does it exist, and should it be ranked as an atrium? In *D. ghatensis* I found variations in the gizzards and spermathecal atrium which would have necessitated so many entries that here I have been compelled to take account only of Michaelsen's original description.

The genus was established by Michaelsen in 1903 (**38**), being separated off from *Moniligaster*; a division had previously been suggested by Rosa (Ann. Mus. Genova, xxxvi, p. 507). The distinction is in the spermathecal atrium; in the worms which retain the name *Moniligaster* this has the form of a bifid muscular chamber, each horn of which bears a gland consisting of branched tubes; in *Drawida* there are no glands, and the atrium may be bifid, simple, a mere swelling of the end of the duct, or absent altogether. When first established, Michaelsen used *Drawida* as a feminine; and it so figures in his list of Indian worms in 1909 (**54**); in 1910 (**125**) he thinks it is more correct to make it masculine, and in his second Indian list (**58**) the specific names are altered accordingly. I have retained it as a feminine in the present work.

A number of species were described by A. G. Bourne during the earlier years of his residence in India; some of these were named, and a few characters noted, in a paper in 1886 (**8**), but the notes are in no sense a description of the worms. In a paper in 1894 (**28**) the descriptions are in certain cases somewhat amplified, but their baldness still leaves us wishing that the

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author had been more generous. Beddard, when composing his Monograph of 1895, apparently had not this latter paper of Bourne's before him; at any rate he does not recognize any of Bourne's species as being sufficiently known for systematic purposes. Michaelsen (38) is more inclusive.

*Moniligaster ruber*, though it appears in both of Bourne's papers, is quite unrecognizable. Its length is stated to be about 100 mm., the average diameter 3·5 mm., the maximum near the anterior end 5 mm. (from the figure); the body-wall is thin, the organs showing through; from the figure the colour is brownish. The gizzards occupy segments xiii and xiv only. Found at Salem.

*Moniligaster papillatus*, mentioned in Bourne's earlier paper, is characterized by the tubular projections bearing the male pores (this, however, is not of much value); the gizzards are in segments xvi–xx; and it is said to be a much longer worm than any of the others mentioned in the same paper with the exception of *M. grandis*. In the second paper Bourne puts *M. papillatus* as a synonym of *M. uniqua*; no justification is offered for this—indeed, *M. uniqua* is stated to be a small weak-looking worm. Michaelsen (38) accepts Bourne's identification; I think *papillatus* may be eliminated from consideration altogether.

*M. naduvatamensis* is one of Bourne's species which is admitted by Michaelsen in the Tierreich (38), and figures in his list of Indian species in 1909 (54); it is, however, omitted from his list of 1910 (58), but I cannot discover which species he has united it with. There are only two other species of anything like its length (500 mm.)—*nilamburensis* and *grandis*; from *nilamburensis* it is sufficiently distinct, and from *grandis* the glandular prostate should distinguish it; though Bourne remarks that it is very like *M. grandis*, occurs along with it, but may be easily distinguished by its small pointed prostomium.

A number of related groups of species can be distinguished. Thus Michaelsen (58) has subsumed *D. bournei* (with which *D. pauli* is identical) under *D. pellucida* as a variety, and holds *D. grandis* also to be related; *D. friderici*, *barwelli*, and *uniqua* may also belong to the same assemblage, and probably *rotungana* also. Of these *barwelli* is a wanderer (Travancore, Burma, Philippine Islands, Caroline Islands, and the var. *impertusa* at Bombay); *pellucida* is found on the Nilgiris and in the Abor Country; *uniqua* and *grandis* occur in the Nilgiris, *rotungana* in the Abor Country, and *friderici* and *pellucida* var. *bournei* in Ceylon.

*D. parva* and *parambikulamana* are much alike, and in the same group perhaps *sulcata* and *kanarensis*, and possibly *burchardi*, may be included. *D. parva* and *sulcata* are both from the Nilgiris, and *parambikulamana* from Cochin not very far away; but *kanarensis* comes from some distance (roughly 300 miles) to the north, and *burchardi* from the Andamans and Sumatra; *parva* has also been found in the Aru Islands.

*D. chlorina* and *sapphirinaoides* are from the Nilgiris, and seem to resemble each other in most points.

Lastly there is a well-marked group of related species found at Rangamati (Chittagong Hill Tracts); this consists of *D. affinis*, *rangamatiana*, *hodgarti*, and *papillifer*; *jalpaigurensis*, also related, comes from 340 miles to the north-west; the group has affinities with *nepalensis*, also found at Rangamati, and in addition at Katmandu, another 200 miles beyond Jalpaiguri; and perhaps with *travancorensis* from S. India.

1. **Drawida affinis** *Steph.*

1917. *Drawida affinis*, Stephensen, Rec. Ind. Mus. xiii, p. 368.

Length 37 mm., maximum diameter 3 mm. Segments 115. Colour a medium grey. Prostomium small. Setæ closely paired; $aa = \frac{3}{7}$ or $\frac{4}{7}$ $bc$; $dd = \frac{1}{2}$ circumference. Nephridiopores in line with *cd*. Clitellum? Male pores inconspicuous, in *b*. Female pores? Spermathecal pores perhaps slightly ventral to *c*.

Septa 5/6–8/9 moderately thickened. Three gizzards, in xiii–xv. Testis sacs wholly in x, ovoid. Vas deferens narrow, coiled, in x. Prostate tubular, of several closely applied coils or loops, rather shiny, narrowing progressively towards ectal end; joined by vas at a point ental to middle of its length. Ovarian chamber as in *D. hodgarti*. Ovisacs? Ampulla of spermatheca approximately spherical; atrium as in *D. hodgarti*.

*Remarks.* Only a single specimen was obtained; the hinder end was regenerating. The worm belongs to the same group as *hodgarti* (elongated prostate, much elongated spermathecal atrium); a distinction is the relatively narrow interval between the ventral setal bundles.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

2. **Drawida annandalei** *Steph.*

1913. *Drawida annandalei*, Stephenson Spol. Zeyl. viii, p. 261, pl. i, fig. 7.

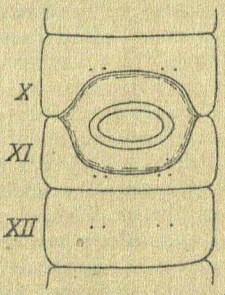


Fig. 47.—*Drawida annandalei* Steph.; genital area.

Length 35 mm.; maximum diameter $1\frac{3}{4}$ mm. Colour olive. Segments 137. Prostomium prolobous. Setæ closely paired; *aa*

less than *bc*; *dd*=$\frac{1}{2}$ circumference. Clitellum includes $\frac{2}{3}$ of x and $\frac{2}{3}$ of xiii (=3$\frac{1}{3}$), not well marked. A genital area (text-fig. 47) over groove 10/11, darker in colour, transversely oval, extending from setæ of x to those of xi; within it a smaller oval area marked out by a slight ridge. Male pores in *ab*.

Septa 5/6–8/9 much thickened. Three gizzards, in xii–xiv. Testis sacs projecting forwards and backwards from septum 9/10; vas deferens coiled, in ix and x, joins ental end of prostate, which is a vertical tube covered with a thick layer of glandular cells, the whole a short cylinder occupying the height of the segment, or directed forwards. Ovisacs extend backwards through several segments (to xvi), and are dilated at their hinder ends. Ampulla of spermatheca a relatively small spherical sac; atrium of moderate size, sac-like, narrowing and becoming tubular at its base, where it is joined by the spermathecal duct.

*Remarks.* The specimen was single, and being of small size was investigated by means of sections. The species presents some resemblance to *D. ramnadana*.

*Distribution.* Caveri River, Tanjore, S. India (in the mud below the water).

### 3. Drawida barwelli (*Bedd.*).

1890. *Moniligaster beddardii*, Rosa, Ann. Mus. Genova, (2) ix, p. 379, pl. xii, fig. 12.
1895. *Moniligaster barwelli*, Beddard, Monog. p. 200.
1900. *Drawida barwelli*, Michaelsen, Tier. x, p. 116.
1910. *Drawida barwelli*, Michaelsen, Abh. Ver. Hamburg, p. 51.

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1886. *Moniligaster barwelli*, Beddard, Ann. Mag. N. H. (5) xvii, p. 94, pl. ii, figs. 4–6.
1887. *Moniligaster barwelli*, Beddard, Zool. Anz. x, p. 678.
1888. *Moniligaster barwelli*, Beddard, Quart. J. Mic. Sci. xxix, p. 119, pl. xii, figs. 10–12.
1891. *Moniligaster barwelli*, Beddard, Tr. Roy. Soc. Edin. xxxvi, p. 2, pl. figs. 1–10.

Length 30–38 mm.; maximum diameter 2·5 mm. Segments ca. 115. Colour yellowish to greenish brown. Body somewhat flattened. Prostomium without dorsal process, small; segments i and ii short. Setæ closely paired, *aa*=*bc*; on ii are small. Dorsal pores present. Nephridiopores in *cd*. Clitellum ring-shaped, x–xiii (=4). Male pores between *b* and *c*. Female pores in *b*. Spermathecal pores in *c*.

Septa 5/6–8/9 much thickened. Gizzards three or four, in xiii or xiv to xv or xvi. Testis sacs projecting forwards into ix or backwards into x; prostates pear-shaped, with a thick glandular investment. Ovaries in segment xi, which is very short; egg-sacs absent (?). Spermathecæ with pear-shaped ampulla, long duct, and no atrium.

*Distribution.* Kerumaadi, at S. end of Vembanaad Lake, Travancore; Chiala, Padaung Dist., Burma. Outside India it

has been obtained from Jap I. (Carolines), from Lombok, and from Manila; there is a doubtful record from Flores. It is thus one of the peregrine species of the genus.

*a.* var. **impertusa** *Steph.*

1920. *Drawida barwelli* var. *impertusus*, Stephenson, Mem. Ind. Mus. vii, p. 200.

Length ca. 45 mm.; diameter 3·5 mm. Segments ca. 130. Colour a blotchy olive, darker dorsally. Prostomium small, prolobous. Dorsal pores absent, indicated in some specimens as small pale dots, but no perforations. Setal interval *aa* rather less than *bc*, except at hinder end. Male pores bounded by very prominent anterior and posterior lips; a pair of indefinite but fairly large whitish papillæ on the segment in front of the male pores. Four gizzards, in xiv–xvii. Prostates flat, sessile, almost circular. Ovarian chamber present, annular; ovisacs present, extending back to xiii or xiv. Otherwise as for the typical form.

*Distribution.* Bombay.

4. **Drawida brunnea** *Steph.*

1915. *Drawida brunnea*, Stephenson, Mem. Ind. Mus. vi, p. 151.

Length 40 mm.; maximum diameter 5 mm. Segments 120; body short and relatively very broad, dorso-ventrally flattened. Colour almost black dorsally, slightly lighter ventrally. Prostomium not recognizable. Setæ very small and very closely paired, not distinguishable in ii; *aa* rather less than *bc*; $dd = \frac{1}{2}$ circumference. Clitellum? Male pores bordered by prominent lips, about midway between *b* and *c*. Female pores apparently between *b* and *c*, but nearer *b*. Spermathecal pores in *cd*.

Septa 5/6–8/9 somewhat thickened. Three gizzards, in xiii–xv, the first less firm than the others. Testis sacs large, projecting on both sides of 9/10, more into x, not constricted by the septum; vas joins prostate on inner side; prostate opaque white, ovoid, with short moderately thick stalk, smooth but no muscular shimmer. Ovarian chamber with its roof at the dorsal parietes; funnel extends upwards on each side of gut nearly to mid-dorsal line; ovisac in xii, tapering towards its free end. Spermathecal ampulla ovoid, atrium mammillary in shape, sessile on parietes, joined by the duct at its base.

*Remarks.* Perhaps related to *D. travancorensis.*
*Distribution.* Parambikulam, Cochin State.

5. **Drawida burchardi** *Mich.*

1909. *Drawida burchardi*, Michaelsen, Mem. Ind. Mus. i, p. 149.

1902. *Drawida burchardi*, Michaelsen, Mt. Mus. Hamburg, xix, p. 7.

Length 50 mm.; diameter 1·4 mm. Segments ca. 180. Colour pure white. Prostomium prolobous, very small. Setæ small,

closely paired; on segment xx $aa=bc$, $dd=$just over half the circumference. Nephridiopores in *cd*. Clitellum? Male pores on large eye-shaped papillæ lateral to *ab*, nearer *ab* than *cd*. Female pores perhaps in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 uncommonly strongly thickened; 7/8–14/15 dorsally displaced backwards, 13/14 most so (about half a segment). Three gizzards, in xv–xvii. Testis sacs project somewhat in front of the septum, and extensively behind into x and xi; funnel ventrally in testis sac, in x, fused with wall of sac. Vas uncommonly long, forming a large coil on each side of the septum. Prostates thickly tubular, either with or without glandular covering. Apparently no ovarian chamber; ovisacs long, irregularly bent. Spermathecal ampulla globular, its duct opening into the neck of a long slender pear-shaped atrial sac.

*Distribution.* Mt. Harriet, S. Andaman Island. Also outside India in Sumatra.

### 6. Drawida chalakudiana *Steph.*

1915. *Drawida chalakudiana*, Stephenson, Mem Ind. Mus. vi, p. 54, pl. vii, fig. 7.

Length 41 mm.; diameter 1·5 mm. Segments 135. Colour bluish grey, darker dorsally. Prostomium prolobous. Setæ not very closely paired anteriorly; $aa=bc$, $dd=\frac{1}{2}$ circumference. Nephridiopores (? always) in *cd*. Clitellum? Male pores in *b*, female in *a*, spermathecal in *c*. A transversely oval genital

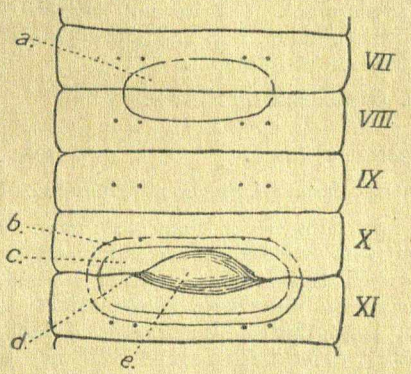


Fig. 48.—*Drawida chalakudiana* Steph.; genital region, diagrammatic. *A.*, anterior genital area; *b.*, light margin of posterior area; *c.*, darker coloured interior of posterior area; *d.*, a shallower part of groove 10/11; *e.*, median tubercle.

marking (text-fig. 48) in 10/11, extending from the setal zone of x to that of xi, and in a transverse direction occupying the whole ventral surface; its margin white, the interior darker; included in the area a semicircular raised patch on x, with its

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base at the furrow. A less well-marked and less extensive area, similar in shape, light in colour, thickened, bisected by 7/8.

Septa 5/6–8/9 thickened, the first less than the rest. Three gizzards, in xiii–xv, not well marked. Testis sacs large, projecting more forwards into ix than backwards into x, not constricted by the septum. Vas enters prostate at middle of its height. Prostate a large rectangular block, taking up the whole length of the segment, attached to the parietes by a somewhat narrowed base, soft in texture. Ovarian chamber has the dorsal parietes for its roof; ovisacs extend back to xvi, tubular, gradually narrowing behind. Spermathecal ampulla spherical, duct apparently joins atrium within the body-wall; atrium conspicuous, sac-like, cylindrical.

*Distribution.* Chalakudi, Cochin State.

### 7. Drawida chlorina (*A. G. Bourne*).

1894. *Moniligaster chlorina*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 364, pl. xxiii, fig. 5.
1900. *Drawida chlorina*, Michaelsen, Tier. x, p. 119.

Length 130 mm.; diameter $3\frac{2}{3}$ mm. Segments 135, not annulated. Colour slightly pigmented, greenish when put in spirit. Setæ absent from ii; $aa = \frac{3}{4}\,bc$, $dd$ = ca. $\frac{1}{2}$ circumference. Nephridiopores in *cd*. Male pores between *b* and *c*, nearer *c*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 thickened. Four gizzards, in xiv–xvii. Testis sacs ovoid, with rather pointed ends. Prostates hemispherical, of glandular appearance. Ovaries not enclosed in an ovarian chamber. Spermathecæ with pear-shaped or ovoid ampulla and small atrial dilatation at ectal end.

*Distribution.* Ootacamund, S. India.

### 8. Drawida decourcyi *Steph.*

1914. *Drawida decourcyi*, Stephenson, Rec. Ind. Mus. viii, p. 373.

Length 100 mm.; maximum diameter 8 mm. Segments 226; except the first four are biannulate as far as the middle of the body (vii and viii triannulate). Colour a dark bluish green dorsally, pale green elsewhere. Prostomium invisible. Setæ closely paired, beginning on ii; $aa = bc$, $dd = \frac{1}{7}$ circumference. Clitellum ? Male pores large curved slits with convexity backwards and somewhat inwards, their centre a little outside *b*, lying within a deep rectangular depression which includes more of x than of xi. Female pores in *b* (or between *a* and *b*). Spermathecal pores below *c*, nearer *c* than *b*.

Septa 4/5–8/9 thickened, especially 5/6–8/9. Eight gizzards, in xviii–xxv, with an additional rudimentary gizzard in xvii; the œsophagus is muscular even in front of xvii, as far as xv. Testis sacs confined to x; vas deferens a relatively immense closely-packed coil, larger than the testis sac, in ix and x. Prostate

oval, cushion-like, sessile; surface shining, muscular. Ovarian chamber present; ovisacs irregularly bulged, extending back into xiv. Ampulla of spermatheca subspherical; duct joins atrium at base of latter; atrium an oval sac, partly in the body-wall, in length about equal to half that of the segment in which it lies.

*Remarks.* The very large number of gizzards, and the immense vas deferens, are noteworthy features.

*Distribution.* Rotung and Renging, Abor Country, E. Himalayas.

### 9. Drawida elegans *Rao.*

1921. *Drawida elegans*, Rao, Ann. Mag. N. H. (9), viii, p. 519; pl. xv, figs. 1 *c*, 2 *c*; pl. xviii, fig. 10 *d*.
1922. *Drawida elegans*, Stephenson, Ann. Mag. N. H. (9), ix, p. 133.

Length 130 mm.; maximum diameter 5 mm. Segments 206; viii–xviii bi- or triannular. Colour grey, non-pigmented. Prostomium retractile, prolobous. No dorsal pores. Nephridiopores in line with lateral setæ. Setæ closely paired; $aa=bc$, $dd=\frac{1}{2}$ circumference. Clitellum? Male pores small, a little outside line of *b*. Female pores minute, in *b*. Spermathecal pores in line with *c*.

Septa 5/6–8/9 exceptionally stout. Five gizzards, in xii–xvi, the first rudimentary. Testis sacs depending into x; vas deferens a very bulky coil in ix and x, enters prostate near ental end of latter. Prostates elongated, no separate stalk. Ovarian chamber present. Ovisacs in xii, hinder end bent forwards, narrower. Spermathecal atrium large, much larger than ampulla, shortly pear-shaped, narrower end on the body-wall; duct enters its upper pole.

*Distribution.* Bhagamandla, Coorg, S. India.

### 10. Drawida fakir *Cogn.*

1911. *Drawida fakir*, Cognetti, Ann. Mag. N. H. (8), vii, p. 495, pl. xiii, figs. 1–3.

Length 85 mm.; maximum diameter 3 mm. Segments 98. Colour a uniform lilac-grey. Prostomium prolobous. Setæ closely paired; $aa=bc$, $dd$ = a little more than half the circumference. Dorsal pores not seen. Nephridiopores in *d*. Clitellum? Male tubercles a little lateral to *b*, small, conical, contained in two small and not very deep pouches, like those of *D. sulcata*. Female pores in *b*. Spermathecal pores a little lateral to *b*.

Septa 6/7–8/9 somewhat thickened. Four gizzards, in xiii–xvi. Last heart in ix; in x a pair of trunks arise, which are directed backwards, joining the subneural at the anterior face of septum 11/12. Testis sacs project on both sides of 9/10, the anteseptal part again divided by a constriction, the postseptal part the larger. Vasa deferentia short and a little wavy. Prostates white, tubular, closely coiled, of equal thickness throughout, muscular at

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the ectal end, joined by the vas at the ental end. Ovaries enclosed in a thin-walled periœsophageal capsule (=ovarian chamber). Ovisacs cylindrical, in xii, folded on themselves. Ampulla of spermatheca globular, duct loosely coiled; no muscular atrial chamber.

*Distribution.* Arumanallur, 45 km. S.E. of Trivandrum, S. India.

### 11. **Drawida friderici** (*Mich.*).

1897. *Moniligaster friderici*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 169.
1900. *Drawida friderici*, Michaelsen, Tier. x, p. 115.
1910. *Drawida friderici*, Michaelsen, Abh. Ver. Hamburg, xix, p. 49.
1913. *Drawida friderici*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 74.

Length 165 mm.; diameter 6–7 mm. Segments ca. 370; secondary annulation on vii–xiii, most marked on x–xii, where the segments are triannulate or (xii) quadriannulate. Prostomium zygolobous. Posterior end tapering. Dorsal pores represented by pits on inner surface of body-wall. Setæ closely paired; *c* and *d* much finer than *a* and *b*; $aa=\frac{1}{2}bc$ in middle and hinder parts of body, *bc* smaller in the anterior part, and in front of xi $aa=bc$; *dd* less than $\frac{1}{2}$ circumference in middle and hinder parts of body. Nephridiopores in middle of body in *cd*. Clitellum? Male pores just above *b*, on prominent papillæ. Female pores in *ab* (?). Spermathecal pores just below *c*.

Septa 5/6–8/9 thickened; 9/10–11/12 displaced backwards dorsally. Three gizzards, in xiii–xv, the first feebly developed; traces of thickening in xii. Testis sacs strongly constricted by the septum. Prostates thickly ovoid, sessile, smooth. Ovarian chamber probably not present: ovisacs long, thin, tubular, reaching as far as xiv. Spermatheca with sac-shaped ampulla; no atrial dilatation.

*Remarks.* The distinction from the *pellucida* group is principally in the setal relations; here $aa : bc = 1 : 2$, and the dorsal setæ are considerably smaller and closer together ($cd=\frac{1}{2}ab$) than in that group of forms (Michaelsen, 58).

*Distribution.* Trincomali, N. Province, Ceylon.

### 12. **Drawida ghatensis** *Mich.*

1910. *Drawida ghatensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 52, pl. figs. 1, 2.
1913. *Drawida ghatensis*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 77.
1915. *Drawida ghatensis*, Stephenson, Mem. Ind. Mus. vi, p. 49, pl. vii, fig. 6.

Dimensions vary considerably; length 80–195 mm.; diameter 2–7 mm. Segments 145–186. Colour grey-brown, with bluish-

green pigmentation dorsally at anterior end. Lateral regions in anterior part of animal appear thickened. Prostomium prolobous or zygolobous. Setæ fairly closely paired; *aa* slightly greater than *bc*; *dd* slightly greater than $\frac{1}{2}$ circumference; one or two of the anterior segments may lack setæ, ventral or lateral or both. Nephridiopores usually in *cd* up to xv, behind xv in *ab* or *cd*. Clitellum x–xiii, interrupted between the lines of setæ *a*. Male pores about midway between *b* and *c*. Female pores in *ab*. Spermathecal pores just below *c*, the upper end touching the line *c*.

Gizzards variable in number and position; four, in xvi–xix or xix–xxii; or six, in xiv–xix or xvi–xxi. Testis sacs situated far back, in extreme cases in xiii-xvi, taking up several segments, connected by a narrow neck with septum 9/10. Vas deferens winding or coiled, lying partly in the neck of the sac. Prostates ovoid or thickly pear-shaped, with investment of glandular cells. Ovarian chamber present; ovisacs reach back to xv or xvi. Spermathecal ampulla thickly pear-shaped. Atrium variable;—large, with bilobed cavity, duct entering atrium in the depression between the lobes; or an upwardly-projecting papilla; or ovoid and sessile on body-wall; or embedded in a recess in the body-wall and not projecting.

*Remarks.* A variable species, especially in regard to size, gizzards, and spermathecal atrium.

*Distribution.* Tenmalai, Maddathoray, and Kulattupuzha at the foot of the western slopes of the Western Ghats, in Travancore; Kottayam, Ponmudi, Bonaccord, also in Travancore; Kavalai, and on the Forest Tramway, in Cochin State.

13. **Drawida grandis** (*A. G. Bourne*).

1886. *Moniligaster grandis*, Bourne, P. Z. S. p. 671.
1894. *Moniligaster grandis*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 307, pls. xxii, xxiv, xxv fig. 27. xxvi figs. 31–34, 37–41, xxvii, xxviii.
1895. *Moniligaster grandis*, Beddard, Monog. p. 198.
1900. *Drawida grandis*, Michaelsen, Tier. x, p. 117.
1910. *Drawida grandis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 48.

Length of a normally extended specimen 520 mm., stretched out after bad preservation may be 1080 mm.; average diameter ca. 12 mm. Segments 266–480; anterior segments (iv–x) multiannular. Almost without pigment, in life a clear brown. Prostomium prolobous. Setæ small, closely paired; *aa* less than *bc*, *dd*=$\frac{1}{2}$ circumference; absent on ii, only the ventral present on iii. Nephridiopores in *cd*, or (in iii–ix) above this level. Clitellum includes $\frac{5}{6}$ of x–xiii (=$3\frac{5}{6}$); saddle-shaped in front, in xiii ring-shaped. Male pores just above *b*. Females pores in *ab*. Spermathecal pores just below *c*.

Septa 5/6–8/9 much thickened; 9/10 and 10/11 displaced backwards (9/10 is attached normally ventrally). Five gizzards,

in xvii or xviii to xxi or xxii. Testis sacs oval, projecting into both ix and x; vas extremely long, 9½ inches when unravelled. Prostates cushion-like, circular, not glandular in appearance. Ovaries in an ovarian chamber; ovisacs tubular, extending into xv. Spermathecal ampulla pear-shaped; a small atrial enlargement of the duct, embedded in the body-wall.

*Remarks.* Belongs to the *pellucida* group (Michaelsen, 58). Bourne remarks that before the rains this worm is only found deep down, and that in May he has made coolies dig as far down as 9–10 ft. before coming upon any worms; in June, after rain, they were found quite near the surface, or even crawling about on the ground.

*Distribution.* Naduvatam, Nilgiris: widely spread on the Nilgiris at elevations of from 5000–8000 ft.

### 14. **Drawida hodgarti** *Steph.*

1917. *Drawida hodgarti*, Stephenson, Rec. Ind. Mus. xiii, p. 366, pl. xvi, fig. 2.

Length 113 mm.; maximum diameter 3·75 mm. Segments 164. Colour non-pigmented, a uniform grey. Prostomium prolobous. Setæ small and closely paired; *aa* less than *bc*; *dd* more than ½ circumference. Nephridiopores in line with *c*. Clitellum? Male pores with swollen anterior lip, their centre just outside *b*. Female pores doubtfully in *ab* or *b*. Spermathecal pores just internal to *c*.

Septa 5/6–8/9 thickened. Four gizzards, in xv–xviii; a slight strengthening of the œsophagus in xiv. Testis sacs kidney-shaped, in x, projecting sometimes slightly into ix also. Prostates (text-fig. 49) small, tubular, with shining surface, slightly coiled,



Fig. 49.—*Drawida hodgarti* Steph.; prostate with vas deferens entering (the spirally coiled end is the ectal).

ental end slightly dilated; vas deferens joining anterior face of prostate. Ovarian chamber bounded by body-wall above, but alimentary canal excluded; ovisacs small, finger-shaped, confined to xii. Spermathecal ampulla small, roundly ovoid; atrium in vii, finger-like, joined by duct within the body-wall.

*Remarks.* Related by form of atrium to *jalpaigurensis* and *travancorensis*.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

### 15. Drawida jalpaigurensis *Steph.*

1916. *Drawida jalpaigurensis*, Stephenson, Rec. Ind. Mus. xii, p. 307, pl. xxx, figs. 4, 5.

Length ca. 23 mm.; diameter 2 mm. Segments 106. Colour dark grey, lighter at anterior end. Prostomium prolobous (?), relatively large; first segment very short. Setæ small, very closely paired; *aa* less than *bc*; *dd*=½ circumference. Clitellum x–xiv (?). Male pores on prominent oval papillæ, the long diameter transversely over groove 10/11; longitudinally the papillæ take up half the length of segments x and xi; the pores between *b* and *c*, nearer to *b*. Spermathecal pores between *b* and *c*, nearer to *c*. A pair of genital papillæ anteriorly on vii, flat-topped and circular, their centres midway between *b* and *c*.

Septa 5/6–8/9 considerably thickened. Four gizzards, in xii–xv, that in xii smaller than the rest; gizzards separated from each other by thinner rings. Testis sacs projecting into x, large, subovoid, attached to the septum only by a narrow neck. Vas deferens comparatively short, wavy. Prostate (text-fig. 50)

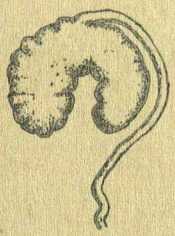

Fig. 50.—*Drawida jalpaigurensis* Steph.; prostate of left side.

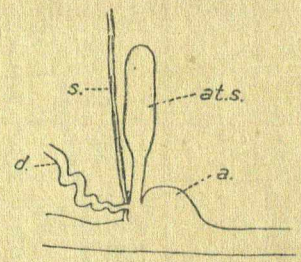


Fig. 51.—*Drawida jalpaigurensis* Steph.; diagrammatic sketch to show relations of parts at ectal end of spermathecal apparatus; *a.*, atrium; *at.s.*, atrial sac; *d.*, spermathecal duct; *s*, septum 7/8.

vertically flattened, shape varies, margin lobulated. Ovarian chamber apparently not developed. Spermathecal ampulla large, ovoid; atrium a simple projection on inner surface of body-wall, from which arises an upwardly-projecting stalked sac, of a much elongated ovoid shape, the stalk being half as thick and half as long as the sac proper (text-fig. 51).

*Remarks.* The atrium resembles that of *D. travancorensis*. The surface of the prostate seems to be glandular, though this is not stated in the original description. The species is described from a single specimen, in a bad state of preservation.

*Distribution.* Jalpaiguri, at the base of the Eastern Himalayas.

16. **Drawida japonica** *Mich.*, f. **typica.**

1917. *Drawida japonica* f. *typica*, Stephenson, Rec. Ind. Mus. xiii, p. 366, pl. xvi, fig. 1.
1922. *Drawida japonica*, Stephenson, P. Z. S. p. 119, pl. i, figs. 1–6.

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1892. *Moniligaster japonicus*, Michaelsen, Arch. f. Naturgesch. lviii (1), p. 232.
1892. *Moniligaster bahamensis*, Beddard, P. Z. S. p. 690, pl. xliv.
1895. *Moniligaster japonicus*+*M. bahamensis*, Beddard, Monog. pp. 201, 202.
1900. *Drawida japonica* + *D. bahamensis*, Michaelsen, Tier. x, pp. 115, 118.
1910. *Drawida japonicus*, Michaelsen, Mt. Mus. Hamburg, xxvii, p. 48.

Length 28–60 mm.; diameter 2–3 mm. Segments up to 142. Colour grey or greenish grey. Prostomium small, prolobous. Setæ closely paired; $aa=bc$; $dd=\frac{1}{2}$ circumference; setæ small or in part absent on ii, large on genital region. Nephridiopores in three situations—not far from the mid-dorsal line, or in line with *cd*, or with *ab*, but no regular alternation. Clitellum

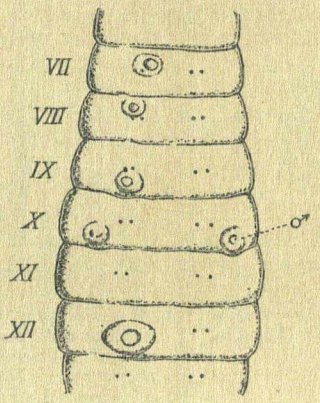


Fig. 52.—*Drawida japonica* Mich.; genital region, showing papillæ and male apertures (♂).

inconspicuous. Male pores between *b* and *c*, nearer *b*, on small tubercles. Spermathecal pores just below *c*. Genital papillæ variable, but apparently always present in the sexual animals; paired or unpaired, two, three, or four in number, on vii–ix and xii; each a transversely oval patch, slightly raised, with a circular groove in the centre (text-fig. 52).

Septa 5/6–8/9 thickened, especially 6/7 and 7/8. Two or three gizzards, large and spherical, except the first if there are three, which is smaller; in xii and xiii, or xi–xiii. Testis sacs spherical, projecting mostly into x. Prostates thickly and shortly tubular, with glandular surface. Ovarian chamber present; ovisacs

thickly tubular, irregularly thickened and twisted, reaching to about xvi. Spermathecal ampulla pear-shaped, duct very long and thin, loosely coiled, altogether in viii; atrium small, pear-shaped, projecting backwards in viii, joined below by the duct.

*Remarks.* The first description of this species was incomplete, and Beddard, who shortly afterwards met with it, described his specimens as a different species. Michaelsen in 1910 subjected his original specimens to a re-examination, and having also a new batch of material before him from China, was enabled to establish the identity of Beddard's species with his own. Up to this time the worm had been found in China, Japan, and the Bahamas, but not in India. I have lately found it in India, but far from the proper *Drawida* region—viz. in the W. Himalayas. The worm is thus a wanderer of a pronounced type.

The immature *Drawida* from Simla, said by Michaelsen (**54**) "probably, or rather doubtless" to belong to *D. willsi*, should, I think, be referred to this species.

I have recently (**98**) given a detailed account of the anatomy of the reproductive system and nephridia in this worm.

*Distribution.* Murree and probably Simla, in the W. Himalayas. Outside India has spread to China, Japan, and the Bahamas.

### 17. **Drawida kanarensis** *Steph.*

1917. *Drawida kanarensis*, Stephenson, Rec. Ind. Mus. xiii, p. 364.

Length 60–70 mm.; maximum diameter 3·5 mm. Segments 150–173. Colour pale grey, anterior end rather lighter. Prostomium small, pro- or zygolobous (?). Setæ small, closely paired; *aa* equal to or rather less the *bc*; *dd*=ca. $\frac{1}{4}$ circumference. Clitellum saddle-shaped, x–xiii (=4), limits rather indefinite. Male pores external to *b*, but nearer to *b* than *c*. Female pores in *b*. Spermathecal pores just below *c*. A pair of oval thickened patches on xi, not always present; setæ *ab* placed on the inner portion of the patch.

Septa 5/6–8/9 thickened, especially the first three. Four gizzards, in xiii–xiv or xiv–xvii, the first or the last smaller than the others. Testis sacs with the longer part in x, not constricted; terminal part of vas deferens rather thicker than the rest. Prostate of moderate size, hemiovoidal, sessile, surface soft and yellowish. No ovarian chamber; ovisacs large, ovoid, in xiv, connected by a neck with septum 11/12. Spermathecal ampulla large, irregular in shape; atrium a cushion-like swelling partly embedded in the body-wall, several times as thick as the duct.

*Remarks.* Near *D. parva*; the genital markings of this species (which are not always present) are the chief difference.

*Distribution.* Castle Rock and Talewadi, N. Kanara Dist., Bombay Pres.

### 18. Drawida kempi *Steph.*

1914. *Drawida kempi*, Stephenson, Rec. Ind. Mus. viii, p. 376.

Length 75 mm.; diameter 5 mm. Segments 125. Colour light olive-green. Prostomium small, prolobous. Setæ closely paired; $aa=bc$; $dd=\frac{1}{7}$ circumference; ventral pairs more approximated in posterior part of body. Male pores on small papillæ, the centre of the papilla just within the line *c*; each papilla in a darker area, which is grooved at its anterior and posterior margins. Female pores in *b*. Spermathecal pores in *c* or *cd*.

Septa 5/6–8/9 thickened, the last most so. Four gizzards, in xvi-xix; the first smallest; a thickened part of the œsophagus in xv (rudimentary gizzard). Testis sacs constricted by the septum, projecting equally forwards and backwards; vas not much coiled. Prostate large, cuboid, with narrow attachment to body-wall, and glandular surface. Ovarian chamber present; ovisacs reach xiv or xv, a relatively narrow neck passes through xii and xiii, and the sacs swell out behind this. Spermathecal ampulla ovoid, duct much coiled, atrial dilatation small or absent.

*Remarks.* The single specimen was found under a stone in water. The form seems to come near *D. pellucida*, of which it might, but for the statement as to the ovarian chamber (which however is not very precise in the original), form a variety.

*Distribution.* Egar Stream, between Rotung and Renging, Abor Country.

### 19. Drawida matthaii *Mich.*

1910. *Drawida matthaii*, Michaelsen, Abh. Ver. Hamburg, xix, p. 47.

Length 110–160 mm.; diameter 2–5 mm. Segments 240–250. Unpigmented, white to grey. Prostomium ? Setæ fine, very closely paired; anteriorly $aa=bc$; in middle of body *aa* is barely $\frac{1}{2}bc$; *dd* is about $\frac{1}{3}$ circumference, perhaps a little more at the anterior end, a little less in the middle of the body. Nephridiopores in *cd*. Clitellum x–xiii (= 4); wanting ventrally in x and xi. Male pores just lateral to *b*, slit-like, surrounded by large circular areolæ; from the hinder margin of each areola passes a ridge, convex outwards, ending just in front of 11/12 somewhat lateral from the female pores; a fine groove runs along the ridge. Female pores in *b*. Spermathecal pores small, eye-like, their centre just internal to *c*.

Septa 5/6–8/9 much thickened. Three gizzards, in xiv–xvi (?), the first much smaller than the others. Testis sacs irregularly ovoid, not constricted by the septum, the part in x rather the larger. Prostates spherical, flattened below, sessile, with a smooth surface. Ovarian chamber present; apparently no ovisacs. Spermathecal ampulla large, thickly pear-shaped; duct very long, loosely coiled; atrial swelling small, about double as thick as the duct, concealed entirely in the septum and body-wall.

*Remarks.* A spermatic groove is present also in *D. sulcata*. In a subsequent paper (70) Michaelsen lays stress on a secondary annulation of the segments on each side of the male pores (x and xi); the annulation is only present on the ventral surface, and is better marked in *D. sulcata* than in the present species. The grooves seem to be merely transverse grooves in front of and behind the apertures, produced perhaps by muscular contraction.

*Distribution.* Calicut, on the Malabar Coast.

20. **Drawida minuta** (*A. G. Bourne*).

1886. *Moniligaster minutus*, Bourne, P. Z. S. p. 672.
1894. *Moniligaster minuta*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 372, pl. xxiii, fig. 12.
1895. *Moniligaster minutus*, Beddard, Monog. p. 199.
1900. *Drawida minuta*, Michaelsen, Tier. x, p. 120.

Length 47 mm.; diameter $1\frac{3}{4}$ mm. Segments 150. Strongly pigmented. The interval *bc* scarcely greater than *aa*; *dd* scarcely greater than $\frac{1}{2}$ circumference; setæ present on segment ii. Nephridiopores in *cd*. Male pores, female pores, and spermathecal pores in *ab*.

Septa 5/6–8/9 very slightly thickened. Two or three gizzards, in xii to xiii or xiv. Testis sacs ovoid. Prostates hemispherical. No ovarian chamber; ovisacs extend back at least to xv. Spermathecal ampulla ovoid; atrium a bifid widening of the duct at its ectal end.

*Distribution.* Salem, Madras Pres.; widely spread in the Madras Presidency at sea-level and up to about 6000 ft.

21. **Drawida modesta** *Rao*.

1921. *Drawida modesta*, Rao, Ann. Mag. N. H. (9), viii, p. 525, pl. xv, figs. 1D, 2D.
1922. *Drawida modesta*, Stephenson, Ann. Mag. N. H (9), ix, p. 134.

Length 75 mm.; diameter 4 mm. Segments ca. 207. Colour brown. Prostomium? Dorsal pores absent. Nephridiopores apparently in line with setæ *d*. Setæ closely paired; $aa = bc$, $dd = \frac{1}{2}$ circumference or slightly more. Clitellum? Male area resembles that of *D. somavarpatana*; male pores have prominent anterior and posterior lips, just outside the line of setæ *b*; transverse groove-like depressions before and behind the pores; midventral regions of x and xi somewhat depressed. Female pores? Spermathecal pores slightly outside the line of setæ *b*; a slightly elevated transversely oval flat papilla in front of each spermathecal aperture.

Septa 5/6–8/9 thickened. Two gizzards, in xii and xiii. Testis sacs project into both ix and x. Prostates small, soft, transversely oval, sessile. Ovarian chamber apparently present; ovisacs extend back into xiii. No visible spermathecal atrium.

*Distribution.* Moornad, Coorg, S. India.

22. **Drawida naduvatamensis** (*A. G. Bourne*).

1894. *Moniligaster naduvatamensis*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 361.
1900. *Drawida naduvatamensis*, Michaelsen, Tier. x, p. 117.

Length 500 mm.; diameter 5 mm. Segments 400. Without pigment. Prostomium small, pointed. Setæ closely paired; *aa* smaller than *bc*; *dd* greater than $\frac{1}{2}$ circumference. Nephridiopores in *cd*. Male pores between *b* and *c*.

Septa 5/6–8/9 moderately thickened. Three gizzards, in xv–xvii. Testis sacs slightly kidney-shaped. Prostates appear glandular. No ovarian chamber. Spermathecal ampulla pear-shaped to spherical; atrium a small simple widening of the duct, embedded in the body-wall.

*Remarks.* On the specific distinctness of this worm *cf.* p. 131.
*Distribution.* Naduvatam, Nilgiris, S. India.

23. **Drawida nepalensis** *Mich.*

1907. *Drawida nepalensis* Michaelsen, Mt. Mus. Hamburg, xxiv, p. 146.
1909. *Drawida nepalensis*, Michaelsen, Mem. Ind. Mus. i, p. 147, pl. xiii, fig. 1.
1917. *Drawida nepalensis*, Stephenson, Rec. Ind. Mus. xiii, p. 372, pl. xvi, fig. 4.
1922. *Drawida nepalensis*, Stephenson, Rec. Ind. Mus. xxiv, p. 430.

Length 50–123 mm.; diameter $3\frac{1}{3}$–5 mm. Segments 149–175. Colour yellowish grey, non-pigmented. Prostomium prolobous. Setæ closely paired; *aa* a little less than *bc*; *dd* a little more than $\frac{1}{2}$ circumference. Dorsal pores absent, but represented by gaps in the muscular coat as seen from the inside of the body-wall; these occur as far forward as 4/5. Nephridiopores in *d*.



Fig. 53.—*Drawida nepalensis* Mich.; spermathecal atrium.

Clitellum ring-shaped, x-xiii (=4). Male pores on prominent transverse oval papillæ, midway between *b* and *c*. Female pores in *b*. Spermathecal pores just ventral from *c*. In some specimens genital markings present as broad transversely oval midventral cushions on vii and viii.

Septa 5/6–8/9 very strong, especially 5/6 and 6/7. Four gizzards, in xiv–xvii, or three in xv–xvii. Testis sacs projecting forwards and backwards, into both ix and x, or backwards only, into x; testis tuft-like, stalked; vas deferens very long, coiled in scores of convolutions. Prostates long, tube-like, in a U-shaped loop, the vas entering the ental end. Ovarian chamber present; ovisacs extend back through some segments. Spermathecal ampulla irregularly pear-shaped; atrial chamber (text-fig. 53) large, sac-like, continued into a narrower undulating neck, which is joined by the end of the duct; the atrial chamber marked by a fairly regular annulation, the epithelium markedly folded internally.

*Remarks.* Michaelsen suspects the identity of this form with *D. uniqua*; *cf.* remarks under the latter species.

My specimens differed from Michaelsen's principally in the relations of the testis sacs—projecting on both sides of the septum in Michaelsen's, backwards only in mine, on one side as far as the level of septum 15/16,—the condition indeed approximated to that of *D. ghatensis*.

*Distribution.* Gowchar, near Katmandu, Nepal Valley; Rangamati, Chittagong Hill Tracts, Bengal; Kierpur, Purneah Dist., Bihar; Dehra Dun, United Provinces.

24. **Drawida nilamburensis** (*A. G. Bourne*).

1894. *Moniligaster nilamburensis*, Bourne, Quart. J. Mic. Sci xxxvi, p. 362.
1900. *Drawida nilamburensis*, Michaelsen, Tier. x, p. 117.

Length 750 mm.; diameter ca. 7 mm. Segments 566; secondary annulation present. Slightly pigmented. Prostomium broad. Setæ long, black; *aa* slightly greater than *bc*; *dd* considerably greater than $\frac{1}{2}$ circumference; not very closely paired, $ab = cd = \frac{1}{6}bc$. Nephridiopores (all ?) in *cd*. Male pores between *b* and *c*, nearer *b*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 much thickened. Five or six gizzards, in xxvii or xxviii–xxxiii or xxxiv. Testis sacs ovoid. Prostates not glandular in appearance. Ovarian chamber present. Spermathecal ampulla pear-shaped: atrium a dilatation of the end of the duct, small, embedded in the body-wall.

*Remarks.* A very distinct form, on account of its very large size, and the very posterior position of the gizzards. For the rest, it seems to approach the *pellucida* group.

*Distribution.* Nilambur, S. India (near the sea-level).

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### 25. Drawida papillifer *Steph.*

1917. *Drawida papillifer*, Stephenson, Rec. Ind. Mus. xiii, p. 370.

Length 70 mm.; diameter $3\frac{3}{4}$ mm. Segments 148. Colour light grey, non-pigmented. Prostomium prolobous (?). Setæ closely paired; *aa* rather less than *bc*; *dd* = $\frac{1}{2}$ circumference. Nephridiopores apparently in line with *d*. Clitellum x–xiii (= 4), hinder end indistinct. Male pores between *b* and *c*, rather nearer to *c*. Female pores? Spermathecal pores with centre just below *c*. A few slightly marked darkish papillæ, paired or single, on vii, x, and xi, above or below the lateral setæ.

Septa 5/6 and 6/7 much strengthened, 7/8 and 8/9 much less so. Three gizzards, in xv–xvii. Testis sacs rather irregular, and asymmetrical; the larger part of the sac may be either in front of or behind the septum. Prostate with glandular surface, elongated, bent with the angle directed forwards, the ental end the thicker, joined by vas deferens at the middle of its length. Ovarian chamber bounded above by the body-wall; ovisacs large, asymmetrical, may reach back to the level of 15/16. Spermathecal ampulla ovoid; atrium relatively large, the upper part a thin-walled sac, the lower part duct-like.

*Remarks.* Belongs to the same group as *hodgarti*. The atrium has here developed further, and the coiling of the prostate is less.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

### 26. Drawida paradoxa, *Rao.*

1921. *Drawida paradoxa* Rao, Ann. Mag. N. H. (9), viii, p. 528, pl. xv, figs. 1 E, 2 E, 3 *c*; pl. xvi, figs. 4, 5; pl. xviii, figs. 10 *h*, 10 *i*.

1921. *Drawida paradoxa*, Stephenson, Ann. Mag. N. H. (9), ix, p. 135.

Length 90 mm.; average diameter 3 mm. Segments 152. Colour light grey, unpigmented. Prostomium prolobous. No dorsal pores. Setæ small, closely paired; *aa* = *bc* in general, but in the region immediately behind the clitellum = $\frac{3}{4}$ *bc*; *dd* slightly less than $\frac{1}{2}$ circumference. Clitellum ? Male pores small, inconspicuous, just outside the line of *b*. Female pores? Spermathecal pores small, in line with setæ *c*.

Septa 5/6–8/9 considerably thickened. Four gizzards, in xiii–xvi or xii–xv, the first smallest, the last largest. Testis sacs depend into x. Vas deferens relatively a very large coil, in ix and x, runs some distance up prostate before becoming lost in it. Prostates large, flattened from side to side, glandular at edges, axial part more shiny; ectal part of prostate a twisted mass, bound together by connective tissue and adherent to the ventral body-wall. Ovarian chamber present; ovisacs form small projections into xii. Spermathecal atrium in vii, large, tongue-shaped, constricted a quarter or a third of its length from the body-wall, margins slightly lobed, duct joins its lower part.

*Distribution.* Madapur, Coorg, S. India.

27. **Drawida parambikulamana** *Steph.*

1915. *Drawida parambikulamana*, Stephenson, Mem. Ind. Mus. vi, p. 53.

Length 84 mm.; diameter 3·5 mm. Segments 140. Colour a bluish grey, lighter ventrally and laterally. Body-wall appears thickened laterally. Prostomium ? Setæ small and closely paired; $aa=bc$, $dd$=ca. $\frac{1}{2}$ circumference. Nephridiopores are found both in *ab* and in *cd*, the majority however in *cd*. Clitellum ? Male pores on minute papillæ outside *b*, but nearer *b* than *c*. Female pores in *b* (?). Spermathecal pores in *c*.

Septa 5/6–8/9 considerably thickened. Three gizzards, in xiii–xv, the first smaller than the others. Testis sacs projecting slightly or not at all into ix. Vas deferens extremely fine and tightly coiled, broader in its terminal portion where it joins the prostate. Prostate large, ovoid, attached by a broad base; upper portion covered with glandular cells; vas deferens joins its anterior margin. Ovarian chamber present, anterior and posterior walls inserted together into the dorsal parietes; ovisacs small, tubular, narrower behind, turned forwards and completely contained within xii. Spermathecal ampulla broadly oval; atrium teat-like, of moderate size, with cavity of simple form.

*Remarks.* A single specimen only was available. The species may be related to Bourne's *D. parva*; the differences appear to be in bodily proportions, colour, and extent of the interval *dd*; possibly also the testis sacs differ in shape; Bourne does not mention ovisacs in his account. The distance between the places where this and Bourne's worm respectively were found is not more than 80 miles; but until the whole region has been thoroughly explored it must be dangerous to attempt identifications with species so sketchily described as those of Bourne.

*Distribution.* Parambikulam, Cochin State, S. India.

28. **Drawida parva** (*A. G. Bourne*).

1894. *Moniligaster parvus*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 371, pl. xxiii, fig. 11.

1900. *Drawida parva*, Michaelsen, Tier. x, p. 118.

1911. *Drawida parvus*, Michaelsen, Abh. Senckenb. Ges. xxxiii, p. 251.

Length 75 mm.; diameter nearly 2 mm. (?). Segments 115. Slightly pigmented. Setæ absent in ii; $aa=bc$; $dd$ greater than $\frac{1}{2}$ circumference. Nephridiopores in *d*. Male pores between *b* and *c*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 thickened. Three or four gizzards, in xiv–xvi or xvii. Testis sacs slightly kidney-shaped. Prostates hemispherical, glandular in appearance. No ovarian chamber. Spermathecal ampulla ovoid; atrium simple, rounded.

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*Remarks.* Michaelsen, in specimens which he identified with Bourne's species, but which came from outside India, found the spermathecal atrium small, muscular, of an inverted pear-shape, projecting into the body-cavity at the ectal end of the duct.

There is a discrepancy in Bourne's account; the circumference is given as $4\frac{1}{4}$ mm.; but the dorsal gap between the setal bundles is $2\frac{3}{4}$ mm., the lateral gaps $\frac{3}{4}$, and the ventral gap also $\frac{3}{4}$ mm.—*i. e.*, the total circumference is 5 mm. without allowing for the intervals between the setæ of the several bundles, say, 5·5 mm. in all. I therefore estimate the diameter as nearly 2 mm.

The worm is possibly identical with *D. parambikulamana*; *cf.* what is said under the latter species.

*Distribution.* Ootacamund, S. India. Also in the Aru Islands (near New Guinea).

29. **Drawida pellucida** (*A. G. Bourne*) f. **typica**.

1894. *Moniligaster pellucida*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 363, pl. xxiii, fig. 3, pl. xxv, fig. 30.
1900. *Drawida pellucida*, Michaelsen, Tier. x, p. 118.
1910. *Drawida pellucidus* f. *typica*, Michaelsen, Abh. Ver. Hamburg, xix, p. 48.
1914. *Drawida pellucida*, Stephenson, Rec. Ind. Mus. viii, p. 368.

Length 75–190 mm.; diameter 3–5 mm. Segments 130–186, no secondary annulation. Without pigment; body-wall very transparent. Contracts its anterior end in a bulbous fashion. Setæ absent in ii; $aa=bc$, or slightly greater; $dd=\frac{2}{3}$ circumference. Nephridiopores in *cd*. Male pores between *b* and *c*, nearer *b*. Female pores just above *b*. Spermathecal pores in or just below *c*.

Septa 5/6–8/9 thickened. Four or five gizzards, the first in xiv to xvii, the last in xvii to xxi. Testis sacs spherical or ovoid, mainly in x. Prostates as flattened hemispheres. No ovarian chamber; ovisacs present. Spermathecal ampulla spherical to oval; atrium a small simple widening embedded in the body-wall, or sometimes absent.

*Distribution.* Ootacamund and Naduvatam, S. India; Upper Rotung, Abor Country.

*a.* var. **bournei** (*Mich.*).

1894. *Moniligaster* sp., Bourne, Quart. J. Mic. Sci. xxxvi, p. 375, pl. xxiii, fig. 14.
1897. *Moniligaster bournei* + *M. pauli*, Michaelsen, Mt. Mus. Hamburg, xiv, pp. 167, 171.
1898. *Moniligaster bournei*, Michaelsen, Zool. Jahrb. Syst. xii, p. 144.
1900. *Drawida bournei* + *D. pauli*, Michaelsen, Tier. x, p. 116.
1910. *Drawida pellucidus* var. *bournei*, Michaelsen, Abh. Ver. Hamburg, xix, p. 50.

Length 55–142 mm.; diameter 2–4 mm. Segments 144–191. Colour bluish or brownish red, strongly pigmented. Prostomium prolobous, retractile. Setæ closely paired; $aa=bc$; $dd$ rather more than $\frac{1}{2}$ circumference. Nephridiopores in $cd$. Clitellum ring-shaped, x–xiii (=4). Male pores just above $b$. Female pores in $b$. Spermathecal pores in or just below $c$.

Septa 5/6–8/9 thickened, 9/10–14/15 displaced somewhat backwards dorsally. Three to five gizzards, in some of the segments xii–xviii. Testis sacs almost spherical, or somewhat constricted by the septum and projecting into both ix and x. Prostates spherical, smooth. No ovarian chamber; ovisacs extend back to about xv. Spermathecal ampulla ovoid; atrium absent.

*Remarks.* In 1894 Bourne shortly described a number of species of *Moniligaster*, and at the end of the paper mentions a single specimen from Kandy in Ceylon, but says that his notes are insufficient, and gives only a coloured drawing, with the information that the colour distinguishes it from all his other species, and that the gizzard is in segments xv–xviii. Michaelsen, in 1897, met with a form, probably from Peradeniya in Ceylon, which he thought could be identified with the above, and which he named *M. bournei*; in this paper he also described as a new species *M. pauli* from Trincomali.

The three forms, *pellucida*, *bournei*, and *pauli*, were kept separate in the Tierreich, and in Michaelsen's first list of Indian species (**54**) in 1909. But in 1910 (**58**), in consequence of the examination of new material, he concluded that *bournei* and *pauli* were identical, and that both represented only a variety of *pellucida*.

The sexual markings (grooves in front of and behind the male pores) in *D. pauli* are due to the clitellum being thinner in these places; they are more marked the better developed the clitellum is, and are not real sexual markings.

*Distribution.* Vakvalla, Bentota, Kaniya (in the last place amongst roots in damp ground near the outflow of a hot spring), Kandy, Colombo (Museum Gardens), Trincomali,—all in Ceylon.

*b.* var. **pallida** *Mich.*

1910. *Drawida pellucidus* var. *pallida*, Michaelsen, Abh. Ver. Hamburg, xix, p. 51.

Length 100–125 mm.; average diameter 3–4 mm. Segments 235–245. Pigmentation very faint, a slight bluish-green shimmer dorsally. Setal interval $aa=\frac{2}{3}bc$; $dd$ about $\frac{1}{2}$ circumference. Three or four gizzards, the first (in a specimen where there were four) in xiii.

*Distribution.* Shencottah, E. side of W. Ghats, Travancore.

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*c.* var. **stewarti** *Steph.*

1914. *Drawida pellucida* var. *stewarti*, Stephenson, Rec. Ind. Mus. viii, p. 369.

Length 37–62 mm.; diameter $3\frac{1}{2}$–4 mm. Segments ca. 165. Colour olive-green, varying in depth. Prostomium small, prolobous. Setæ of moderately large size, closely paired; *aa* = *bc* behind the genital region, but is greater than *bc* in front of this; *dd* = $\frac{4}{7}$ circumference. Male pores between *b* and *c*, rather nearer to *b*, on papillæ which are surrounded by a circular depression. A transverse dumbbell-shaped ridge on segment ix just in front of groove 9/10.

Four gizzards, in xv–xviii or xvi–xix, the first smallest. Testis sacs pear-shaped, with the small end forwards, in ix, the rounded end in x. Ovisacs small, curved and sausage-shaped, contained wholly in xii. Spermathecal ampulla ovoid; no atrium.

*Remarks.* The chief distinguishing mark is the ridge on segment ix; the other marks and irregularities in the region of the male pores have probably no significance. The shape of the testis sacs may also be distinctive.

*Distribution.* Rotung and Renging, Abor Country, E. Himalayas.

The above forms (except var. *stewarti*, since described) are discussed by Michaelsen (**58**), and shown to form, along with *D. grandis*, a group to which *D. friderici* and *D. barwelli* are also related.

30. **Drawida ramnadana** *Mich.*

1907. *Drawida ramnadana*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 145.

1909. *Drawida ramnadana*, Michaelsen, Mem. Ind. Mus. i, p. 146.

Length 44–55 mm.; maximum diameter $1\frac{3}{4}$–2 mm. Segments 165. Colour in dorsal and lateral regions anteriorly a bluish grey, for the rest yellowish grey. Prostomium prolobous. Setæ minute, closely paired; *aa* less than *bc*; *dd* greater than $\frac{1}{2}$ circumference; setæ present on ii. Nephridiopores in *cd*. Clitellum ring-shaped, x–xiii (= 4). Male pores in *b*, on small eye-shaped papillæ. Female pores in or near *ab*. Spermathecal pores in *b*.

Septa 5/6–8/9 thickened. Three gizzards, in xii–xiv. Testis sacs large, somewhat constricted by the septum, the larger part of the sacs in x; vas deferens enters front of prostate within the body-wall. Prostates shortly tubular, stumplike, invested with a thick covering of gland cells. Ovarian chamber perhaps absent; ovisacs extend backwards through several segments, constricted by the septa. Spermathecal ampulla large, pear-shaped; atrium a small, simple sac, thickly pear-shaped; spermathecal duct opens into basal part of atrial chamber.

*Remarks.* Seems to be nearly allied to *D. japonicus*. The original does not mention whether there is or is not an ovarian chamber.

*Distribution.* Ramnad, Madura Dist., S. India, on sandy coastal plains.

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### 31. Drawida rangamatiana *Steph.*

1917. *Drawida rangamatiana*, Stephenson, Rec. Ind. Mus. xiii, p. 369, pl. xvi, fig. 3.

Length 137 mm.; maximum diameter 7·5 mm. Segments 237. Non-pigmented, light grey in colour. Prostomium absent (?). Setæ closely paired, small; anteriorly $aa = bc$, behind the genital region $= \frac{2}{3}\, bc$, in the middle of the body and posteriorly is less than $\frac{1}{2}\, bc$; $dd = \frac{1}{2}$ circumference. Nephridiopores in *cd*. Clitellum? Male pores between *b* and *c*, but nearer to *c*. Female pores between *b* and *c*, but nearer to *b*. Spermathecal pores with their centre just below *c*.

Septa 5/6–8/9 very stout. Four gizzards, in xvi–xix. Last heart in viii; there are two commissures on each side in this segment. Testis sacs recall those of *D. ghatensis*; on one side (in the single specimen) in xii, on the other extending back into xiii,

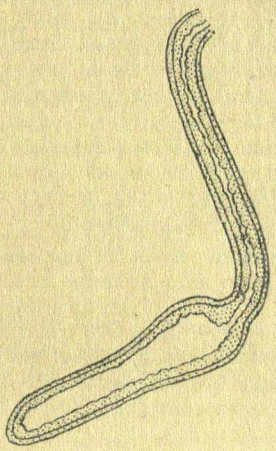

Fig. 54.—*Drawida rangamatiana* Steph.; spermathecal atrium, seen by transparency under the low power.

a neck passing forwards. Prostate closely curled, cylindrical, softish, not shiny, joined by vas deferens below its middle. Ovarian chamber present; ovisacs small, finger-shaped, reaching back into xiii. Spermathecal ampulla small, globular; atrium (text-fig. 54) a long stalked appendage, erect, ental portion dilated in the form of a cone with a rounded tip; duct joins atrium in body-wall.

*Remarks.* The relationships are with the *hodgarti* group. The last hearts appear to be characteristic, and the shape of the atrial appendage.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

### 32. Drawida robusta (*A. G. Bourne*) f. typica.

1886. *Moniligaster robustus*, Bourne, P. Z. S. 1886, p. 672.
1893. *Moniligaster indicus*, Benham, Quart. J. Mic. Sci. xxxiv, p. 363, pl. xxxii, pl. xxxiii, figs. 8–15.
1894. *Moniligaster robusta*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 366, pl. xiii, fig. 7.
1895. *Moniligaster robustus* + *M. indicus*, Beddard, Monog. pp. 198, 202.
1900. *Drawida robusta typica* + *D. robusta indica*, Michaelsen, Tier. x, pp. 119, 120.
1916. *Drawida robusta* f. *typica*, Stephenson, Rec. Ind. Mus. xii, p. 309.

Length 136–200 mm.; diameter 6 mm. Segments 150–160. Body depressed behind the anterior region, posterior end pointed. Colour bluish to greenish brown. Setæ closely paired, very small; *aa* greater than *bc*; *dd* greater than $\frac{1}{2}$ circumference. Nephridiopores in *cd*. Male pores between *b* and *c*, nearer to *c*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 thickened, but not so much as in many other species. Four gizzards, in xii–xv or xiii–xvi. Testis sacs large, subovoid or nearly spherical, projecting backwards, or forwards and backwards. Prostates hemispherical, with glandular surface, may overhang towards the middle line. Ovarian chamber present; ovisacs small, tubular, confined to xii. Spermathecal ampulla pyriform to oval or nearly spherical; atrium bilobed, large, one lobe projecting on each side of the septum.

*Remarks.* I believe that there is no need to distinguish Benham's *M. indicus* even as a separate variety, as Michaelsen does in the Tierreich. The only differences there brought forward are the length (137 as against about 200 mm.), a difference of one segment in the position of the gizzards, and the fact that the prostates do not overhang towards the middle line in var. *indica*.

*Distribution.* Widely spread on the Nilgiris, S. India.

#### *a.* var. ophidioides (*A. G. Bourne*).

1894. *Moniligaster ophidioides*, Bourne, Quart. J. Mic. Sci. p. 365, pl. xxiii, fig. 6, pl. xxv, figs. 28–29.
1900. *Drawida robusta ophidioides*, Michaelsen, Tier. x, p. 120.

Length ca. 310 mm.; diameter ca. 7 mm. Segments 200, no secondary annulation. Colour bluish to olive-green. Setal distance *aa* scarcely less than *bc*; *dd* more than $\frac{1}{2}$ circumference. Nephridiopores mostly in *cd*, occasionally in *ab*, occasionally above *cd*. Three gizzards, in xiv–xvi. Prostates hemispherical, or even more prominent, not overhanging.

*Distribution.* Ootacamund and Coonoor, Nilgiris, S. India; in swamps and wet ground.

### 33. Drawida rosea *Steph.*

1922. *Drawida rosea*, Stephenson, Rec. Ind. Mus. xxiv, p. 430.

Length 102 mm.; maximum diameter 3 mm. Segments 149. Colour grey, with a faint pinkish tinge dorsally. Prostomium prolobous. Vestiges of dorsal pores visible in the middle of the body. Nephridiopores in the line of the lateral setæ. Setæ closely paired; $aa = \frac{1}{3} bc$, $dd = \frac{1}{4}$ circumference. Male pores on transversely elongated papillæ at the hinder border of x, immediately outside the line *b*; a pair of smaller and rounder papillæ on the anterior part of xi, immediately behind the papillæ of the male pores. Mid-ventral region between the four papillæ depressed, and darker in colour. Female pores minute, in line with *ab*. Spermathecal pores conspicuous, between *ab* and *cd*, nearer the latter, the upper end of the pore reaching *cd*.

Septa 5/6-8/9 much thickened. Four gizzards, in xiii–xvi. The greater part of the testis sacs in x, reaching to septum 10/11; the sacs slightly constricted at septum 9/10. Prostates elongated, cylindrical, bent, ental end rather thicker, no separate duct, surface soft and glandular, vas enters near ental end. No ovarian chamber; ovisacs extend back to 13/14. Atrium large, not much smaller than ampulla, a pear-shaped sac, the lower and narrower portion marked by a number of annular constrictions and prolonged ectally into a tube leading to the exterior.

*Remarks.* The species, which was described from a single specimen, is related to *D. nepalensis* and *papillifer*.

*Distribution.* Cherrapunji, Assam.

### 34. Drawida rotungana *Steph.*

1914. *Drawida rotungana*, Stephenson, Rec. Ind. Mus. viii, p. 372.

Length 62 mm.; diameter 4 mm. Segments 187. Non-pigmented, whitish throughout, with a faint yellow tinge at the anterior end. Prostomium prolobous. Setæ small, closely paired; *aa* slightly less than *bc*; $dd = \frac{1}{3}$ circumference; setæ *ab* absent on x. Clitellum indistinct. Male pores on small papillæ, midway between *b* and *c*. Female pores just outside *b*. Spermathecal pores perhaps slightly internal to *c*. A pair of small genital papillæ on ix, close to posterior border, in the line of setæ *b*.

Septum 4/5 thick, 5/6–8/9 extremely thick. Six gizzards, in xv–xx. Testis sacs large, compact, rectangular, constricted by the septum. Vas deferens joins the body-wall just in front of and internal to prostate. Prostate hemispherical, sessile. Ovarian chamber present; ovisacs extend backwards into xiv. Spermathecal ampulla ovoid; no atrium.

*Remarks.* Perhaps related to the *pellucida* group. The vas deferens can by dissection be traced to the inner side of the prostate, which it joins.

*Distribution.* Rotung, Abor Country, E. Himalayas.

### 35. Drawida sapphirinaoides (*A. G. Bourne*).

1886. *Moniligaster sapphirinaoides*, Bourne, P. Z. S. 1886, p. 672.
1894. *Moniligaster sapphirinaoides*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 366, pl. xxiii, fig. 8, pl. xxvi, figs. 35, 36.
1895. *Moniligaster sapphirinaoides*, Beddard, Monog. p. 198.
1900. *Drawida sapphirinaoides*, Michaelsen, Tier. x, p. 119.

Length 125–175 mm.; diameter $5\frac{1}{2}$ mm. Segments ca. 160. Colour bluish red. Setæ closely paired; *aa* less than *bc*; *dd* almost equal to $\frac{2}{3}$ circumference. Nephridiopores in *cd*. Clitellum x–xiii (= 4). Male pores midway between *b* and *c*. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 6/7–8/9 very slightly thickened. Four or five gizzards, in xvii–xx or xxi. Testis sac ovoid. Prostates hemispherical, flattened, of glandular appearance. An ovarian chamber present. Atrium as a large undivided swelling at the end of the spermathecal duct.

*Remarks.* This is another species that lives in a very damp habitat; the original find was "in immense numbers in some very wet black mud under turf." Bourne refers to the variability of the species, and to the possibility of the existence of hybrids between this form and *D. robusta*; intermediate forms are found, and it is possible, therefore, that the present is only a variety of *D. robusta*.

*Distribution.* Pykara Waterfalls, ca. 6000 ft.; and widely spread on the Nilgiris, S. India.

### 36. Drawida scandens *Rao*.

1921. *Drawida scandens*, Rao, Ann. Mag. N. H. (9), viii, p. 515, pl. xv, figs. 1B, 2B, 3*b*; pl. xvii, fig. 9; pl. xviii, figs. 10*c*, 10*e*.
1921. *Drawida raui*, Stephenson, Rec. Ind. Mus. xxii, p. 755, pl. xxviii, fig. 7.
1922. *Drawida scandens*, Stephenson, Ann. Mag. N. H. (9), ix, p. 132.

Length 38–45 mm.; diameter $1\frac{1}{2}$–$1\frac{3}{4}$ mm. Segments ca. 144–161. Colour dark bluish grey, brown, or olive. Anterior end rather bulbous. Prostomium prolobous. Setæ closely paired, large and prominent, especially in the ventral bundles of iii–xii; $aa = bc$, or in the anterior part of the body is rather greater; $dd = \frac{1}{2}$ circumference or rather more. Clitellum? Male pores two pairs, the anterior in 9/10, rather outside the line of setæ *b*, on a median transverse somewhat dumbbell-shaped cushion, extending on each side to between the lines of *b* and *c* (this cushion may be represented by a pair of papillæ); posterior male pores over the normal situation of groove 10/11, just outside the line of setæ *b*, in the antero-lateral angles of a thickened median patch which occupies the ventral surface of xi, pushing forwards

groove 10/11 (text-fig. 55). Female pores perhaps in 11/12 between the lines *a* and *b*. Spermathecal pores in *ab*.

Septa 6/7–8/9 considerably thickened, 5/6 thin, 9/10 and a few following also slightly thickened. Two gizzards, in xiii and xiv, or three, in xiii–xv. Testis sacs extending into ix and x. Prostates two pairs, in ix and x, elongated, cylindrical or pear-shaped,

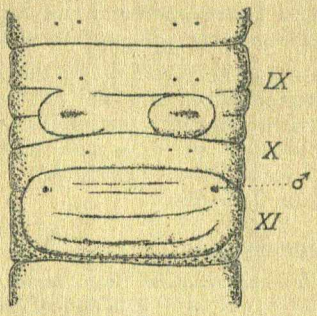


Fig. 55.—*Drawida scandens* Rao ; genital field.

surface soft, minutely papillated. No ovarian chamber; ovisacs may extend back to xv. Spermathecal atrium relatively large, ovoid and sac-like, duct entering near base.

*Remarks.* This species is especially interesting on account of the well-developed second pair of prostates, which mark it out as perhaps the most primitive member of the genus.

*Distribution.* Forests of Shimoga and Kadur Dists., Mysore; Bhagamandla, Coorg, S. India.

### 37. Drawida shunkarai *Mich.*

1913. *Drawida schunkarai*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 74.

Length 110 mm.; diameter 3½–5 mm. Segments ca. 200; secondary annulation on the posterior parts of each of segments vii–xi. Setæ very fine and closely paired, beginning in iii (?); $aa = 1\frac{1}{2}\,bc$ anteriorly, $= bc$ in middle and hinder parts of body; *dd* distinctly (anteriorly) or slightly (behind) greater than ½ circumference. Male pores about midway between *b* and *c*, on thick papillæ, which project from a transverse spindle-shaped slit on each side; segments ix and x swollen between the lines *b* and *c*. Female pores in *ab* (?). Spermathecal pores in *cd*, on small papillæ.

Septa 5/6–8/9 thickened, the first moderately, the rest very much. Four gizzards, in xvii–xx. Testis sacs large, much constricted by the septum, projecting equally on each side; each portion of the sac concave inwards, nearly meeting its fellow above the gut. Ental portion of vas deferens is the thicker, and

wavy; it then becomes thinner, and closely coiled. Prostates hemispherical, smooth, and with muscular shimmer. Ovarian segment much narrowed by the approximation of the septa; ovisacs thickly tubular, irregular, constricted at the septa, extending back into xv. Spermathecal ampulla large, thickly pear-shaped; atrium small, almost concealed in the body-wall, receives the duct at its broad ental pole. Accessory organs as two pairs of blind club-shaped tubes, in vii and viii, attached to the hinder septum of each segment, wavy, the ental end the thicker.

*Remarks.* Owing to the condition of the single specimen it could not be determined whether or not there was any connection between the accessory apparatus just mentioned and the spermathecal atrium; if so, they would be atrial sacs. For a somewhat similar accessory apparatus, cf. *Hoplochætella*.

*Distribution.* Cape Comorin.

38. **Drawida somavarpatana** *Rao.*

1921. *Drawida somavarpatana*, Rao, Ann. Mag. N. H. (9), viii, p. 497; pl. xv, figs. 1 A, 2 A, 3 *a*; pl. xvi, figs. 5 *a*, 6, 6 *a*; pl. xvii, figs. 7, 8, 10, 10 *a*, 10 *b*; pl. xviii, figs. 10 *f*, 10 *g*, 10 *j*.

1922. *Drawida somavarpatana*, Stephenson, Ann. Mag. N. H. (9), ix, p. 131.

Length 85 mm.; diameter 4 mm. Segments 124. Colour brownish yellow. Prostomium small, retracted under segment i. No dorsal pores. Nephridiopores in line with lateral setæ. Setæ closely paired; $aa=bc$, $dd=\frac{1}{2}$ circumference. Clitellum apparently x–xiii (= 4). Male pores as puckered orifices with tumid lips, a little outside line of setæ *b*; a curved depression in front of and behind each, the concavities of the curves facing each other; x and xi depressed midventrally. Spermathecal pores in line with *cd*.

Septa 5/6–8/9 slightly thickened. Three gizzards, in xvi–xviii, the last the largest. Testis sacs as in *D. ghatensis*, extending back to xiv, in which segment the main portion of the sac lies. Prostates consist each of two finger-shaped structures, side by side, united below in a narrow neck, which again swells out somewhat at its termination, where it joins the parietes; surface soft, friable. Ovarian chamber present; ovisacs extend back to xiv. Spermathecal atrium bifid, one horn in vii, the other in viii, the duct joining in the angle between the two. Strong transverse muscular bands on inner surface of body-wall in prostatic region.

*Distribution.* Somvarpet, Coorg.

39. **Drawida sulcata** *Mich.*

1907. *Drawida sulcata*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 144, text-fig. 1.

1909. *Drawida sulcata*, Michaelsen, Mem. Ind. Mus. i, p. 141, pl. xiii, fig. 2.

Length 67–70 mm.; diameter 3–3½ mm. Segments 150; x and xi with a very sharp transverse furrow ventrally. Colour a dirty grey. Prostomium? Setæ very fine, very closely paired; *aa* anteriorly distinctly larger than *bc*, in rest of body about equal to *bc*; *dd* a little more than ½ circumference. Nephridiopores usually in *cd*. Clitellum x–xiii (=4), ring-shaped in the hinder part. Male pores on very prominent papillæ, midway between *b* and *c*. Female pores? Spermathecal pores just ventral to *c*.

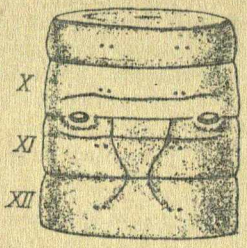


Fig. 56.—*Drawida sulcata* Mich.; genital field.

Seminal furrows beginning at 10/11, medial from *a* (thus unconnected with the male pores); at first converge slightly, and reach 11/12 near the middle line; then diverge, and die away at the middle of xii; the furrows included in a darker smooth area; probably not connected with the female pores (text-fig. 56).

Septa 5/6–8/9 very strong. Five gizzards, in xv–xix, or perhaps xiv–xviii, the first two rather smaller. Testis sacs large, sharply incised by the septum, the portion in ix much shorter than that in x. Prostates hemispherical, shortly stalked, surface mammillated ("glandular"). Ovarian chamber absent; ovisacs extend back into xiii, much constricted by septum 12/13. Spermathecal ampulla pear-shaped; atrium very small, simple, nearly hidden in body-wall.

*Remarks.* Except for the seminal grooves, the species is very like *D. parva*; and it is to be remembered that Bourne had a somewhat meagre scheme for the description of his species, and so might not have described actually existent grooves. Another worm that might possibly be identified with *D. sulcata* is *D. kanarensis*; the locality of *D. sulcata* is within a few miles of that of *D. parva*, but *D. kanarensis* was found 300 miles away.

*Distribution.* Coonoor, Nilgiris, S. India.

### 40. Drawida travancorensis *Mich.*

1910. *Drawida travancorensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 46.

Length ca. 185 mm.; diameter 3 mm. Segments 130. (Colour and prostomium no longer recognizable in the specimens.) Setæ closely paired, especially the lateral in the anterior part of the

body; $aa = \frac{3}{4}$ to $\frac{5}{6}bc$, in the anterior part the first relation, in the middle of the body the second; *dd* rather greater than $\frac{1}{2}$ circumference. Clitellum saddle-shaped, interrupted between the lines *a*, including x–xiii (=4). Male pores comma-like slits, the broader end towards the middle line, about midway between *b* and *c*. Spermathecal pores in *c*.

Septa 5/6–8/9 fairly strongly thickened. Two gizzards, apparently in xiii–xiv, the first rather smaller. Testis sacs projecting into both ix and x, not markedly constricted. Prostates large, regularly pear-shaped, smooth, no glandular investment. Ovarian chamber present; ovisacs thick, short, extending backwards through one or two segments. Spermathecal ampulla thickly pear-shaped; atrium a fairly large, simple, slender club-shaped sac free in vii, the duct entering its ectal end.

*Distribution.* Kottayam, Travancore, S. India.

41. **Drawida uniqua** (*A. G. Bourne*).

1886. *Moniligaster uniquus*, Bourne, P. Z. S. 1886, p. 671.
1894. *Moniligaster uniqua*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 363, pl. xxiii, fig. 4.
1895. *Moniligaster uniquus*, Beddard, Monog. p. 198.
1900. *Drawida uniqua*, Michaelsen, Tier. x, p. 118.

Length 220 mm.; diameter 5 mm. Segments 316, faint secondary annulation. Unpigmented. Setæ present on ii; *aa* practically equal to *bc*; *dd* very slightly greater than $\frac{1}{2}$ circumference. Nephridiopores in *cd*. Male pores between *b* and *c*, often on papilla-like evaginations. Female pores in *ab*. Spermathecal pores in *cd*.

Septa 5/6–8/9 thickened. Gizzards four or five, the first in xv–xvii, the last in xix–xxi. Testis sacs lemon-shaped. Prostates teat-like, turned backwards. No ovarian chamber. Spermathecal ampulla pear-shaped to ovoid; duct with simple atrial widening at ectal end.

*Remarks.* Bourne in 1894 identified this species with his *M. papillatus*; the reason is not evident, as *M. uniquus* is said to be "a small weak-looking worm," while *M. papillatus* "is a much longer worm than any of the other species, with the exception of *M. grandis*." Michaelsen follows Bourne in identifying the two; I think (*cf.* the Introduction to the present genus) that *M. papillatus* must be left out of consideration altogether.

Michaelsen considers (**58**, p. 21) that *D. nepalensis* is probably identical with this species. I cannot agree here either; *D. nepalensis* has an ovarian chamber, and the atrium is a large annulated sac.

Bourne states that "this species and *M. pellucida* occur together and form, I believe, hybrids,—I have found so many specimens with an intermixture of character . . ." The two species are much

alike externally, except for the bulbous anterior end of *D. pellucida* (an effect of contraction); the teat-like prostate of the present form seems to be the main difference. It might therefore be possible to unite this species with *D. pellucida*.

*Distribution.* Ootacamund and Coonoor, in the Nilgiris.

## 42. Drawida willsi *Mich.*

1907. *Drawida willsi*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 145.
1909. *Drawida willsi*, Michaelsen, Mem. Ind. Mus. i, p. 143.

Length 55–60 mm.; maximum diameter 2·5 mm. Segments 155–160. Colour variable, bluish grey or reddish grey. Prostomium prolobous, transversely oval in shape. Setæ closely paired, especially the lateral; *aa*=*bc*, or anteriorly a little less; *dd* rather more than $\frac{1}{2}$ circumference. Nephridiopores in *cd*. Clitellum ring-shaped, x–xiii (=4). Male pores on transversely oval papillæ in *b*; in many specimens an additional pair of rudimentary male pores in a corresponding position in 9/10. Female pores in *ab*. Spermathecal pores in *ab*, inconspicuous.

Septa 6/7–8/9 thickened, especially the first two; 9/10 and 10/11 dislocated backwards dorsally. Two gizzards, in xiv and xv. Testis sacs constricted by the septum. Prostates short thick tubes, somewhat bent or depressed, nearly disc-like, with thick covering of pear-shaped glands. A second pair of prostates, similar but smaller, in connection with the additional male pores. Ovarian chamber present; ovisacs large, extending back through about six segments, constricted by the septa. Spermathecal ampulla ovoid; atrium moderately large, simple, ovoid, almost unstalked; duct enters ectal end of atrium.

*Remarks.* The presence of vestigial prostates points to the origin of the genus from a form which possessed two pairs of glands; such a genus is *Desmogaster*. Compare the condition in *D. scandens*, where the second pair of prostates is quite well developed.

The special ovarian chamber mentioned by Michaelsen is, if it occurs as described by him, apparently something different from the usual ovarian chamber, which is the eleventh segment. Here the ovarian chamber is "separated from the small 11th segment by a fine membrane, which connects septa 10/11 and 11/12."

The specimen referred to by Michaelsen as coming from the W. Himalayas was probably *D. japonica*.

*Distribution.* Bilaspur, Central Provinces; Hyderabad, Deccan.

## Family MEGASCOLECIDÆ.

1895. Megascolicidæ + Eudrilidæ, Beddard, Monog. pp. 357, 573.
1900. Megascolecidæ, Michaelsen, Tier. x, p. 120.

Setæ simply pointed, sigmoid, four pairs per segment, or numerous; in the latter case forming rings which may be either closed, or broken dorsally and ventrally; the setæ in the rings either arranged at fairly equal distances, or approximated in couples. Clitellum beginning with or in front of xv, with few exceptions including the whole of xv. Male pores one pair, usually on xviii or xvii, exceptionally on xix. Female pores one pair, often fused midventrally, on xiv or immediately behind this. Œsophagus usually with one on several gizzards in front of the testis segments, rarely no gizzard. Two pairs testes and funnels in x and xi, or one pair in x or xi; one or two pairs of prostates, rarely reduced to one only or altogether wanting. One pair of ovaries in xiii.

*Distribution.* Over the whole of the southern half of the globe, and the southern part of the N. Hemisphere; apparently absent from N. and W. Asia, and from N. Europe and Arctic N. America; present as an introduced element of the fauna in Central and S. Europe, and occasionally in N. Africa; endemic, however, in the Nile countries.

The Megascolecidæ, considerably the largest family of the Oligochæta, can be traced back to their evolutionary starting point, which is represented by worms of the genus *Notiodrilus* as defined by Michaelsen in the Tierreich. The ancestor of the family was characterized by the possession of two pairs of testes and funnels, not enclosed in testis sacs, in segments x and xi; the vasa deferentia passed backwards to open by a pair of pores on segment xviii, probably in the setal zone; of two pairs of prostates, tubular in structure, contained in and opening on segments xvii and xix; of two pairs of spermathecæ, opening in grooves 7/8 and 8/9; of four couples of setæ per segment; and of a pair of meganephridia per segment; there was a single gizzard in the region of segments v–vii. This may be called the "original Acanthodriline" condition, from the name of the genus (in which *Notiodrilus* is now included) which comprehends forms having these characters.

From this base the Megascolecid tree has branched out in a number of directions. The larger offshoots have a unity of their own, their evolution follows a fairly definite course, and they constitute well-defined subfamilies—the Megascolecinæ, Octochætinæ, Diplocardiinæ, etc. But after the separation of these

main branches there is left a group of forms, which we may best compare to the undergrowth around the base of the tree—short sprouts from the base itself, mostly taking different directions, and none of them growing very far. It is found most convenient to group all these together as another subfamily, the Acanthodrilinæ, which thus has rather a different character from the rest.

The Acanthodrilinæ scarcely interest the Indian worker, since only one species of the subfamily, and that a well-known wanderer, is known to occur. The chief subfamilies which will occupy his attention are the three already mentioned—the Megascolecinæ, Octochætinæ, and Diplocardiinæ.

*Key to the Indian subfamilies of* Megascolecidæ.

| | |
|---|---|
| 1. One pair of calciferous glands (often fused ventrally) in segment ix | Ocnerodrilinæ. |
| Calciferous glands not, or not only, in segment ix | 2. |
| 2. Two or three gizzards in front of the first testis segment | 3. |
| One gizzard, or none, in front of the first testis segment | 4. |
| 3. Calciferous glands in 2 or 3 of the segments x–xiii | Gen. *Eudichogaster* (Octochætinæ). |
| Calciferous glands behind the ovarian segment, or absent | Diplocardiinæ. |
| 4. Spermathecal pores behind groove 8/9, often fused with the female pores | Eudrilinæ. |
| Spermathecal pores at or in front of 8/9 | 5. |
| 5. Vasa deferentia opening into the prostates (unless the prostates are absent) | Megascolecinæ. |
| Vasa deferentia opening separately from the prostates, at most close besides them, or into the prostatic duct at its termination | 6. |
| 6. Micronephridial | Octochætinæ (part.). |
| Meganephridial | Acanthodrilinæ. |

## Subfamily ACANTHODRILINÆ.

1900. Acanthodrilinæ, Michaelsen, Tier. x, p. 122.
1921. Acanthodrilinæ, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 58.

Setæ mostly eight per segment, seldom numerous and then approximated in couples within the ring. Clitellum beginning with or in front of xiv. Calciferous glands mostly absent, rarely present in segments vii–ix or in xiii. Male pores on xviii or xvii; prostatic pores two pairs on xvii and xix, or one pair on xvii. Spermathecal pores in grooves 7/8 or 8/9 or both, rarely absent. One gizzard in front of the testis segment, rarely vestigial or

absent. Purely meganephridial. Prostates tubular, lumen of glandular portion lined by a non-glandular columnar epithelium; vas deferens ending independently of the prostates or in a common pore, but at any rate not entering the gland.

*Distribution.* Mostly in the S. Hemisphere, but introduced into other parts. Thus the only Indian representative is a "world-wanderer."

### 1. Genus **MICROSCOLEX** *Rosa*, emend. *Mich.*

1895. *Microscolex* (part.), Beddard, Monog. p. 459.
1900. *Microscolex* + *Notiodrilus* (part.), Michaelsen, Tier. x, pp. 139, 128.
1905. *Microscolex* (part.), Michaelsen, O. südpolar-Exp. p. 21.
1907. *Microscolex*, Michaelsen, Fauna S.W. Austral. p. 143.
1909. *Microscolex* + *Notiodrilus* (part.), Benham, O. Sub-antarctic Is. pp. 254, 269.
1911. *Microscolex*, Michaelsen, Zool. Jahrb. Syst. xxx, p. 528.

Setæ eight per segment. Nephridiopores in one longitudinal line on each side. Male pores on xviii or xvii. Two pairs prostatic pores on xvii and xix, or one pair on xvii. Spermathecal pores two pairs in 7/8 and 8/9, or one (or three?) pairs, the last in 8/9. Gizzard vestigial or absent (at most recognizable as a slight thickening of the circular muscle of the tube in sections, scarcely thicker and narrower than the neighbouring parts of the œsophagus). Two pairs free testes and funnels in x and xi.

The history of the various schemes of partition of this and related genera is given up to 1907 in Michaelsen (**123**); and further changes in the arrangement and content of the several genera in Michaelsen, (**127, 128, 129**); *cf.* Benham also (**115**). It is an interesting history, but as the subfamily has so slight a relation to the Indian fauna it would hardly be justifiable to enter into an account of it here.

*Distribution.* In India only at Peshawar. Widely spread in the S. Hemisphere, circummundane; has also been carried into the N. Hemisphere.

#### 1. **Microscolex phosphoreus** (*Ant. Dug.*).

1914. *Microscolex phosphoreus*, Stephenson, Rec. Ind. Mus. x, p. 338.

---

For the complete synonymy and distribution, up to 1907, see:—

1907. *Microscolex phosphoreus*, Michaelsen, Fauna S.W. Austral. p. 148.

Length 10–50 mm.; diameter 1–2 mm. Unpigmented, in life phosphorescent. Segments 75–90. Prostomium epilobous $\frac{1}{2}$.

No dorsal pores. Nephridiopores intersegmental, as far as iv in *d*, behind this immediately below *c*. Setæ widely paired; $ab=\frac{1}{2}-\frac{2}{3}\ aa=\frac{1}{2}\ bc=\frac{3}{4}\ cd$; $dd=2\ bc$. Clitellum ring-shaped, xiii–xvi (=4 or 5). Prostatic pores on xvii just outside seta *b*; vasa deferentia end at the same level as the prostatic pores, but just inside seta *b*. Other genital apertures in line with *a*; spermathecal pores in 8/9.

Septa 6/7–12/13 moderately thickened. Gizzard in v, vestigial. No typhlosole. Last heart in xii. Seminal vesicles two pairs, in xi and xii. Prostates small, extending over no more than one segment. Penial setæ delicate and slender, slightly bowed, with scattered broad teeth apposed to shaft. Spermathecal ampulla pear-shaped; one or two short diverticula given off from the duct.

*Remarks.* The relation of the prostatic pore to the opening of the vas deferens as given above was determined from a series of sections. The Indian specimens had two spermathecal diverticula instead of the more usual one.

This is the only representative of the Acanthodrilinæ in India.

*Distribution.* In India only found at Peshawar. Its original home is in S. America; it has been widely spread through artificial transfer, as well as in the S. Hemisphere by the drift across the S. Atlantic and Indian Ocean.

## Subfamily MEGASCOLECINÆ.

1900. Megascolecinæ, Michaelsen, Tier. x, p. 161.
1907. Megascolecinæ, Michaelsen, Fauna S.W. Austral. i, p. 149.
1909. Megascolecinæ, Michaelsen, Mem. Ind. Mus. i, p. 118.
1910. Megascolecinæ, Michaelsen, Abh. Ver. Hamburg, xix, p. 21.
1916. Megascolecinæ, Michaelsen, Mjöberg's Austral. Exp. p. 53.

Setæ either eight per segment, or numerous, and then either in regular chains or approximated in couples. Clitellum beginning with or in front of xiv. Male pores on xviii. Spermathecal pores, if present, one to six pairs, in front of the testis segments. Usually one gizzard in front of the testis segments, sometimes two or three, exceptionally none. Mega- or micronephridial. Two pairs testes and funnels in x and xi, or only one pair; prostates tubular or branched, rarely absent; vas deferens enters prostatic duct or gland.

*Distribution* (Charts II and III). The subfamily occurs throughout the whole of India, but in the N.W. and Central regions it is represented only by peregrine species. In general its home is the Australian and Indian regions, with the Malay Peninsula and Archipelago, the Philippines, China, Japan, and Polynesia; a very few species are found in N. America. Certain

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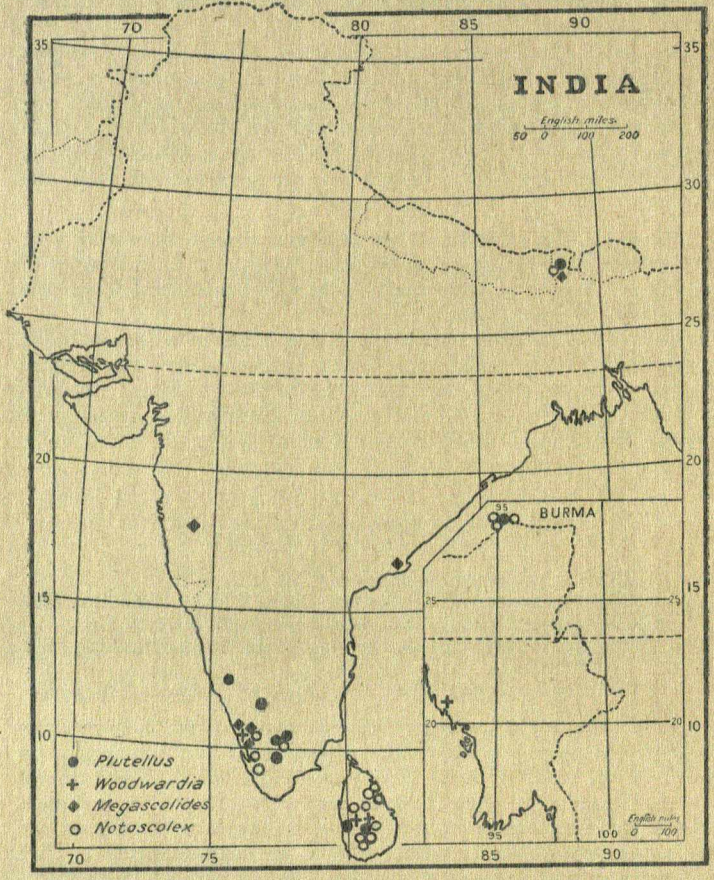
widely wandering species are found in many parts of the world; the littoral *Pontodrilus* is found on the coasts of all the warmer parts of the globe.

CHART II.

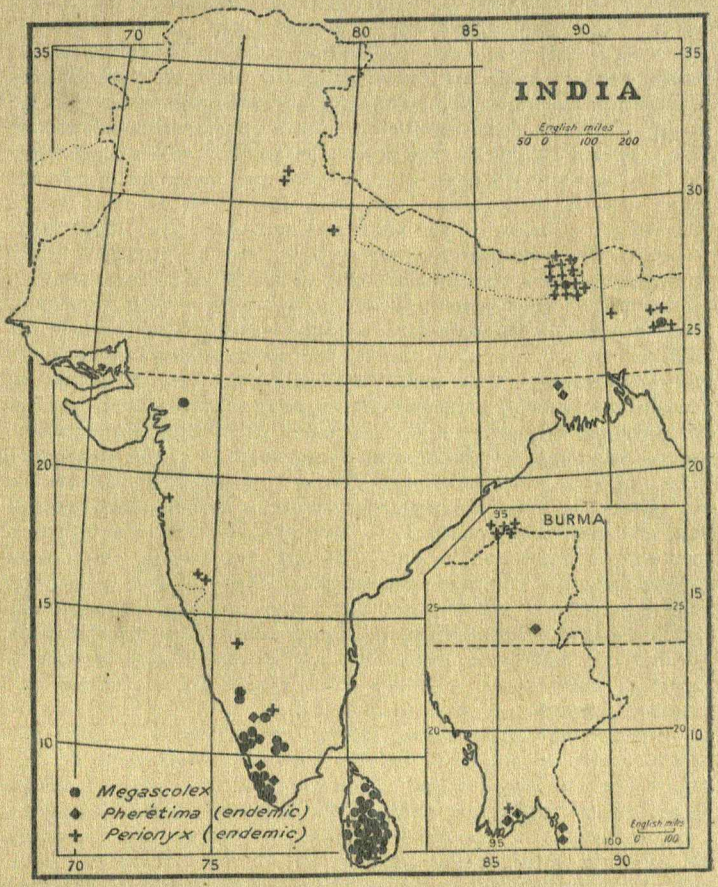



The whole of the family Megascolecidæ is, as previously indicated, to be derived from an original form which has essentially the characters of the genus *Notiodrilus* as defined by Michaelsen in the Tierreich volume of 1900 (for these characters *v. ant.* p. 162).

The Megascolecinæ, however, take their origin from a form which is one remove from this—*Diplotrema*, in which the anterior pair of prostates have disappeared and the posterior pair of prostatic pores have moved forwards to open on xviii near the apertures of the vasa deferentia.

In *Plutellus*, the first genus of the Megascolecinæ, the prostatic pores have fused with the openings of the vasa deferentia on xviii so that there is but one pair of pores; and this remains

CHART III.




throughout the subfamily as its distinguishing character. In the remaining genera the changes are of three chief kinds—the setæ may take on the perichætine arrangement, the four pairs multiplying in number and becoming spread out to form a more or less complete ring round each segment; the nephridia may be broken up, with the substitution of a number, sometimes a very large number, of small micronephridia for the single pair of meganephridia in each segment; and the single central canal of the

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prostate may branch, with the consequence that the organ is no longer tubular and cylindrical in form, but racemose. In a small group of genera there is a development of two or more gizzards, instead of the single gizzard of *Plutellus*.

*Plutellus*, then, has meganephridia, eight setæ per segment arranged in four pairs (the lumbricine arrangement), and a pair of tubular prostates opening on segment xviii in common with the vasa deferentia. From *Plutellus* is derived *Megascolides*, in which the nephridia are breaking up or have broken up; this apparently does not always take place in the same way: in one group of forms there are three or four nephridia on each side of each segment, all about the same size, while in other cases there is one large one and a number of quite small ones; however, all stages of the process are united in this genus, so long as the prostates and setæ retain their original condition. The next stage is *Notoscolex*: the prostates now become branched; in a number of cases the branches of the central canal are so insignificant that they have no effect on the form of the gland, and can only be demonstrated in sections—the genus, however, is defined as including all forms in which there is any branching at all. Following this we come to *Megascolex*, where the setæ take on the perichætine arrangement; here again there are a number of intermediate stages; in a number of species the anterior segments retain the lumbricine arrangement, and the increase in the number of setæ takes place gradually as we move backwards; in others the anterior segments show an increase too, but the paired arrangement still holds—there are six pairs, or eight pairs, instead of four; and so on. The last genus along this line is *Pheretima*; the essential characters are those of *Megascolex*, but the gizzard is further back, the testes and male funnels are enclosed in testis sacs instead of being free in the segments (this occurs occasionally in *Megascolex*), and on the whole the ring of setæ is more closed up—has smaller gaps in the dorsal and ventral lines than is usual in *Megascolex*.

But there are other lines starting from *Plutellus*. In the line just considered the first change was the breaking up of the nephridia: in another line the multiplication of the setæ comes first. This change, occurring in the basal genus *Plutellus*, gives *Diporochæta*, the generic characters of which are therefore tubular prostates, meganephridia, and perichætine setæ. It is, of course, impossible to derive this form from any of the first line, since those all have micronephridia; the meganephridial condition is the primitive one, and a meganephridial cannot be derived from a micronephridial form. From *Diporochæta* is derived *Perionyx*, in which the prostates have branched; this genus therefore possesses meganephridia, perichætine setæ, and racemose prostates. As in the case of *Megascolides* and *Notoscolex*, the transition between these two genera is gradual, and in some cases the branching of the central canal of the

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prostate or its absence can only be determined by microscopic examination.

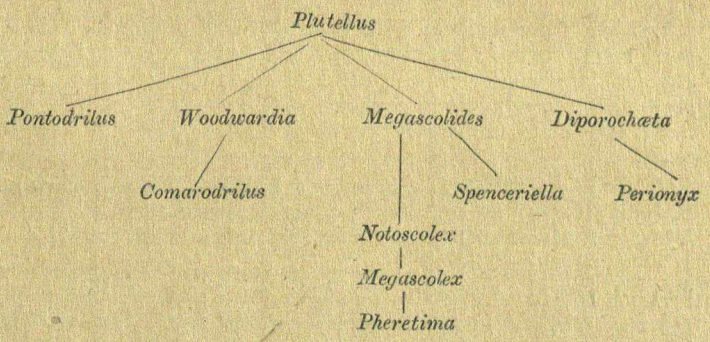
In the third line which starts from *Plutellus* the initial change is the modification of the prostates; *Woodwardia*, having thus racemose prostates, lumbricine setæ, and meganephridia, cannot be placed on either of the other lines, since in them either the setæ or the nephridia are modified from the start. From *Woodwardia* is probably to be derived *Comarodrilus*, in which the nephridia in front of the clitellum, but only these, are broken up, the gizzard has become vestigial, and the originally paired spermathecal pores have fused in the middle line.

The genus *Spenceriella* has the primitive form of prostate, but is micronephridial, and has the perichætine arrangement of setæ; it is probably to be derived from *Megascolides* by multiplication of the setæ. It could, however, equally come from *Diporochæta* by the breaking up of the nephridia.

A group of small genera are characterized by the reduplication of the gizzard. *Digaster* and *Didymogaster* have two gizzards, and are distinguished from each other by the number and position of the spermathecæ; *Perissogaster* has three gizzards, situated anteriorly, as in the two former species. The condition of the other systems indicates that these are all to be derived from *Notoscolex*. *Plionogaster*, in which there are several gizzards more posteriorly situated, at the beginning of the intestine, is to be considered as originating from *Megascolex*.

Finally *Pontodrilus* is to be mentioned. The majority of species are littoral in habitat; one is terrestrial, and one is limnic. It is derived directly from *Plutellus*; the gizzard has become vestigial, and nephridia are absent from the first twelve or fourteen segments.

The above relationships may be graphically expressed in the form of a tree, as follows:—



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*Key to the Indian genera of* Megascolecinæ.

| | | |
|---|---|---|
| 1. | Setæ eight throughout the body | 2. |
| | Setæ numerous (more than eight) at least in the middle and hinder parts of the body | 7. |
| 2. | Meganephridia alone present | 3. |
| | Micronephridia present with or without meganephridia | 5. |
| 3. | Prostates tubular, with unbranched canal | 4. |
| | Prostates with branching canal system | WOODWARDIA. |
| 4. | Gizzard well developed | PLUTELLUS. |
| | Gizzard small or vestigial | PONTODRILUS. |
| 5. | Prostates tubular, with unbranched canal | MEGASCOLIDES. |
| | Prostates with branching canal system | 6. |
| 6. | Spermathecal pores in a single median series | COMARODRILUS. |
| | Spermathecal pores paired | NOTOSCOLEX. |
| 7. | Meganephridia alone present | 8. |
| | Micronephridia present, with or without meganephridia | 9. |
| 8. | Prostates tubular with unbranched central canal | DIPOROCHÆTA. |
| | Prostates with branching canal system | PERIONYX. |
| 9. | Prostates tubular, with unbranched central canal | SPENCERIELLA. |
| | Prostates with branching canal system | 10. |
| 10. | Gizzard in segment v, vi, or vii | MEGASCOLEX. |
| | Gizzard in viii | PHERETIMA. |

## 1. Genus **PLUTELLUS** *E. Perr.*

1900. *Plutellus* + *Fletcherodrilus*, Michaelsen, Tier. x, pp. 163, 178.
1907. *Plutellus* + *Fletcherodrilus*, Michaelsen, Fauna S.W. Austral. i, p. 159.
1909. *Plutellus* + *Fletcherodrilus*, Michaelsen, Mem. Ind. Mus. i, pp. 118, 119, 120.
1910. *Plutellus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 22.
1916. *Plutellus*, Michaelsen, Mjöberg's Austral. Exp. p. 53 ff.

Setæ eight per segment. Male pores paired or single; female pores mostly paired; spermathecal pores end at groove 8/9 or on segment ix, a single pair or a series of two to five pairs or single pores. One gizzard in the region of segments v–vii. Purely meganephridial. Prostates tubular, with simple unbranched canal.

*Distribution* (Chart II). Palni and Nilgiri Hills, and Cochin, S. India; Ceylon; Darjiling Dist. and Abor Country, E. Himalayas. Outside India in Australia, Tasmania, and N. America.

Michaelsen has included the genus *Fletcherodrilus* under this heading, otherwise *Plutellus palniensis*, with unpaired male pore, spermathecæ, and spermathecal pores, would be a *Fletcherodrilus*. The morphological difference between a typical *Plutellus* and a "*Fletcherodrilus*" is, of course, considerable; but if the latter is retained as a separate genus it would be diphyletic—one species

having arisen in Australia and another in India, from *Plutellus* in each case. The tendency to fusion of the male and spermathecal pores is seen also in *Perionyx*, and markedly in *Comarodrilus*. The female pores seem to be fused in only one species of *Plutellus* (*P. halyi*).

The genus is a variable one; developments seem to be starting in several directions. Thus in several species the gizzard is becoming vestigial; one species has testis sacs; one has a number of vestigial spermathecæ; in one the spermathecæ are reduced to one pair; in *P. timidus* and *indicus* spermathecal pores appear on viii (*i. e.*, some distance from a furrow), and in *aquatilis* on viii and ix.

*Key to the Indian species of* Plutellus.

| | |
|---|---|
| 1. Spermathecæ and their pores unpaired ..... | *P. palniensis.* |
| Spermathecæ and their pores paired ..... | 2. |
| 2. Spermathecæ more than two pairs, vestigial .... | *P. sikkimensis.* |
| Spermathecæ two pairs ..... | 3. |
| Spermathecæ one pair ..... | *P. timidus.* |
| 3. Spermathecal pores on segment viii and in groove 8/9 ..... | *P. indicus.* |
| Spermathecal pores in grooves 7/8 and 8/9 ..... | 4. |
| Spermathecal pores on segments viii and ix ..... | *P. aquatilis.* |
| 4. Penial setæ present ..... | 5. |
| No penial setæ ..... | 6. |
| 5. Penial setæ without ornamentation, spermathecal duct short ..... | *P. aborensis.* |
| Penial setæ ornamented, spermathecal duct long and thin ..... | *P. singhalensis.* |
| 6. Clitellum saddle-shaped; genital markings as papillæ in neighbourhood of male pores ..... | *P. halyi.* |
| Clitellum ring-shaped; genital markings a pair of longitudinal ridges on xviii–xx ..... | *P. dubariensis.* |

In addition to the above, an indeterminable species has been recorded from Parambikulam, in Cochin State (Stephenson, Mem. Ind. Mus. vi, p. 61, 1915).

### 1. Plutellus aborensis *Steph.*

1914. *Plutellus aborensis*, Stephenson, Rec. Ind. Mus. viii, p. 384, pl. xxvi, figs. 9, 10.

Length 100 mm.; diameter relatively small, in front 3 mm., behind 1½ mm. Segments 385. Colour pale. Prostomium small, prolobous. Segment v. biannulate, subsequent ones triannulate; the secondary annulation lost towards the hinder end. Dorsal pores from 9/10. Setæ small and inconspicuous, difficult or impossible to see in front of xi; $aa = 4\,ab = 1\frac{1}{4}\,bc$; $ab = \frac{2}{3}\,bc$; $dd = \frac{1}{2}$ circumference; setæ *a* and *b* absent on xviii. Clitellum? Male pores on small papillæ which occupy the interval *ab*; a brownish coloration around and internal to the papillæ. Female pores? Spermathecal pores in 7/8 and 8/9, between *a* and *b*.

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Septa 5/6–9/10 thickened. A short gizzard, square in shape, in v. No calciferous glands. Last heart in xiii. Testes and funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, lobulated, rather compressed antero-posteriorly, attached to the anterior faces of 11/12 and 12/13. Prostate small though extending through several segments, as far as xxi, coiled, tubular; duct muscular and shining, forming a single rather elongated loop in xviii, its ectal end thickened. Spermathecal ampulla a straight or bent cylinder lying obliquely on the body-wall; duct short, from its under surface; diverticulum finger- or club-shaped, joining the mesially situated end of ampulla (text-fig. 57). Penial setæ (text-fig. 58) 0·88 mm. long, 11 $\mu$ broad, without ornamentation, sharply pointed, with a gentle wavy curve at the distal end; the rest of the shaft straight.

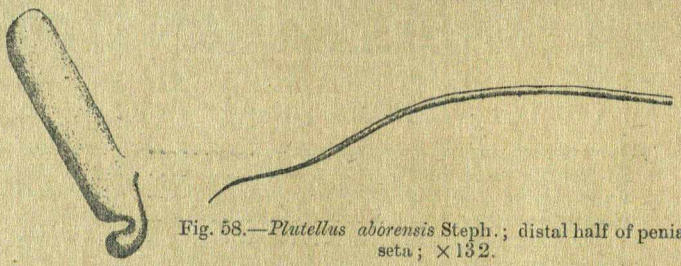

Fig. 58.—*Plutellus aborensis* Steph.; distal half of penial seta; ×132.

Fig. 57.—*Plutellus aborensis* Steph.; spermatheca.

*Remarks.* The situation of the seminal vesicles seems peculiar—one would have expected vesicles in xi and xii to be attached to the posterior faces of septa 10/11 and 11/12.

*Distribution.* Rotung, Abor Country, E. Himalayas.

## 2. Plutellus aquatilis *Steph.*

1921. *Plutellus aquatilis*, Stephenson, Rec. Ind. Mus. xxii, p. 756, pl. xxxviii, fig. 8.

Length 115 mm.; maximum diameter 2 mm. Segments 162. Unpigmented. Prostomium small, proepilobous. Dorsal pores from 8/9. Setæ paired; in middle of body $ab=\frac{2}{5}\,aa=\frac{1}{2}\,bc=\frac{2}{3}\,cd$; behind genital region $ab=\frac{1}{3}\,aa=\frac{2}{5}\,bc=\frac{1}{2}\,cd$; in front of genital region $ab=\frac{2}{5}\,aa=\frac{1}{2}\,bc=\frac{1}{2}\,cd$; $dd=\frac{1}{3}$ circumference in middle of body. Clitellum ? Male pores on small papillæ, between *a* and *b*, papillæ connected across middle line by a ridge. Female pores ? Spermathecal pores rather outside *b*, in setal zones of viii and ix.

Septum 5/6 very thin, 6/7–13/14 all slightly thickened. Gizzard in v; swelling of œsophagus with vascular striations in xii. Intestine begins in xv. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, small, racemose, arranged as a transverse band across the hinder surface of the



Fig. 59.—*Plutellus aquatilis* Steph.; spermatheca.

septa. Prostates relatively large; duct thin, twisted, much shorter than the gland. Spermathecal ampulla ovoid or of an inverted pear-shape; duct about as long as ampulla, stout, straight or rather twisted; diverticulum single, tubular, as long as ampulla and duct together, with a few irregular swellings, the seminal chambers (text-fig. 59). No penial setæ.

*Distribution.* Below Kotagiri, Nilgiris, S. India.

### 3. Plutellus dubariensis *Mich.*

1921. *Plutellus dubariensis*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 61, text-fig. 7.

Length 78 mm. or less; diameter 1–1½ mm. Segments ca. 143. Colour whitish, unpigmented. Prostomium proepilobous ca. ¼. Dorsal pores from 6/7 (? 5/6). Setæ widely paired, the dorsal almost separated; $aa : ab : bc : cd : dd = 15 : 10 : 15 : 12 : 12$; in the most anterior segments *ab* and *dd* rather wider. Nephridiopores in *b*. Clitellum ring-shaped, ⅓ xiii–⅓ xvii (= 4). Male pores as elongated slits, somewhat converging behind, on xviii, nearly in the position of the (absent) setæ *b*, on the anterior ends of longitudinal ridges, which can be followed back to segment xx, somewhat converging; the area between the ridges depressed, sometimes almost sucker-like. Female pores inconspicuous, placed anteriorly on xiv in front of setæ *a*. Spermathecal pores two pairs, in 7/8 and 8/9, in the line of setæ *b*. Ventral surface of segment viii glandular.

Septa 6/7–10/11 thickened, 7/8–9/10 fairly strongly. Gizzard large, cylindrical, in v. No calciferous glands. No typhlosole. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles one pair, lobed, in xii. Prostates very long, irregularly twisted and undulating, pressed together, occupying xvii–xx; duct short, set off. Spermathecæ in viii and ix; ampulla narrower

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ectally, passing into the short cylindrical duct; diverticulum small, club-shaped, a quarter as long as the main pouch, entering the ectal end of duct. No penial setæ.

*Remarks.* Comes near *P. indicus* (Mich.).
*Distribution.* R. Cauvery, Dubari, Coorg.

### 4. Plutellus halyi (*Mich.*).

1898. *Megascolides halyi*, Michaelsen, Zool. Jahrb. Syst. xii, p. 142.
1900. *Plutellus halyi*, Michaelsen, Tier. x, p. 165.
1916. *Plutellus halyi*, Michaelsen, Mjöberg's Austral. Exp. p. 43.

Maximum length 40 mm.; diameter 0·8–1 mm. Segments 75. Colour whitish to bluish grey, without pigment. Prostomium epilobous (?). Setæ small, fairly widely paired; $aa=2\,ab=bc=1\frac{1}{2}\,cd=\frac{1}{2}\,dd$. First dorsal pore at 7/8. Clitellum saddle-shaped, from xiii or $\frac{1}{2}$xiii to xvii ($=4\frac{1}{2}$–5); xviii may be glandular and thickened ventrally. Male pores just outside the line *b*, on small papillæ. Female pore single. Spermathecal pores two pairs, in line with *b*, in 7/8 and 8/9. Copulatory papillæ in the neighbourhood of the male pores, variable, one median on xviii, or one on the right side on xix.

Septa all thin, 7/8–9/10 rather thicker than the rest. Gizzard in vi, fairly well developed; no calciferous glands. Last hearts in xii. Testes and funnels two pairs, in x and xi, free. Seminal vesicles two pairs, in ix and xii, each consisting of a few large lobes. Prostates long, extending back as far as xxii or even further; glandular part thick, closely wavy; duct short, narrower, muscular. Spermathecal diverticulum thickly pear-shaped, somewhat shorter than the duct, which it joins just below its middle; duct straight, thin, somewhat shorter than and well marked off from the ampulla. No penial setæ.

*Distribution.* Colombo, the Museum Garden.

### 5. Plutellus indicus *Mich.* f. typica.

1907. *Plutellus indicus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 148.
1909. *Plutellus indicus*, Michaelsen, Mem. Ind. Mus. i, p. 153.
1916. *Plutellus indicus*, Michaelsen, Mjöberg's Austral. Exp. p. 43.

Length 60–110 mm.; maximum diameter $2\frac{1}{2}$–3 mm. Segments ca. 160. Colour uniform grey or brownish grey. Prostomium indistinctly epilobous to tanylobous. Setæ widely paired; in front of the clitellar region $ab=\frac{1}{3}\,aa=\frac{2}{3}\,bc=cd$; just behind the clitellar region the pairs are narrower; towards hinder end the pairs become wider, finally almost equalling *bc*; *dd* is less than $\frac{1}{2}$ circumference, a little less in the anterior part, much less in the hinder part. First dorsal pore in 12/13 (or ? more anteriorly). Clitellum? Male pores on large transversely oval papillæ which

comprise a space equal to *ab* and extend outwards beyond the line *b*; papillæ connected by a ridge and surrounded by a common dumbbell-shaped wall. Female pores in front of and slightly medial to *a*. Spermathecal pores two pairs, those of each side approximated to each other, in line with *a* or between *a* and *b*, one pair in 8/9 and one in the setal zone of viii. No copulatory organs.

Septa 6/7–12/13 somewhat thickened, especially the middle ones. A large gizzard in vi (? v); œsophagus in xii–xvii moniliform, vascular and lamellated internally; no calciferous glands. No typhlosole. Nephridia relatively small. Male funnels free in x and xi. Two pairs seminal vesicles, in ix and xii, lobulated, the posterior pair the larger. Prostates with glandular portion long



Fig. 60.—*Plutellus indicus* Mich. var. *silvestris*; spermatheca made transparent by acetic acid; × 26.

and fairly thick, coiled; duct short and thin, almost straight. Spermathecal ampulla oval or thickly tubular; duct not sharply set off, about as long and half as thick as ampulla, narrowing rapidly towards its ectal end; below the middle of the duct a shortly tubular, straight or bent diverticulum enters, about as long as the duct or somewhat longer, with simple seminal chamber (text-fig. 60). No penial setæ.

*Distribution.* Kodaikanal, Palni Hills, S. India.

*a.* var. **silvestris** *Mich.*

1907. *Plutellus indicus* var. *silvestris*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 149.
1909. *Plutellus indicus* var. *silvestris*, Michaelsen, Mem. Ind. Mus. i, p. 155, pl. xiii, fig. 9.

Median ventral and dorsal distances less than in the f. *typica*; anteriorly $ab = \frac{1}{2}\ aa$; at the hinder end $aa = 1\frac{1}{2}\ bc$, and $dd = 2\ cd$ (in f. *typica* $dd$ at hinder end $= 3\frac{1}{2}\ cd$). Spermathecal pores of the anterior pair just in front of groove 8/9, almost fused with those of the hinder pair.

*Distribution.* Tiger Shola, near Kodaikanal, S. India.

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### 6. Plutellus palniensis *Mich.*

1907. *Plutellus palniensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 149, text-fig. 3.
1909. *Plutellus palniensis*, Michaelsen, Mem. Ind. Mus. i, p. 157, pl. xiii, fig. 7, text-fig. 11.
1916. *Plutellus palniensis*, Michaelsen, Mjöberg's Austral. Exp. p. 42.

Length 70–125 mm.; diameter 2–4 mm. Segments 240–260. Colour yellowish white or light grey. Body very slender. Prostomium epilobous $\frac{2}{3}$, hinder end tapering backwards. Segments of anterior part of body, except the first two, with 2-5 secondary annuli. Setæ rather small; in general $cd = 2\,ab = \frac{2}{3}\,bc = \frac{3}{5}\,aa$; in anterior part of body *ab* is wider, *bc* and *aa* narrower, *aa* especially so on the clitellum and just in front of it; $dd$=ca. $\frac{1}{2}$ circumference; at the hinder end the setæ *d* are somewhat irregular. Dorsal pores visible only behind clitellum. Clitellum indistinctly saddle-shaped, xii–xix (=8). Male pore single, on a small median papilla, which is surrounded, or bordered in front and behind, by a rather thick wall. Female pores in the place of the missing setæ *a* of xiv, on a common oval cushion. Spermathecal pores unpaired, midventrally in 7/8 and 8/9. Copulatory cushions unpaired, midventral, on the anterior parts of viii and ix, just behind the spermathecal pores; sometimes an additional one similarly placed behind the male pore, on xix, rather more indistinct.

Septa 6/7–12/13 thickened, especially 8/9–11/12. A fairly large cylindrical gizzard in vi (or v?); two pairs of lateral swellings of the œsophagus in xiv and xv, not set off, internally with longitudinal lamellæ. No typhlosole. One pair of testes and funnels free in xi. One pair of grape-like seminal vesicles in xii. Prostates paired, with fairly thick and long glandular



Fig. 61.—*Plutellus palniensis* Mich.; spermatheca made transparent by acetic acid; × 10.

portion, and short, narrow and almost straight duct; the ducts enter the body-wall in the position of *a*, and join in the body-wall. Spermathecæ unpaired, on the left side, with exit underneath the nerve cord; ampulla sac-like; duct sharply set off, about one-third as long and broad as ampulla; two diverticula, opening near ectal end of duct, short, with narrow stalk, one diverticulum simple and

almost spherical, the other broader with two or three seminal chambers incompletely separated (text-fig. 61). Penial setæ apparently absent.

*Remarks.* For the unpaired male pores and spermathecal pores, and unpaired spermathecæ, see the introduction to the genus.

*Distribution.* Tiger Shola, near Kodaikanal, S. India.

### 7. Plutellus sikkimensis *Mich.*

1907. *Plutellus sikkimensis,* Michaelsen, Mt. Mus. Hamburg, xxiv, p. 147, text-fig. 2.
1909. *Plutellus sikkimensis,* Michaelsen, Mem. Ind. Mus. i, p. 155, pl. xiii, fig. 8, text-fig. 10.
1916. *Plutellus sikkimensis,* Michaelsen, Mjöberg's Austral. Exp. p. 43.

Length 42 mm.; diameter $\frac{3}{4}$–$1\frac{1}{4}$ mm. Segments 90. Colour pale, without pigmentation. Prostomium epilobous $\frac{2}{5}$, tongue with parallel borders, open behind. Setæ rather stout, widely paired, especially the dorsal, and the ventral also in front of the clitellum; in general $aa = 2\,ab$, $ab = \frac{2}{3}\,bc$, $bc = 1\frac{1}{5}\,cd$; in the anterior part of the body *aa* and *bc* are equal, and *ab* and *cd* are equal and nearly as large as *aa* and *bc*; $dd = 4\,cd = \frac{1}{3}$ circumference. First dorsal pore in 6/7. Clitellum ? Male pores on minute papillæ in the line of *b*; a male area can be distinguished, midventral on xviii and encroaching on xvii and xix, laterally reaching *b*, not sharply defined, approximately circular. Female pores in front of setæ *a* of xiv. Spermathecal pores (probably) five pairs, in 4/5–8/9, just median from the line of *b*. A pair of transversely oval glandular areas in *ab*, over 12/13 and divided by it, sometimes connected by a glandular median area.



Fig. 62.—*Plutellus sikkimensis* Mich.; distal end of penial seta; × 450.

Septa 6/7–12/13 thickened, especially 9/10 and 10/11. Gizzard in v, small but distinct; œsophagus behind this moniliform, with folded walls, but no calciferous glands. Intestine begins in xiv. Last hearts in xii. Two pairs testes and funnels, free in x and xi.

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Seminal vesicles apparently in ix, xi, and xii. Glandular portion of prostate consisting of closely apposed undulations, the whole almost tongue-shaped in appearance; duct fairly long, narrow, in its first part somewhat wavy. Spermathecæ (in sections) very small (or undeveloped), without distinct lumen, five pairs, behind septa 4/5–8/9, just medial from *b*. Penial setæ (text-fig. 62) ca. $\frac{1}{3}$ mm. long, 9 $\mu$ thick in middle, with curved proximal end; distal end bent at an obtuse angle and somewhat tapering, ending in a sharply pointed slender tip, slightly recurved; distal end (except the tip) ornamented by about 9 oblique circlets of relatively very large teeth, about 9 teeth in a circle.

*Distribution.* Sandakphu, Darjiling Dist., E. Himalayas.

### 8. Plutellus singhalensis (*Mich.*).

1897. *Megascolides singhalensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 174.
1900. *Plutellus singhalensis*, Michaelsen, Tier. x, p. 165.

Length ca. 65 mm.; diameter 0·8–1·2 mm. Segments 87–108. Colour an indefinite equable grey. Prostomium epilobous $\frac{2}{3}$. Setæ widely paired; $aa=1\frac{1}{2}\ ab=bc=cd=\frac{1}{2}\ dd$; $dd$ rather less than $\frac{1}{4}$ circumference; setæ ornamented with several deep scars, of which the proximal border is sharp and concave, but the distal border not definite. First dorsal pore in 5/6. Nephridiopores between the lines of *c* and *d*, not regularly in the same line. Clitellum ring-shaped, $\frac{1}{2}$xiii or xiv to xvii (=4 to $4\frac{1}{2}$). Male pores between the lines *a* and *b*, on small round papillæ. Female pores paired, in front of setæ *a*. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *b*. Copulatory papillæ, small, in 17/18 and 18/19, or anteriorly and posteriorly on xviii, in line with *a* and also midventral; often some or all absent; a maximum of six may be present.

No septa specially thickened. Gizzard small, in v, not sharply set off, in comparison with other forms appears vestigial; no calciferous glands. Intestine begins in xviii or xix; ? lateral glands at beginning of intestine. Hearts in x and xi. Nephridia with bladder-like peritoneal cells. Two pairs of testis sacs in x and xi, meeting ventrally. Lobular seminal vesicles in ix, x (?), xi, and xii. Prostates thickly tubular, glandular part coiled and adherent, with warty surface; duct shorter, thinner. Spermathecal ampulla irregularly sac-like; duct long and thin, in broad apposed curves; diverticulum thickly pear-shaped, entering ectal end of duct. Penial setæ 0·6 mm. long, with a maximum thickness of 6 $\mu$; slightly and irregularly bent, with sharp straight tip, and a few broad closely apposed teeth at the distal end.

*Remarks.* The species is peculiar in possessing testis sacs.
*Distribution.* Nuwara Eliya, Ceylon.

**9. Plutellus timidus** *Cogn.*

1911. *Plutellus timidus*, Cognetti, Ann. Mag. N. H. (8) vii, p. 497, pl. xiii, fig. 4.

Length 30–48 mm.; diameter ca. 1 mm. Segments 116–119. Colour violaceous grey, clitellum violaceous brown. Prostomium small, epilobous. Body slightly compressed behind clitellum, except the tail. Dorsal pores from 11/12 (? from 10/11). Nephridiopores, in front of clitellum at least, nearly in line with *b*. About segment x $aa=1\frac{2}{3}\,ab$, $ab=\frac{3}{4}\,bc$, $bc=cd$, $cd$ somewhat smaller than $dd$, which is a little larger than $\frac{1}{2}$ circumference; at middle of body $aa=1\frac{2}{3}\,ab$, $ab=\frac{1}{2}\,bc$, $cd=\frac{2}{3}\,bc$, $dd=cd$; at the tail $aa=ab=\frac{1}{2}\,bc=cd=dd$. Clitellum xiv–xvii (=4), ring-shaped. Male pores on small papillæ, "about equally distant from the two bundles of setæ." Female pores internal to and in front of *a*, in a small transversely oval area. Spermathecal pores one pair on viii, in the setal zone, between the lines of *b* and *c*. A pair of papillæ on xix, just lateral to *b*, prolonged obliquely forwards to join the porophores.

Septum 5/6 the first, very thin; 7/8–12/13 thickened. Gizzard in v, not very strong. Testes and funnels free in x and xi. Sperm-sacs small and grape-like, in xii. Prostates in xviii with their ental ends in xix; muscular duct a little coiled. No penial setæ. Spermathecæ one pair in viii consisting only of a long pear-shaped ampulla.

*Remarks.* Distinguished by only one pair of spermathecæ. Something has gone wrong with the original account of the setal relations—*cd* and *dd* cannot stand to one another as stated; but I cannot suggest what correction should be made.

*Distribution.* Muvattupuzha, 170 km. N.N.E. of Trivandrum, S. India.

## 2. Genus **PONTODRILUS** *E. Perr.*

1900. *Pontodrilus*, Michaelsen, Tier. x, p. 179.
1909. *Pontodrilus*, Michaelsen, Mt. Mus. Hamburg, xxvii, p. 83.
1922. *Plutellus* (*Pontodrilus*), Michaelsen, Capita Zool. i, 3, p. 22.

Setæ eight per segment. Male pores paired. Female pores paired. Spermathecal pores two or four pairs, the last in 8/9. Gizzard vestigial or absent. Purely meganephridial, nephridia wanting in front of the clitellar region. Two pairs free testes and funnels. Prostates tubular, with simple unbranched canal.

*Distribution.* The genus is found chiefly on the shore, and is very widely distributed, especially over the islands of the S. Hemisphere, the shores of S. Asia, and the islands and coasts of N. America. There is one lacustrine species, *P. lacustris* (Benham) in New Zealand, and one terrestrial species, *P. agnesæ* Steph. from Ceylon.

Michaelsen, in a recent publication (**131**), ranks *Pontodrilus* as a subgenus of *Plutellus*.

A thorough revision of the genus is to be found in Michaelsen's paper of 1909. Apart from *P. lacustris* (which, according to Michaelsen, may not be a true *Pontodrilus*) the then known forms belonging to the genus may be arranged in three species according to the characters of the prostates: (1) *P. bermudensis*—prostates with a large, definitely marked off spindle-shaped muscular duct; (2) *P. litoralis*—with small, sharply marked off muscular duct equally thick throughout; (3) *P. matsushimensis*—with very small, almost vestigial, cone-shaped muscular duct, not definitely marked off. Within these species there are various forms, concerning the systematic value of which there may be differences of opinion; Michaelsen calls them "forms." *P. bermudensis* includes *laccadivensis*, *ephippiger*, *arenæ*, *insularis*, *michaelseni*, and *hesperidum*.

Michaelsen speaks of the generic affinities of *P. lacustris*, from fresh water in New Zealand, as not being beyond doubt. It was first described by Benham as a *Plutellus*; but according to the generic definitions it clearly belongs to *Pontodrilus*; moreover, it has two peculiarities, also possessed by *Pontodrilus*, which would hardly have arisen twice in association—sculptured setæ (ornamented with a number of extremely fine crescent-shaped marks near the distal extremity), and the absence of nephridia from the anterior segments.

The habitat (one species littoral and one terrestrial), and the characteristic male field of *P. bermudensis*, will at once distinguish between the two Indian species.

### 1. Pontodrilus bermudensis *Bedd.*

1897. *Pontodrilus insularis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 173.
1900. *Pontodrilus ephippiger* + *P. arenæ* + *P. insularis* + *P. michaelseni* + *P. hesperidum*, Michaelsen, Tier. x, pp. 180, 181, 182.
1903. *Pontodrilus laccadivensis*, Beddard, Fauna Laccad. Archip. i, p. 374.
1914. *Pontodrilus ephippiger*, Stephenson, Rec. Ind. Mus. x, p. 256.
1915. *Pontodrilus bermudensis* f. *ephippiger*, Stephenson, Mem. Ind. Mus. v, p. 145.
1915. *Pontodrilus bermudensis* f. *ephippiger*, Stephenson, Mem. Ind. Mus. vi, p. 61.
1916. *Pontodrilus bermudensis* f. *ephippiger*, Stephenson, Rec. Ind. Mus. xii, p. 311.
1917. *Pontodrilus bermudensis* f. *ephippiger*, Stephenson, Rec. Ind. Mus. xiii, p. 375.
1920. *Pontodrilus bermudensis* f. *ephippiger*, Stephenson, Mem. Ind. Mus. vii, p. 202.

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1909. *Pontodrilus bermudensis* f. *typica*, Michaelsen, Mt. Mus. Hamburg, xxvii, p. 84.

Length 32–65 mm.; maximum diameter 2–2½ mm. Colour light grey, or olive-green; bright pink in life. Segments 106–108. Prostomium slightly epilobous. No dorsal pores. Lateral setæ

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not paired; *aa*, *bc*, and *cd* all equal in front of clitellum, and equal to $1\frac{2}{3}$ *ab*; behind the clitellum $aa = cd =$ or is slightly greater than $bc = 2\,ab$; $dd = 2\,cd$ throughout the body. Clitellum saddle-shaped, $\frac{1}{2}$xiii–xvii ($=4\frac{1}{2}$); the ventral region forms a broad groove; at the ventrolateral margins of xviii and extending on to the adjacent parts of xvii and xix are a pair of very prominent white and rounded longitudinal ridges; internal to each ridge is a narrow deep depression, *i.e.*, a groove parallel to the ridge. Male pores on small papillæ in line with *b*, on the inner wall of the groove just described. Female pores as white points anterior to the setal zone and internal to *a*. Spermathecal pores two pairs, on small white papillæ, in 7/8 and 8/9, in line with *b*. Genital markings variable; a transversely oval papilla which may have a sucker-like depression in its centre is generally present in 19/20; a similar low flat papilla is often present in 12/13; an ill-defined papilla is occasionally present in 13/14.

Septa increase in thickness from 6/7 to 9/10, continue thick to 11/12, 12/13 thinner again. No gizzard; intestine begins in xv. Last heart in xiii. Nephridia absent from the first 12 segments. Testes and funnels free, in x and xi. Seminal vesicles grape-like, in xi and xii. Prostates of moderate size, slightly coiled, in xviii and xvii; duct runs backward and outward, on the inner side of the glandular portion, is only slightly curved, and of about the same diameter throughout, rather shorter than the gland, strong and very muscular. Spermathecal ampulla variable in shape, elongated to subspherical; duct of moderate width, shorter than the ampulla; diverticulum implanted into body-wall near termination of duct, tubular, about as long as the main part of the apparatus, not or only slightly swollen at its ental end. No penial setæ.

*Remarks.* The above describes the worm as it has been found on the shores of India. It is, however, a variable species, and the following points are brought out by Michaelsen in his discussion of the synonymy.

The setæ are typically ornamented, the markings consisting of "scars," *i.e.*, depressions with steeper proximal border which is denticulated in varying degrees; the depth and so the conspicuousness of the scars may vary; sometimes they may seem to be almost worn away. I did not notice any such markings on the setæ I examined—either the examination was not sufficiently minute, or they were worn away altogether on those particular setæ.

Often the only genital papilla is that on 19/20; that on 12/13 is perhaps the next in constancy; they are also recorded on 11/12, and on 14/15–16/17. The papilla on 13/14 which I found on some examples does not seem to have been recorded elsewhere. When papillæ are absent altogether it may probably be due to immaturity.

The depression of the male field, and the lateral walls, vary in

distinctness. As will be seen, I have not found the prostatic duct distinctly spindle-shaped, though this forms part of Michaelsen's diagnosis of the species.

In Rosa's originals of *P. insularis*, and in specimens described under this name by Michaelsen, spermathecal diverticula were absent; this Michaelsen now ascribes to the immaturity of the specimens in both cases, and therefore unites *P. insularis* with the present species. There were, however, in the original specimens of *P. insularis* other peculiarities—the muscular coat of the œsophagus was thickened in segment vii, the prostatic duct was considerably curved, and the setal relations were somewhat different (setæ not paired, the intervals from one to the next successively increasing; *dd* is not large, scarcely twice *cd*, and the setæ *d* are therefore dorsally situated; $aa = 2\,ab$; in the hindmost segments the regular arrangement of the setæ is disturbed). Rosa's specimens came from the Aru Islands, Michaelsen's were found in Schmarda's collection and were taken at Belligamme, Ceylon.

*P. laccadivensis*, also merged in the present species by Michaelsen, and found both in the Laccadives and Maldives, is described as being characterized by papillæ in front of the clitellum (this is now known not to be a distinction from *bermudensis*), by having a feeble but recognizable gizzard in vii (compare the specimens described as *P. insularis*), and as having the prostatic duct long and curved. The papilla on the anterior part of xiv is less convex than the one on 12/13, and is said by Michaelsen to be the female field surrounding the female pores.

*Distribution.* Littoral; Chilka Lake, E. Coast (in damp mud under stones at edge of lake; in wet sand or sand mixed with mud both in the main area and in the outer channel of the lake, the water being either fresh, brackish, or as salt as that of the Bay of Bengal); under stones on the shore in Mormugao Bay near Goa; Ennur backwater, near Madras (in wet sand where the water was slightly brackish); Pamban, Malabar Coast (in a rotten palm-tree lying in the water); Bombay; Belligamme, Ceylon; Laccadives and Maldives. It is widely distributed throughout the tropics and warmer coasts of both hemispheres; the form described as *P. ephippiger*, which the Indian specimens resemble most closely, has been recorded from the Cape Verde Islands, Portuguese W. Africa, N.E. Madagascar, Christmas Island, W. Australia, Celebes, and Hawaii; the form described as *P. insularis* was recorded from the Aru Islands.

### 2. Pontodrilus agnesæ *Steph.*

1915. *Pontodrilus agnesæ*, Stephenson, Mem. Ind. Mus. vi, p. 61.

Length 65 mm.; average diameter 1 mm. Segments 116. Colour dark brown. Prostomium prolobous, only slightly delimited from the first segment. Setæ *a* and *b* absent on xviii; $aa = 2\,ab$; $bc = 1\frac{1}{2}\,ab = cd$; $dd$ = about $3\,cd$ = about $\frac{1}{3}$ circumference, the

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setæ *d* being thus dorsolateral; *dd* is rather greater in the anterior part of the body than behind. Clitellum lighter than the rest of the surface, ½xiii–xvii or ½xvii (=4 or 4½); the midventral region is grooved in this part of the body. Male pores on small papillæ between the lines *a* and *b*. Female pores paired, in the setal zone. Spermathecal pores minute, in 7/8 and 8/9, in *b*.

Septa 9/10–11/12 moderately thickened; 7/8 and 8/9, and also 12/13 slightly thickened. Œsophagus dilated in v, but the walls not thickened, and there is no gizzard. No calciferous glands. Last heart in xii. Nephridia begin in xii or xiii. Testes free in x and xi. Seminal vesicles in ix and xii. Prostates moderate in size, confined to xviii, the coils closely pressed together so that the organ resembles a lobed Pheretima-prostate; duct at first thin-walled and winding, stouter and more muscular near its termination. Spermathecal ampullæ ovoid or subspherical; duct stout, narrowing towards its termination, not sharply demarcated from the ampulla, about half as long as the ampulla; diverticulum single, from middle of duct, spindle- or club-shaped, reaching upwards to about half height of ampulla.

*Remarks.* This is the only terrestrial species of the genus, and may perhaps represent the terrestrial ancestor from which the littoral species have descended.

*Distribution.* Horton Plains and Elk Plains, Ceylon.

## 3. Genus **WOODWARDIA** *Mich.*

1907. *Woodwardia*, Michaelsen, Fauna S.W. Austral. i, p. 153.
1916. *Woodwardia*, Michaelsen, Mjöberg's Austral. Exp. pp. 55, 59, 65.

Setæ eight per segment. One gizzard in v or a neighbouring segment. Purely meganephridial. Prostates with branched canal system in the glandular part.

*Distribution* (Chart II.). W. Akyab Dist., Lower Burma; Ceylon: Cochin State, S. India. The genus is also found in Australia, and in Java.

The genus was instituted by Michaelsen in 1907 for several species previously included in *Plutellus* and *Megascolides*, characterized by the above combination of anatomical features. Since it is now recognized that the "Pheretima-prostate" may have arisen more than once, there is no difficulty in deriving the genus directly from *Plutellus*, from which it differs only in the character of the prostates. This, I think, is very much to be preferred to Michaelsen's alternative—that it may be descended from *Notoscolex* by a retrogression of the micronephridial into the original meganephridial condition (Michaelsen, **83** *a*, p. 59). I am doubtful of the possibility of a reversal of the evolutionary process such as would lead to the restoration of a meganephridium on each side, when once the micronephridial condition has been established.

Michaelsen, however, would also consider as possible a descent of *Woodwardia* from *Diporochæta*, in the course of which the perichætine arrangement of the setæ would have given place to the lumbricine (*ib.*, p. 55).

I have included in the genus two species—*Megascolides hastatus* and *Notoscolex sarasinorum*—which I believe to be meganephridial, instead of micronephridial (or mixed mega- and micronephridial), as they were originally described. In *Megascolides hastatus* Steph. the nephridia in the anterior part of the body are a pair of tufts in each segment, each tuft with a single narrow duct; in the hinder region of the body the tuft is joined to a nephridial loop which stretches upwards on the body-wall. In *Notoscolex sarasinorum* (Mich.) compact tufts are present throughout the body, one pair in each segment, attached to the body-wall in the line of setæ *c*; no other nephridia are mentioned at all.

These tufted nephridia are well known to all students of the Megascolecidæ; they occur in a large number of genera in the region of the pharynx, gizzard, and œsophagus, and often in worms which in the rest of the body are typically micronephridial. They have always hitherto, I think, been considered as aggregations of micronephridia. I believe, however, that they are more correctly to be interpreted as meganephridia, and that consequently such species as the two just mentioned, where there are no scattered nephridia at all, must be removed from the micronephridial genera in which they have hitherto been placed.

The development of the tufted type of nephridia has been described by Bourne (**27**) and by Bahl (**105**). According to Bourne they arise as paired structures, each consisting of a preseptal funnel, a neck, and a postseptal glandular loop and excretory duct; from a portion of the loop a number of outgrowths develop, into which the canals extend in a very complicated manner; and this bunch of outgrowths, the tuft, ultimately constitutes by far the largest portion of the nephridium. In meganephridia of the ordinary form these outgrowths are not produced; the nephridia therefore retain the form of a loop.

It is, I think, obvious that in the tufted form of the nephridia the essential character of micronephridia—the breaking up into separate organs—never develops; the tuft is an appendage of the looped meganephridium which by its great development, along with the regression of the loop, comes to overshadow the latter altogether.

The anatomy of the tufted nephridia of the pharyngeal region of *Pheretima posthuma* has lately been described by Bahl (**90**), who apparently, like other students of the Oligochæta, regards the tufts as aggregates of micronephridia. The individual tubules of the tufts possess no funnels; and each tuft discharges by a single duct (in this case into the pharyngeal cavity). This suggests a branched single organ rather than an aggregate of separate organs; and this interpretation is confirmed by the same author's account of their development (**105**), which is similar to

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that given by Bourne. Bahl finds that in *Pheretima* the tufts make their appearance as small club-shaped solid masses, produced into strings of cells leading to the pharynx; the strings of cells become canalized and form the duct; "secondary pharyngeal nephridia" (*i.e.*, the individual components of the tuft) develop as buds on the nephridial ends of the pharyngeal ducts, the buds becoming "fully formed nephridia," and their ducts remaining continuous with the primary pharyngeal duct. Thus the original single nephridium never breaks up; the primary duct remains; the continuity of the organ persists; the components have neither morphological nor physiological independence; there is one organ from beginning to end—a meganephridium of a peculiarly modified form.

In *Notoscolex sarasinorum* there appear to be no other nephridia than the tufts, and I therefore regard this species as meganephridial,—*i.e.*, as a *Woodwardia*; the great similarity of this species to *Woodwardia uzeli* is a confirmatory argument for my view of its position. In *Megascolides hastatus* it appears that the loop from which the tuft arises as an outgrowth has not regressed in the manner described by Bourne, and we have therefore the tuft along with a meganephridial loop of something like the ordinary form. It is possible that other species also ought to be included in *Woodwardia*, but we are probably not in all cases in possession of the necessary data; tufted nephridia may merely have been described as micronephridia.

*Key to the Indian species of* Woodwardia.

| | | |
|---|---|---|
| 1. | No penial setæ ..... | *W. burkilli.* |
| | Penial setæ present ..... | 2. |
| 2. | Metandric*; no genital papillæ ..... | *W. hastata.* |
| | Holandric; genital papillæ present ..... | 3. |
| 3. | Copulatory papillæ one pair on xvii ..... | *W. uzeli.* |
| | Copulatory papillæ median on 19/20, 20/21, and sometimes 21/22 ..... | *W. sarasinorum.* |

## 1. Woodwardia burkilli *Mich.*

1907. *Woodwardia burkilli*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 152, text-fig. 5.
1909. *Woodwardia burkillii*, Michaelsen, Mem. Ind. Mus. i, p. 162, pl. xiii, fig. 6.

Length 50 mm.; average diameter 1 mm. Segments 125. Unpigmented; rosy in life. Prostomium prolobous. Setæ moderately large, not very closely paired; $aa=2\,ab=\frac{2}{3}\,bc=2\,cd$; $dd=\frac{1}{2}$ circumference. Clitellum ring-shaped, xiv–xvii (=4). Male pores just medial from the line of *b*, on papillæ which have a semicircular outline in front, but are indistinctly defined behind. A narrow but distinct furrow, convex towards the middle line, is prolonged backwards from each pore on to segment

* Holandric, with two pairs of testes, in segments x and xi; metandric, with the posterior pair of testes only, in segment xi.

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xix (pseudo-spermatic groove). Female pores medial from *a* and in front of the setal zone, on a common, almost linear, transverse area, which extends outward beyond *a* on each side. Spermathecal pores two pairs, in 7/8 and 8/9, somewhat lateral from *a*; the ventral setæ of viii and ix seem to be wanting (? changed into copulatory setæ and fallen out in copulation).

Septa 7/8–15/16 somewhat thickened, especially the middle ones, 10/11 and 11/12. Gizzard stout, in vii (?). Œsophagus widened in ix–xii, with the structure of calciferous glands, but not set off from the tube. Intestine with simple typhlosole. Meganephric, the nephridia rather small. Two pairs testes and funnels free in x and xi. Seminal vesicles small, one pair, in xii. Prostates with an oblong densely grape-like glandular part, and fairly long somewhat coiled duct; vas deferens enters ental end of duct. Spermathecal ampulla large, irregularly pear-shaped; duct very short and narrow, almost hidden in body-wall; diverticulum club-shaped, somewhat shorter than ampulla, into the narrowed ectal end of which it opens. No penial setæ.

*Distribution.* Buthidaung, W. Akyab Dist., Lower Burma.

2. **Woodwardia hastata** (*Steph.*).

1915. *Megascolides hastatus*, Stephenson, Mem. Ind. Mus. vi, p. 63, pl. vii, fig. 9.

Length and diameter variable; of mature specimens, length 55–175 mm., diameter $1\frac{1}{4}$–$2\frac{1}{2}$ mm. Colour grey. Segments 216. Prostomium small, epilobous $\frac{1}{2}$. Dorsal pores from 10/11. Setæ paired, the lateral rather widely; the setæ of the first 20 segments smaller than those behind; $aa$=2–3 $ab$, $bc$=$1\frac{1}{2}$–2 $ab$, $cd$=about $1\frac{1}{2}$ $ab$; near the hinder end the lateral setæ are no longer paired, $bc$ being equal to $cd$; $dd$=$\frac{1}{2}$ circumference. Clitellum apparently $\frac{1}{2}$xiv–xvii (=$3\frac{1}{2}$). Male pores on small circular papillæ between the lines of *a* and *b*. Female pores paired, between and in front of *a*. Spermathecal pores small, in 7/8 and 8/9, in *a*.

Septa 7/8–11/12 moderately thickened, 6/7 and 12/13 slightly. Gizzard well developed, barrel-shaped, in vi. No calciferous glands, though the œsophagus is vascular and segmentally bulged in xiii–xvi. Intestine begins in xix. Last heart in xiii. Nephridia in anterior part of body as bush-like tufts on each side of each segment, attached to parietes by a stalk; none elsewhere in the segment. In the posterior segments these tufts are still present, and in addition there is a relatively large loop intimately connected at its lower end with the tuft and extending dorsalwards nearly to the middle line. Testes and funnels free in xi. Seminal vesicles one pair, in xii, small and grape-like. Prostate elongated and tongue-shaped, straight and rather flattened, with smooth borders, or the glandular part coiled; duct short and cylindrical. Spermathecal ampulla elongated, cylindrical, bent on itself; duct practically absent; diverticulum single, arising from base of main pouch where it joins the body-wall, cylindrical, two-thirds as long

and two-thirds as wide as ampulla. Penial setæ (text-fig. 63) 3–3·5 mm. long, sac extends back to xxii; 16 $\mu$ thick in middle, straight for the greater part of their length, bowed distally, and

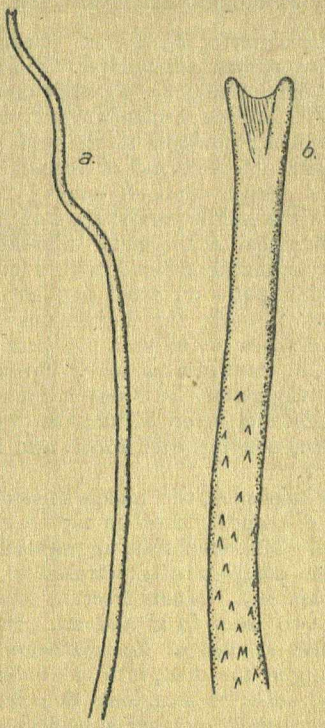


Fig. 63.—*Woodwardia hastatus* (Steph.); penial seta; *a*, distal portion, × 90; *b*, extreme end, × ca. 600.

sinuous at the end; the tip presents the appearance of a web stretched across a bifid termination; numerous fine triangular sculpturings irregularly arranged over the distal portion except the extreme tip.

*Remarks.* I investigated the prostate microscopically, and found besides the main duct in the centre of the mass other smaller ducts joining it; though externally of the tongue-shaped variety the glands are thus to some extent branched in structure.

The species is metandric.

For a discussion of the significance of the nephridial condition see the Introduction to the genus.

*Distribution.* Parambikulam, Cochin State, S. India.

### 3. Woodwardia sarasinorum (*Mich.*).

1897. *Cryptodrilus sarasinorum*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 177, text-figs. 14, 15.
1900. *Notoscolex sarasinorum*, Michaelsen, Tier. x, p. 192.

Length 120 mm.; diameter 1½–2 mm. Segments 134; iii–vi biannular, subsequent segments triannular. Prostomium epilobous ½, tongue open behind. Colour an indefinite grey. First dorsal pore at groove 9/10. Setæ ornamented with numerous fine-toothed transverse lines; enlarged at the ends of the body, and set widely apart; setal intervals not of very different extent—*bc* greater than *cd*, *cd* greater than *ab*, *aa*=1½–2 *ab*, *dd* less than ½ circumference; in the middle part of the body the setæ of a pair rather closer together than at the ends. Clitellum swollen, ring-shaped, xiv–xvii (=4), sharply defined, with a longitudinal median ventral groove. Male pores on small papillæ in line with *b*; a depression in front of each, the depressions surrounded by a common wall, which fuses behind with the male papillæ. Female pores internal to *a*, in front of setal zone. Spermathecal pores in 7/8 and 8/9, in *c*. Copulatory cushions midventral, flat, sucker-like, on 19/20, 20/21, and often 21/22; the two anterior rather larger than the last, meeting each other, and laterally reaching almost to *c*.

Septa 6/7–13/14 thickened, the middle ones of the series most so. A strong barrel-shaped gizzard in vi; no calciferous glands. Last hearts in xiii. Micronephridia aggregated on each side of the middle line into compact tufts, attached to the body-wall in line with *c*. Testes and funnels free, in x and xi. Seminal vesicles racemose, two pairs, in xi and xii. Prostates racemose, extending over three segments. Spermathecæ with club-shaped diverticulum, as long as the duct, into the ental end of which it discharges. Penial setæ 1·3 mm. long, 30 μ in maximum thickness, slightly curved distally, pointed, style-like, with many circlets of long, slender, not very closely applied teeth.

*Remarks.* There is a distinct resemblance to *W. uzeli*, from the same locality.

*Distribution.* Ceylon (probably Peradeniya).

### 4. Woodwardia uzeli (*Mich.*).

1903. *Plutellus uzeli*, Michaelsen, Jb. böhm. Ges. xl, p. 4, text-figs. A–C.
1904. *Plutellus uzeli*, Michaelsen, Mt. Mus. Hamburg, xxi, p. 127.
1910. *Woodwardia uzeli*, Michaelsen, Abh. Ver. Hamburg, xix, p. 57.
1916. *Woodwardia uzeli*, Michaelsen, Mjöberg's Austral. Exp. p. 46.

Length 30–40 mm.; diameter 1–1½ mm. Segments 96–112; more or less distinctly multiannular (3–5 annuli). Unpigmented.

Prostomium minute, epilobous $\frac{1}{2}$, tongue not closed behind. Dorsal pores from 9/10 or 10/11. Setæ somewhat larger at hinder end, widely paired, especially the lateral; $aa = bc > cd > ab$, but all nearly equal; $ab$ = ca. $\frac{2}{3}\,bc$; $dd$ anteriorly = $\frac{1}{2}$ circumference or little less, at hinder end = $\frac{2}{3}$ circumference; setæ *c* and *d* irregular in the last 10–20 segments. Clitellum ring-shaped, though thinner ventrally, xiv-$\frac{1}{2}$xvii (=$3\frac{1}{2}$). Male pores in line with *b*, on circular papillæ which take up nearly the whole length of xviii. Female pores paired. Spermathecal pores two pairs, close behind 7/8 and 8/9, above *b*, nearer *b* than *c*. Copulatory papillæ one pair, in *b*, posteriorly on xvii, transversely oval in shape.

No septa notably thickened. A large barrel-shaped gizzard in vi (?). No calciferous glands. Intestine begins in xix. Testes and funnels free in x and xi. Seminal vesicles compressed racemose, in xi and xii. Prostates confined to xviii, glandular part of an elongated heart-shape, small, much cut up; duct emerges from the basal cleft between two rounded lobes; duct only slightly curved, somewhat thinner at both ends. Two penial setal sacs on each side. Spermathecæ thickly pear-shaped; duct not marked off, as long as the ampulla, narrowing towards the ectal end; diverticulum single, small, pear-shaped, $\frac{1}{2}$–$\frac{2}{3}$ as long as duct, attached to ental portion of duct. Penial setæ fine, ca. 1 mm. long, 7$\mu$ thick in middle, switch-like, undulating in its distal third, each small convexity constituted by a scale-like tooth, which is depressed within a scar-like hollow; tip simple-pointed.

*Remarks.* The interval *dd* at the hinder end of the body is given in the original both as two-thirds and as one-third of the circumference.

*Distribution.* Peradeniya and Avissavela, Ceylon.

## 4. Genus **COMARODRILUS** *Steph.*

1915. *Comarodrilus*, Stephenson, Mem. Ind. Mus. vi, p. 69.

Setæ eight per segment. Spermathecal pores in a single series, median. A somewhat vestigial gizzard in v. Micronephridia in the anterior part of the body, as far as segment xii; behind this meganephridia only. Testes and funnels free in x and xi. Prostates a compact glandular mass, not tubular.

*Distribution.* Cochin State. The genus is not known outside India.

I have discussed the derivation of the genus in my paper of 1915 (**80**), and concluded that it is probably to be derived from *Woodwardia*, by degeneration of the gizzard and breaking up of the nephridia in front of the clitellum. The single series of spermathecæ may not be a generic character; Michaelsen no longer recognizes it as such in *Fletcherodrilus* (*cf.* p. 170 ant.).

GSL



1. **Comarodrilus gravelyi** *Steph.*

1915. *Comarodrilus gravelyi*, Stephenson, Mem. Ind. Mus. vi, p. 69, pl. vii, fig. 13.

Length 92 mm.; average diameter 1 mm., maximum 1¼ mm. A long thin worm, constricted at the clitellum. Segments 135. Colour grey. Prostomium? First dorsal pore in 6/7. Ventral setæ paired, but not the lateral; in front of clitellum $aa=2\,ab$ approximately, *c* being about the lateral line of the body and *d* much above this level, *bc* being less than *cd*, and *cd* less than *dd*; in the middle and hinder parts of the body the setæ *d* are much closer together, not far from the mid-dorsal line, *dd* being obviously less than *cd*. Clitellum xiv–xvii (=4). Male pores on small conical papillæ which touch each other in the middle line; in front and behind each is a semicircular depression with defined margins, the concavities of the depressions facing each other. Female pores? Spermathecal pores mid-ventral, in 7/8 and 8/9.

Septa 7/8–9/10 considerably thickened, 5/6, 6/7, and 10/11 somewhat so. A somewhat vestigial gizzard in v, folded on itself. No calciferous glands. Micronephridia in the anterior part of the body, as far back as xii; behind this only a pair of meganephridia per segment. Funnels free in x and xi. Seminal vesicles two pairs, lobed, in xi and xii. Prostate a compact glandular mass confined to xviii; duct strongly muscular, contorted in its first part, straight in its last portion. Spermathecæ single in each segment (viii and ix); ampulla ovoid to spherical; duct thick, in length equal to the ampulla; a small diverticulum given off from the duct near its junction with the body-wall. No penial setæ.

*Remarks.* In the specimen examined the two spermathecal ducts were placed on opposite sides of the nerve cord—the anterior one on the left, the posterior on the right.

*Distribution.* Trichur, Cochin State, S. India.

## 5. Genus **SPENCERIELLA** *Mich.*

1907. *Spenceriella*, Michaelsen, Fauna S.W. Austral. p. 153.

Setæ numerous (more than eight per segment). Spermathecal pores 1–3 pairs. One gizzard in segment v. Micronephridial. Prostates tubular, with simple unbranched canal.

*Distribution.* Palni Hills, S. India. Outside India in Victoria, Australia.

The genus was instituted by Michaelsen in 1907 to receive worms with the above characters, previously included in *Diporochæta*. It can be derived either from *Megascolides* by a change from the lumbricine to the perichætine arrangement of setæ along with a further breaking up of the nephridia, or from *Diporochæta*

by the breaking up of the meganephridia merely. In 1907 Michaelsen thought the latter more likely; in 1916 (**83** *a*, p. 60) he hesitated between deriving it from *Megascolides* in the way just mentioned and seeking its origin in *Megascolex*. In this latter case it would be necessary to suppose that there had been a regression of the Pheretima-prostates to the tubular form.

I am strongly opposed to this latter method of deriving genera by retracing evolutionary steps. The becoming vestigial of organs is of course a well-recognized occurrence, and does not involve the passage backwards through the successive steps of morphological evolution. But this is a different matter; such a derivation as this suggested by Michaelsen postulates the restitution of the steps themselves along with their former modes of functioning.

The genus is quite a small one, having one species only in the Indian region and two in Australia (Victoria). It is possible that the Indian species has been evolved independently of the Australian.

### 1. Spenceriella duodecimalis *Mich.*

1907. *Spenceriella duodecimalis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 152.
1909. *Spenceriella duodecimalis*, Michaelsen, Mem. Ind. Mus. i, p. 161, pl. xiii, fig. 10.
1916. *Spenceriella duodecimalis*, Michaelsen, Mjöberg's Austral. Exp. p. 52.

Length 32–40 mm.; maximum diameter 2–2½ mm. Segments 94–109. Colour reddish grey anteriorly, yellowish or brownish behind. Prostomium epilobous ½, tongue open behind. First dorsal pore at 5/6. Setæ rather large at ends of body, moderately large in the middle part; in anterior half 12 per segment, in front of the clitellum arranged in distinct pairs, distances between the pairs a little less than the middorsal and midventral intervals; behind the clitellum the pairing ceases; and behind segments xlv to l the arrangement becomes irregular, and the number per segment increases to 16 or 17. Clitellum ring-shaped, occupying ⅔xiii–⅔xvii (=4⅓). Male pores on circular papillæ just medial from the line of *b*. Spermathecal pores one pair, in 7/8, just lateral from the line of *b*.

Septa 7/8–12/13 somewhat thickened. A large gizzard in vii (or ? somewhat in front of this). Calciferous gland-like swellings of the œsophagus in xiii and xiv, but not stalked or set off, their lumen continuous with that of the œsophagus. Intestine begins in xvi; no typhlosole. Last hearts in xii. Micronephric; in the posterior segments several nephridia in each segment appear to be larger than the rest. Funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, broad, grape-like. Prostates with thick and very long glandular part, extending through about 12 segments, from xxiii to xxxiv, irregularly winding, the bends pressed

closely together; no branching of the central canal microscopically; duct thin at first, thicker towards termination, relatively long (from xxiii to xviii), irregularly winding. Spermathecal



Fig. 63 *a*.—*Spenceriella duodecimalis* Mich.; spermatheca made transparent by acetic acid; × 20.

ampulla large, sac-like; duct short, narrow and indistinct; diverticulum thin, tube-like, half as long as main pouch, rather bent, opening into the duct (text-fig. 63 *a*). No penial setæ.

*Distribution.* Kodaikanal, Palni Hills, S. India.

## 6. Genus **MEGASCOLIDES** *McCoy*.

1900. *Megascolides* (part.)+*Trinephrus* (part.)+*Notoscolex* (part.), Michaelsen, Tier. x, pp. 182, 184, 187.
1904. *Megascolides* (part.), Benham, P. Z. S. 1904, ii, p. 257.
1907. *Megascolides*, Michaelsen, Fauna S.W. Austral. p. 161.
1916. *Megascolides*, Michaelsen, Mjöberg's Austral. Exp. p. 56.

Setæ eight per segment. Spermathecal pores 1–5 pairs, the last in 7/8 or 8/9 or on ix. One gizzard in the region of v and vi. Micronephridial in the anterior part of the body. Prostates tubular, with simple unbranched canal.

*Distribution* (Chart II). Cochin State, S. India; Western India; Godaveri Dist., E. Coast; E. Himalayas. Outside India occurs in Australia and Tasmania, and has one species in N. America.

The definition of this genus has given much trouble to previous authors. The early history is given by Benham, 1904.

In Michaelsen's definition of 1900, the excretory system is said to consist of micronephridia, with, in addition, one pair of meganephridia in each of the hinder segments; the prostates are tubular (? often racemose); Michaelsen adds "perhaps several of the species under *Notoscolex* belong here, in which the hinder end of the body has not been investigated." The essential difference of the genus *Trinephrus* was the occurrence of three to five pairs of micronephridia regularly in each segment. *Notoscolex* was distinguished essentially by the presence of micronephridia (diffuse

nephridia) throughout the body. Thus the nephridia were the chief point of distinction between the three genera; the prostates in all might be either tubular or racemose (this was queried in the case of *Megascolides*, v. sup.).

Benham in 1904 doubted whether the nephridia should be used to so great an extent in the separation of genera, and thought the prostates would furnish more suitable criteria. He would distinguish the tubular prostate from the elongated tongue-shaped and from the lobed and compact "Pheretima-prostate"; these three, he thought, perhaps form a developmental series. He established a genus *Tokea* for forms with (among others less important) the following characters:—Setæ eight, spaced, and more or less equidistant. Two pairs of seminal vesicles in ix and xii. Prostates long, tongue-shaped, lie below the gut, close to one another, and extend through several segments. No penial setæ. Micronephric, with meganephridia in the last few segments.

Benham's suggestion as to the importance of the prostates was taken up by Michaelsen in 1907; he now united under *Megascolides* all the Megascolecines which possess lumbricine setæ and tubular prostates, and which show any trace of a division of the meganephridia up to the complete replacement of mega- by micronephridia; the genus includes both such species of *Trinephrus* as have tubular prostates, and Benham's genus *Tokea* (Michaelsen considered the "tongue-shaped" prostate to be tubular; though Benham had examined the microscopical structure in *Tokea esculenta*, and found that the main duct received small canalicules at intervals).

In 1916 Michaelsen made an examination of a large number of species of many genera of Megascolecinæ, and found that transition forms of the prostate in the series *Plutellus-Megascolides-Notoscolex* are numerous; all stages in the evolution of the typical racemose "Pheretima-prostate" are actually extant. He now defines as *Notoscolex* all species in which any lateral branches at all enter the main central duct, as well as those in which the main duct branches early, and in which therefore there is no central canal at all within the gland. The prostates are now all-important, the nephridia negligible.

It is certainly true that the strap-shaped or tongue-shaped prostates of "*Tokea*" and of certain other forms (e.g. *Woodwardia hastata*) are very nearly allied to the "Pheretima-prostate"; for example, I have described *Megascolides oneili* with much lobulated prostates (*i.e.*, the Pheretima form), and a variety of the same species (var. *monorchis*) in which the organs have the tongue-shaped form. If the prostates are to be made a chief basis of distinction, "*Tokea*" and *Megascolides oneili* must go to *Notoscolex*.

The separation of two genera the characters of which merge into one another is difficult, and however effected is bound to be merely arbitrary; the difficulty here is increased by the fact that microscopic examination by means of serial sections is necessary

in some cases before the tubular can be distinguished from the branched gland. But, to reduce the necessity for resorting to this procedure, it may perhaps be assumed that the flattened tongue-shaped glands, especially if their borders have any trace of lobing, will have branched ducts; while all glands which are definitely cylindrical in shape will quite possibly have simple ducts.

But the division of *Megascolides* and *Notoscolex* is unsatisfactory in another way. The strap-shaped (tongue-shaped) prostates occur both in New Zealand and in India; there is apparently no close relationship between the Indian forms and Benham's "Tokeas," and it seems probable that the two groups have arisen independently. Michaelsen supposes the "Tokeas" to be closely related species in a small secluded area which have sprung from a common ancestral species. In other words, the forms with intermediate characters between the typical *Megascolides* and typical *Notoscolex* are not closely related among themselves, and hence cannot be traced to a common origin. The genus *Notoscolex* will then be diphyletic at least—perhaps even polyphyletic.

The nephridial conditions in the two genera are interesting, but do not help towards a satisfactory division. In *Notoscolex oneili* there are micronephridia throughout the body, with, in addition, meganephridia of considerable size in the hinder segments. In *N. tenmalai* there are apparently only micronephridia throughout; this is so also in the var. *karakulamensis*, but there the micronephridia are few and relatively large. The "Tokeas" have micronephridia throughout the body, and in the last twenty segments there is in addition on each side a compact group of tubules constituting a meganephridium, with the usual funnel; a similar funnel is present throughout the animal, but in the anterior segments it is unconnected with the micronephridia and has no external opening. And the species both of *Megascolides* and *Notoscolex* described below will furnish numerous examples of other arrangements, of varieties of form of both mega- and micronephridia, and of combinations of these. *Megascolides-Notoscolex* represents, in fact, a group of forms in which the nephridial system and the prostates are so to speak in a fluid condition; changes are in progress, and in the nephridia are certainly taking place in various ways, and have reached various stages along each of the ways; it is at least probable that the changes in the prostates too have been initiated more than once, and here too the various species show various stages of the change. In these circumstances the only reason for keeping the two genera distinct must be one of convenience.

That any of these various admixtures of mega- and micronephridia are reversions from a micronephric to a partially meganephric condition I do not believe; I mean, of course, towards a meganephric condition such as that from which the evolution may be supposed to have started, *i.e.*, an anteseptal funnel, followed by a coiled tube with an external opening in the

next following segment. The contrary, however, is the opinion of Michaelsen in regard to the "Tokeas." That micronephridia might aggregate together, forming tufts of a size comparable to that of an ordinary meganephridium, seems possible (though the actual tufted nephridia appear to have arisen otherwise; cf. *antea*, p. 184). It is also conceivable that when the micronephridial condition has been established a number of the small organs may disappear, and that one of those that are left may increase in size so as to resemble a meganephridium. But that the original meganephric condition can be restored, or even that the evolutionary steps can be partially retraced, in a worm which has become micronephric, I cannot agree. Not only does Michaelsen believe this reversion to have taken place in the case of the "Tokeas," but he thinks that it may have taken place elsewhere in the subfamily independently (compare, on this and similar points, the introductions to the genera *Woodwardia* and *Spencerielle*, ant.).

*Key to the Indian species of the genus* Megascolides.

| | | |
|---|---|---|
| 1. | Spermathecæ one pair | 2. |
| | Spermathecæ two pairs | 4. |
| 2. | Penial setæ present | *M. annandalei.* |
| | Penial setæ absent | 3. |
| 3. | Seminal vesicles in ix and xii; copulatory organs on xii, xiii, xx | *M. bergtheili.* |
| | Seminal vesicles in ix, x, and xii; copulatory organs on viii, xix, xx | *M. prashadi.* |
| 4. | No calciferous glands | *M. cochinensis.* |
| | Calciferous glands in segments x–xiii | 5. |
| 5. | Penial setæ bayonet-shaped, tip flattened; last heart in xiii | *M. pilatus.* |
| | Penial setæ tapering, pointed; last heart in xii | *M. duodecimalis.* |

### 1. Megascolides annandalei *Steph.*

1921. *Megascolides annandalei*, Stephenson, Rec. Ind. Mus. xxii, p. 757, pl. xxviii, fig. 9.

Length 95 mm.; diameter 5 mm. Segments 130, secondary annulation from v onwards, triannular or triannular with one or two more secondary rings. Unpigmented. Prostomium prolobous; median dorsal groove on segment i. Dorsal pores begin from 12/13. Setæ paired; in middle of body $ab = \frac{1}{3}$ to $\frac{2}{7}$ $aa = \frac{1}{2}$ $bc$ or slightly less $= cd$; in front of clitellum $ab = \frac{1}{4}$ $aa = \frac{1}{3}$ $bc$ = slightly less than $cd$; $dd = \frac{2}{3}$ circumference. Clitellum xiii-xvii (=5). Male field a transverse depression on xviii, from outside $b$ on one side to the same point on the other. Male pores as pits in the line $b$, with curved grooves in front of and behind each, the concavities facing each other. Female area transversely oval, on xiv, just in front of the setal zone. Spermathecal pores one pair, in 7/8, in $b$ or between $a$ and $b$.

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Septum 4/5 slightly thickened, 5/6–8/9 considerably, 9/10 and 10/11 moderately, the next two slightly. Gizzard in v; calciferous glands in xi and xii, stalked, lamellated internally. Last heart in xii; a large obliquely transverse vessel in xiii passing backwards and outwards from the dorsal vessel. Micronephridial; the nephridia behind the clitellum in a transverse row of about six on each side, the inner two or three smaller than the rest; towards the hinder end seven or eight on each side, the inner three or four smaller, except the innermost of all, which is larger and forms a compact coil. Testes and funnels free in x

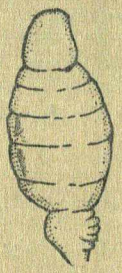

Fig. 64.—*Megascolides annandalei* Steph.; spermatheca.

and xi. Seminal vesicles in ix and xii, lobed. Prostates closely coiled, tubular; duct narrow, short, bent, slightly shining, bulged at its ectal end. One pair spermathecæ (text-fig. 64), in viii; ampulla of inverted pear-shape, annulated; duct short, $\frac{1}{3}$ to $\frac{1}{4}$ length of ampulla, bulged in its upper portion, narrowed ectally, with a row of four or five small seminal chambers on its inner side. Penial setæ 0·66 mm. long, tapering, slightly bowed, the curve more marked towards the distal end, tip slightly hooked and rounded; a few very fine transverse markings or slight notches a little distance from the tip.

*Distribution.* Dowlaishweram, Godaveri Dist., E. Coast.

### 2. Megascolides bergtheili *Mich.*

1907. *Megascolides bergtheili*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 150, text-fig. 4.
1909. *Megascolides bergtheili*, Michaelsen, Mem. Ind. Mus. i, p. 159, pl. xiii, fig. 3.
1916. *Megascolides bergtheili*, Michaelsen, Mjöberg's Austral. Exp. p. 48.

Length 100–120 mm.; maximum diameter 4½–5 mm. Segments 146–175; secondary annulation, up to 5 annuli in preclitellar segments, 3 in postclitellar. Colour light grey, unpigmented. Prostomium tanylobous, tongue with parallel sides. Setæ rather small, the ventral closely paired, the lateral almost separated; $aa : ab : bc : cd = 10 : 2 : 8 : 9$; $dd$ = ca. $\frac{3}{7}$ circumference. Dorsal

pores from 12/13. Clitellum ring-shaped, xiii–xvii (=5); less thick on xiii. Male pores in line with *b*, if not between *a* and *b*, on a short penis-like cone, which projects from a depression on the centre of a large knob-like papilla; these papillæ are transversely oval, occupy the whole length of xviii, and nearly meet in the midventral line. Female pores are transverse slits, anterior to and medial from *a*, in a more or less distinct furrow. Spermathecal pores one pair, in 7/8, between *a* and *b*, each on a small eye-shaped papilla. Copulatory organs on xii, xiii, and xx, sometimes on xi and xxi, as midventral dumbbell-shaped areas, extending laterally beyond *b*, surrounded by a wall, and enclosing on each side a transversely oval papilla the centre of which is in *a*; the less constant of these organs may be present only on one side.

Septum 6/7 (5/6?) very strong, (? 6/7 and) 7/8 wanting, 8/9 and 9/10 very strong, 10/11 and 11/12 successively thinner. A strong gizzard in front of 8/9; calciferous gland-like swelling of œsophagus in xi, not set off from the main tube. A pair of cæca, short, wide, confined to the segment of their origin, in xx (?). Micronephridia scattered on the lateral walls between the lines of *b* and *c*, and a somewhat irregular row dorsal to *d*; in front of the clitellum the micronephridia are aggregated to form a rosette-like bunch in each segment; at the hinder end the micronephridia are apparently replaced by one meganephridium on each side.



Fig. 65.—*Megascolides bergtheili* Mich.; spermatheca.

Testes and funnels in x and xi, the anterior pair of each free, the posterior perhaps enclosed in testis sacs; funnels of the anterior pair near the midventral line, of the posterior higher and more laterally placed. Seminal vesicles one pair, large, grape-like but rather compact, in xii; and one pair smaller, rosette-like, in ix. Prostates tubular, with fairly thick, closely coiled glandular part, and much shorter, thinner, and ectally somewhat thickened duct. Vasa deferentia are separate in their course, uniting at ental end of prostatic duct, which they enter and pursue their course in its wall, joining its lumen one-fourth of the length of the duct from its termination. Spermathecal ampulla sac-like, transversely striated; duct very short, about half as thick as ampulla; two groups of short spherical diverticula opposite each other at base of ampulla, about three in each group, more or less fused together, and discharging by a common short thick stalk (text-fig. 65). No penial setæ.

*Distribution.* Sandakphu, Darjiling Dist., E. Himalayas.

### 3. Megascolides cochinensis *Mich.*

1910. *Megascolides cochinensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 56, pl. figs. 4, 5.

Length 155 mm.; diameter 2½–4 mm. Segments ca. 280. Colour and prostomium ? Setæ of some segments of the anterior part of the body (ca. iv–vii) fairly large, for the rest rather small; in the middle of the body closely paired ventrally, rather widely laterally; in the anterior part both sets are wider apart; anteriorly $aa : ab : bc : cd = 3 : 2 : 4 : 3$; in the middle of the body $= 5 : 1 : 4 : 2$; $dd = \frac{2}{3}$ circumference. First dorsal pore in 9/10. Clitellum (? xiii or) xiv–xviii (=?5 or 6). Male pores in setal zone in *a*, on the slopes of a midventral depression on xviii, which passes on to the hinder part of xvii, where it becomes a transverse depression reaching laterally to *c*. Female pores somewhat median from *a* and a little in front of setal zone. Spermathecal pores two pairs, in *a*, on viii and ix in the anterior part of the segments.

Septa 7/8–11/12 thickened. A large gizzard in vii (?). Calciferous glands apparently absent. Last heart in xiii. Micronephridia in the anterior part of the body. Seminal vesicles two pairs, in xi and xii, compact, grape-like. Prostates tubular, small; glandular part fairly thick, with uneven surface, irregularly doubled together and forming almost a compact mass; duct narrow and fairly long, somewhat bent. Spermathecal ampulla long, sausage-like, 2 mm. long and ¼ mm. thick; a single diverticulum ⅔ mm. long, consisting of about 5 seminal chambers, of which one is more prominent than the rest; the diverticulum appears to join the body-wall separately from the main part of the apparatus (it probably unites inside the body-wall). Penial setæ small, simple, almost straight, ca. ⅓ mm. long, 12 μ thick in the middle, distal end pointed, tip very fine, sometimes bent; no ornamentation.

*Remarks.* The species is only known from one badly preserved specimen.

*Distribution.* Foot of Nelliampathis Hills, Cochin State.

### 4. Megascolides duodecimalis *Steph.*

1915. *Megascolides duodecimalis*, Stephenson, Mem. Ind. Mus. vi, p. 65, pl. vii, figs. 10, 11.

Length 160 mm.; diameter 5 mm. Segments ca. 317; segments triannular, except a few in the anteclitellar region. Colour a dirty grey. Prostomium ? First dorsal pore in 11/12. Setæ small, especially at the anterior end, where they are invisible (ventral) or difficult of recognition (lateral) in front of vii; ventral setæ closely paired, especially in the anterior part, the lateral more widely; $bc = \frac{2}{3} aa$, and $dd$ = ca. $\frac{4}{7}$ circumference. Clitellum slightly marked, xiv–xvii (=4). Male pores in small porophores in *ab*, on the sides of a rectangular depression situated

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midventrally on xviii. Female pores internal to *a*, near each other in front of the setal zone. Spermathecal pores two pairs, in 7/8 and 8/9, in *a* or *ab*.

Septa 5/6 slightly, 6/7–11/12 considerably thickened, 12/13 and 13/14 decreasingly so. A large globular gizzard in v. Calciferous glands in x–xiii, well set off, attached by a pedicle, with semicircular margin, flattened antero-posteriorly between successive septa. Intestine begins in xvi. Last heart in xii. Tufted nephridia behind the pharynx; micronephridia in anterior part of body mainly on the septa; in the hinder part, besides the septal nephridia, a regular chain of micronephridia on the body-wall between *a* and *b*, a less regular series in *cd*, and others



Fig. 66.—*Megascolides duodecimalis* Steph.; spermatheca, with small diverticulum showing at the base.



Fig. 67.—*Megascolides duodecimalis* Steph.; distal end of penial seta; × ca. 400.

scattered irregularly more dorsally; these three series are fairly large and easily visible to the naked eye. Funnels free in x and xi. Seminal vesicles small, in xi and xii; the anterior pair appear as lobed fringes around the calciferous glands, and are adherent in places to septum 11/12, not apparently to 10/11; both pairs racemose, and those of each segment fused together dorsally above the alimentary canal. Prostates tubular, rather coiled at their ental ends in xix; duct narrow and short. Spermatheca (text-fig. 66) elongated and finger-like, marked by indistinct transverse

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striations, often bent on itself; the basal portion, instead of being narrowed to form a duct, is dilated, and gives origin where it joins the body-wall to a small spherical diverticulum. Penial setæ (text-fig. 67) 0·82 mm. long, 14$\mu$ thick, straight as far as the distal end, which is curved, the tip tapering and slightly recurved; a few minute spines with their points towards the base of the seta are scattered irregularly near the free end.

*Distribution.* Parambikulam, Cochin State, S. India.

### 5. Megascolides pilatus *Steph.*

1915. *Megascolides pilatus*, Stephenson, Mem. Ind. Mus. vi, p. 68, pl. vii, fig. 12.

Length more than 123 mm. (the single specimen was incomplete posteriorly); diameter 4 mm. Secondary annulation in some of the anterior segments from viii onwards. Colour grey, not pigmented. Prostomium? First dorsal pore in 11/12. Setæ paired, except the lateral anteriorly, which are separated; behind the male pores the setæ are very small; near the anterior end *aa* = 2 *ab*, *cd* slightly greater than *ab*, and *bc* only slightly greater than *cd*; in front of the male pores *aa*=3–4 *ab*, *bc*=2–3 *ab*=2 *cd*; behind the male pores *aa* becomes larger, =6–7 *ab*, and *bc*=3 *ab* =2 *cd*. Clitellum? Male pores on small porophores in *ab*, in the middle of an oval thickened area which takes up the whole length of xviii and encroaches on the anterior part of xix. Female pores in front of setal zone and internal to *a*. Spermathecal pores on minute papillæ in 7/8 and 8/9, in *a*.

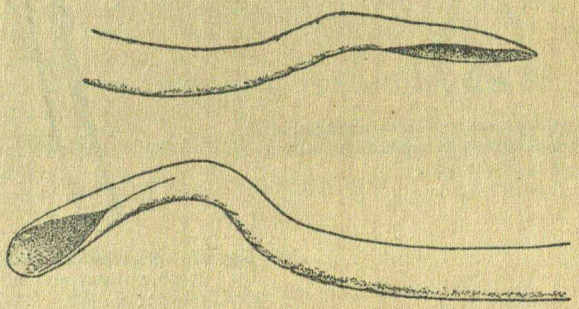

Fig. 68.—*Megascolides pilatus* Steph.; the distal ends of two penial setæ, seen from two different aspects; × ca. 350.

Septa 6/7–12/13 thickened, 13/14 less so. A large spherical gizzard in v; calciferous glands in x–xiii, bean-shaped, flattened, stalked, with attachment to œsophagus at their ventral ends. Intestine begins in xvi. Last heart in xiii. Micronephridial; in the anterior part numerous small nephridia on the septa, and tufted nephridia by the side of the œsophagus; behind, a row of small tufts in the line *ab*, and others irregularly arranged, mostly

on the parietes but some on the septa; arrangement not known at the hinder end, which was lost. Testes and funnels free in x and xi. Seminal vesicles small, in xi and xii, the attachment of each to the septum being linear, and the vesicle consisting of a row of grape-like lobes on each side of the axis, the whole flattened against the septum. Prostates tubular, small and narrow, of a few windings; the duct does not differ much in appearance from the gland, is straighter, slightly shiny, but not narrower, and runs inwards to its termination. Spermathecæ quite small, near the middle line, simple cylindrical sacs, without any separate duct; no diverticulum. Penial setæ (text-fig. 68) curved in various degrees; length, neglecting curves, 0·57 mm., thickness 21 $\mu$; the free end bayonet-shaped, the tip flattened and hollowed, the edge thin and sharp.

*Distribution.* Parambikulam, Cochin State, S. India.

### 6. **Megascolides prashadi** *Steph.*

1920. *Megascolides prashadi,* Stephenson, Mem. Ind. Mus. vii, p. 202, pl. ix, figs. 5, 6.

Length 42 mm.; diameter 4 mm. Segments 140. Unpigmented, buff-coloured. Prostomium prolobous. Dorsal pores from 12/13. In middle of body $ab = \frac{2}{7}\,aa = \frac{2}{5}\,bc = \frac{4}{5}\,cd$; behind clitellum $ab = \frac{2}{7}\,aa = \frac{1}{3}\,bc = \frac{3}{4}\,cd$; in front of clitellum $ab = \frac{2}{7}\,aa = \frac{2}{7}\,bc = \frac{3}{4}\,cd$; $dd$ = ca. $\frac{1}{2}$ circumference in middle of body. Clitellum smooth, thickened, well defined, xiii–xvii (=5). Male

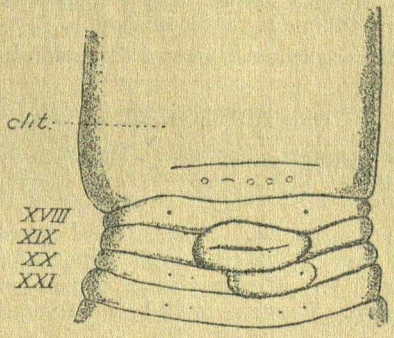


Fig. 69.—*Megascolides prashadi* Steph.; male genital field.

pores on xviii, just outside *b*. Female pore single. Spermathecal pores in 7/8, in or immediately outside *b*. A large flat oval papilla (text-fig. 69) on xix (rather on the left side in the single specimen), with groove-like depression across the centre; on xx a smaller and less definite papilla, also on the left side; a few small whitish spots on ventral part of xvii; on hinder border of viii a pair of indefinite papillæ opposite setal intervals *ab*.

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Septum 4/5 slightly thickened; 5/6–10/11 moderately strengthened, 11/12 slightly. Gizzard in v. No calciferous glands. Intestine begins in xv (? xvi). Last heart in xii. Nephridia in the body generally in transverse rows, 8–10 on each side; about 40 segments from hinder end the innermost on each side enlarges, and continues larger to the hinder end. Testes and funnels free in x and xi. Seminal vesicles 3 pairs, in ix, x and xii, the largest



Fig. 70.—*Megascolides prashadi* Steph.; spermatheca.

in xii, the smallest in x. Prostates tubular, consisting of a number of thick adpressed coils which extend through several segments; duct relatively short, narrow, broadening slightly towards ectal end. Spermathecæ (text-fig. 70) one pair, ampulla a large irregular sac with much crenulated margins; duct about as long as ampulla, of moderate thickness; a single diverticulum from ental end of duct, lobulated, half as long as the duct, to the side of which it is adherent. No penial setæ.

*Distribution.* Sakarwari, on the way to Mahableshwar, W. India.

## 7. Genus **NOTOSCOLEX** *Fletcher.*

1900. *Notoscolex* (part.), Michaelsen, Tier. x, p. 187.
1907. *Notoscolex*, Michaelsen, Fauna S.W. Austral. i, p. 162.
1916. *Notoscolex*, Michaelsen, Mjöberg's Austral. Exp. p. 58.

Setæ eight per segment. Spermathecal pores one, two, or three pairs, the last in 8/9 (in certain abnormal species in 7/8). One gizzard in v or vi. Micronephridia present, sometimes with meganephridia also. Prostates with branched canal system.

*Distribution* (Chart II). Mainly in Ceylon; also in S. India (Cochin, Travancore, Palni Hills, all close together), and in the E. Himalayas (three species in the Abor Country, a var. in Darjiling Dist.). Outside India the genus occurs in Australia and New Zealand.

In 1900 Michaelsen did not regard the constitution of the prostates as of prime importance in the diagnosis of this genus, and in the Tierreich he lays more stress on the condition of the nephridia, which are said to be diffuse, while the prostates may be either tubular or racemose. As has already been said, views as to

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the importance of the prostates have changed, and this is reflected in the diagnosis of the genus given in 1907, of which the above is a slight modification.

An account has been given of the relation of *Notoscolex* to *Megascolides*, from which it is descended; we have now to consider its relation to *Megascolex*, its descendant. The difference is in the setæ; in *Megascolex* the lumbricine has given place to the perichætine condition.

This would seem at first to afford a good basis for distinction. But it is found that here also there are intermediate forms, and consequently the dividing line is again bound to be more or less arbitrary.

There are also special relationships between certain species of *Notoscolex* and certain species of *Megascolex*. Thus Michaelsen points out (**70**) the great similarity between *Notoscolex ponmudianus* and *Megascolex travancorensis*, and the propriety (except for the setæ) of ranging *N. ponmudianus* and its variety *nanus* (=*N. tenmalai*) as mere varieties of *M. travancorensis*, which also has several varieties of its own—the whole forming a large group of related forms. Again in a later paper (**83** *a*) Michaelsen remarks on the arbitrary character of any division between the two genera, and adds another case of similarity between species of the one and species of the other genus found in the N. Island of New Zealand. He believes that the genera must be united, but does not actually carry this out in practice. Perhaps the most striking instance of similarity between species of *Megascolex* and *Notoscolex* is that which I have described (**104**) between *M. horai* and the *Notoscolex* group comprising *N. oneili*, *stewarti*, and *striatus*.

The series of connecting forms between *Notoscolex* and *Megascolex*, beginning from the purely lumbricine arrangement of the setæ, shows us first an increase in the number of the setæ at the hinder end of the body only, while the anterior end still has the four couples (*Megascolex willeyi*); then the number of setæ in the anterior segments also begins to increase, at first from four couples to six (*Megascolex zygochætus*), in other cases to eight couples, and so on; when the number has increased considerably the coupled arrangement begins to be lost, and we arrive at the ordinary perichætine condition. For the purpose of classification the dividing line is placed at the first departure from the pure lumbricine condition; if a specimen shows an increase in the number of setæ in any part of the body, it is a *Megascolex* (in the same way that a specimen showing any departure from the purely tubular condition of the prostates is to be accounted a *Notoscolex*, not a *Megascolides*). It may, of course, be impossible to assign a worm to its right genus, if we have only the anterior end for examination, since in some cases, as already said, the multiplication of setæ has taken place only in the posterior part of the body.

What force is there in the arguments for the fusion of the two genera? Is their fusion, as Michaelsen says, unavoidable? I do not think so.

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Genera are established for our convenience, to denote an assemblage of forms bound together by a set of common characters; if the range of the characters is too wide, the genus ceases to be useful; to a certain extent this is also the case if the number of included forms becomes too large. In the case of Birds, for example, quite minute characteristics are used for generic distinctions, so that in this Class the amount of difference between the Orders is less than that between the genera, or perhaps even between species in some other groups. In other words the amount of splitting which is permissible depends on the number of forms to be dealt with; groups which are too large become unwieldy.

Now any definite dividing line can be used for purposes of classification. And the abandonment of the lumbricine arrangement of the setæ is such a definite dividing line—there are either eight setæ per segment throughout the body, or there are more in some part of the body. Moreover, the distinction is a natural one and corresponds to the path of phyletic evolution; the lumbricine is the primitive arrangement and the perichætine the derived.

As to the objection that if we have not the hinder part of a worm we may be unable to classify it—there is no law forcing us to classify or describe every specimen that comes before us. Specimens which are in a bad condition, or imperfect, have to be put on one side daily; if some essential part of the specimen is lacking, we can do nothing with it, and so we can do nothing with an animal without hinder end if the hinder end happens to be an essential portion.

The only objection which could cause hesitation is that implied in Michaelsen's citation of closely allied individual species of *Notoscolex* and *Megascolex*. Certain species of these two genera, occurring in the same neighbourhood, resemble each other remarkably; it is a fair supposition that the *Megascolex* form has evolved from the *Notoscolex* in each case, *i. e.*, an increase in the numbers of the setæ has taken place independently in more than one locality—in other words the genus *Megascolex* is polyphyletic. This, it is held, cannot be permitted, and a way out of the difficulty is found in fusing the parent genus *Notoscolex* with the descendant *Megascolex*.

I have argued the whole question of polyphyly at some length elsewhere (**95**). The conclusion at which I arrived is that certainly *Megascolex* and possibly other genera of Megascolecinæ are polyphyletic, but that this cannot be obviated by fusions of genera. Thus not only is *Megascolex* descended from more than one species of *Notoscolex*, but it is descended from *Perionyx* as well, and possibly from *Spenceriella* too. It would be necessary therefore to fuse not only *Notoscolex* and *Megascolex*, but *Perionyx* as well. Nor would this be enough; the new genus *Megascolex* so arrived at would still be diphyletic, derived from *Diporochæta* and

*Megascolides*. We could not, in fact, get a monophyletic genus until we had united all the members of the *Perionyx* line of descent with all those of the *Notoscolex* line down as far as their common starting point in *Plutellus*.

I might point out that exactly the same arguments which are used to justify the union of *Notoscolex* and *Megascolex* may be used in favour of a fusion between *Megascolides* and *Notoscolex* (*cf.* p. 194 *supra*). I have already said that the only reason for keeping these two genera distinct is one of convenience; but the reason is sufficient.

*Key to the Indian species of* Notoscolex.

| | | |
|---|---|---|
| 1. | Penial setæ present | 2. |
| | Penial setæ absent | 5. |
| 2. | Calciferous glands in xv–xvii | 3. |
| | No calciferous glands | 4. |
| 3. | Copulatory cushions median, 4–6 in number, on 17/18 and following segments | *N. crassicystis.* |
| | Copulatory cushions one pair, on 11/12 | *N. jacksoni.* |
| 4. | Spermathecæ one pair, opening in 8/9 | *N. termiticola.* |
| | Spermathecæ two pairs, opening in 7/8 and 8/9. | *N. gravelyi.* |
| 5. | Calciferous glands in one or more of segments xv–xvii | 6. |
| | Calciferous glands in viii, ix, or x to xii (3–5 pairs) | 8. |
| | No calciferous glands | 10. |
| 6. | Vesiculæ seminales one pair, vestigial, in xii | *N. ceylanensis.* |
| | Vesiculæ seminales two pairs, in xi and xii | 7. |
| 7. | Spermathecæ without diverticulum | *N. trincomaliensis.* |
| | Spermathecæ with short club-shaped diverticulum | *N. decipiens.* |
| 8. | Three pairs calciferous glands | *N. stewarti.* |
| | Four or five pairs calciferous glands | 9. |
| 9. | Meganephridia in posterior part of body | *N. oneili.* |
| | No meganephridia | *N. striatus.* |
| 10. | Three pairs of spermathecæ | *N. dambullaensis.* |
| | Two pairs spermathecæ | 11. |
| 11. | Copulatory organs on 12/13 and 20/21 | *N. kraepelini.* |
| | No such copulatory organs | 12. |
| 12. | Anterior pairs of (testes) funnels and seminal vesicles vestigial | *N. ponmudianus.* |
| | Anterior pairs of testes, funnels and seminal vesicles absent (metandric condition) | *N. scutarius.* |
| | Both pairs of testes, funnels and seminal vesicles well developed (holandric condition) | *N. tenmalai.* |

A number of small groups of allied species may be distinguished within the genus. *N. trincomaliensis* and *decipiens*, both from Ceylon, form such a group; *N. ponmudianus*, *scutarius*, and *tenmalai* (*i. e.*, the whole of the S. Indian species) form another. Possibly *N. gravelyi* and *termiticola*, both from Ceylon, constitute a third.

The most striking group of related species, however, is that from the Abor Country (a variety of one species also in Darjiling Dist.),

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*N. stewarti, striatus*, and *oneili*. All these have the organs of the anterior part of the body one segment further forward than normal (male pore on xvii, etc.); they are the only members of the genus which have the calciferous glands in front of the ovarian segment; secondary annulation is present in most of the preclitellar segments; and *dd* is equal to about $\frac{2}{3}$ circumference. In addition, several characters are common to two out of three of the group.

1. **Notoscolex ceylanensis** (*Mich.*).

1897. *Cryptodrilus ceylanensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 183, pl. fig. 3.
1900. *Notoscolex ceylanensis*, Michaelsen, Tier. x, p. 194.

Length 120–280 mm.; diameter 3½–6 mm. Segments 159–230. Colour? Prostomium retractile, no distinct tongue. In general triannular. In anterior and middle parts of the body $aa=\frac{2}{3}bc$, *ab* less than *cd*, $cd=\frac{1}{2}bc$, $dd=\frac{1}{2}$ circumference; in hinder part of body $ab=cd=\frac{1}{2}aa=\frac{2}{3}$ to $\frac{3}{4}bc$, *dd* less than $\frac{1}{2}$ circumference. First dorsal pore at 10/11. Clitellum ring-shaped, swollen, well defined, xiii–xvii (=5). Male pores in line with *b*, on small papillæ in the centre of sucker-like depressions with raised edges, which are often united by a median bridge. Female pores paired, within the lines *a*, in a depressed oval area. Spermathecal pores on the hinder part of viii and ix, between *b* and *c*. A copulatory cushion, rectangular or square, on xix–xxi, reaching as far as *b* on each side, often divided by a transverse or a longitudinal groove, bearing two pairs of sucker-like pits, large and round, corresponding to grooves 19/20 and 20/21. Often in addition a midventral depression on 16/17 or 17/18, or on xx.

Septa 6/7–11/12 much thickened, 5/6 and 12/13 slightly. Gizzard in v; calciferous glands in xv–xvii, three pairs, broadly kidney-shaped. Intestine begins in xix. Last hearts in xiii. Nephridia form on each side of the nerve cord a thick tuft, attached to the body-wall in *c*; further out there are only scattered villus-like nephridia. Funnels enclosed in unpaired testis sacs in x and xi. One pair vestigial seminal vesicles, racemose, in xii. Prostates of the Pheretima-type, compact, confined to xviii; duct fairly short and thin, bent, slightly wider towards its termination. Spermathecal ampulla an elongated sac; duct long and narrow, half as thick and somewhat longer than ampulla, fairly well demarcated from ampulla; two small club-shaped diverticula, one of which is vestigial or may be wanting, join the duct above its middle. No penial setæ.

*Remarks.* The testis sacs are noteworthy.
*Distribution.* Nuwara Eliya, Ceylon.

## 2. Notoscolex crassicystis (*Mich.*).

1897. *Cryptodrilus crassicystis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 194, pl. figs. 19, 20.
1900. *Notoscolex crassicystis*, Michaelsen, Tier. x, p. 195.

Length 221–425 mm.; maximum diameter 9–11 mm. Segments 230–294; v biannular, vi and subsequent segments triannular, or with other secondary annulations in addition. Colour? Prostomium prolobous. Dorsal pores from 11/12. Setæ small, not visible on the first and last few segments, all ventrally situated; $aa = 5\,ab = 1\frac{1}{2}\,bc$, $ab = \frac{2}{3}\,cd$; $dd = \frac{5}{7}$ circumference. Clitellum swollen, ring-shaped, well defined; xiii–xvii (=5). Male pores on papillæ in *ab*. Female pores paired, close to the middle line. Spermathecal pores in 7/8 and 8/9 in *ab*. Copulatory cushions 4–6 in number, median, transversely elongated, laterally reaching to *b*, on 17/18–20/21, 21/22 or 22/23; each bears a transverse row of dark points, probably gland pores.

Septum 5/6 very thin, 6/7–9/10 strongly thickened, 10/11 and 11/12 slightly thickened. A very strong gizzard in vi; calciferous glands three pairs, in xv–xvii, bulky, kidney-shaped, constricted in several places. Intestine begins in xix. Last hearts in xii. Testes and funnels free in xi, large. Vesiculæ seminales racemose, in xii. Prostates of Pheretima-type, compact; duct almost straight, fairly short and thin. Spermathecal ampulla small, semi-globular; duct short, very thick, appearing bulged on one side; one or two short, thickly pear-shaped diverticula on duct. Penial setæ ca. 2 mm. long, maximum diameter 40 $\mu$, tapering gradually, bent in a simple curve with truncated tip, proximal to which is a knife-like sharp ridge; distal end ornamented with numerous oblique circlets of fine teeth which often fuse to form oblique ribs.

*Remarks.* Apparently metandric.
*Distribution.* Nuwara Eliya, Ceylon.

## 3. Notoscolex dambullaensis (*Mich.*).

1897. *Cryptodrilus dambullaensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 181, pl. fig. 6.
1909. *Notoscolex dambullaensis*, Michaelsen, Tier. x, p. 196.

Length 230 mm.; maximum diameter 9 mm. Segments ca. 540; ii–vii biannular, viii–xi triannular, vii–xvii quadriannular. Colour? Prostomium? Setæ small, invisible in the anterior segments, on raised ridges, the lateral widely, the ventral somewhat more closely paired; $aa = 4\,ab = 2\,bc = 2\,cd$; $dd = \frac{2}{3}$ circumference. First dorsal pore at 12/13. Clitellum? Male pore unpaired, midventral, on a broad oval cushion which takes up the length of segment xviii; on xvii and xix are also median elevations, and so too on the following segments in diminishing degree, the whole forming a sole-like elevation sharply defined in front,

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gradually fading behind. Two pairs of small papillæ, on the anterior border of the cushion of xix and the hinder border of that of xvii. Female pores? Spermathecal pores three pairs, near the middle line, in 6/7–8/9.

Septa 5/6 thin, 6/7–12/13 thickened. Gizzard in v. No calciferous glands; swellings of œsophagus in xiv–xvii (?). Intestine begins in xviii or xix. Last hearts in xiii. Micronephridial. Testes and funnels free in xi. Small seminal vesicles in xii. Spermathecal duct short; diverticulum broadly ovoid, without stalk, sessile on the duct, containing numerous seminal chambers. No penial setæ.

*Remarks.* Apparently metandric. The species was described from a single specimen, somewhat immature; the prostates were not fully developed.

*Distribution.* Plains N. of Dambulla and Trincomali, Ceylon.

### 4. Notoscolex decipiens (*Mich.*).

1897. *Cryptodrilus decipiens*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 197, pl. fig. 18.
1899. *Cryptodrilus decipiens*, Michaelsen, Zool. Jahrb. Syst. xii, p. 140.
1900. *Notoscolex decipiens*, Michaelsen, Tier. x, p. 191.
1910. *Notoscolex decipiens*, Michaelsen, Abh. Ver. Hamburg, xix, p. 62, pl. fig. 21.

Length 75 mm.; diameter 2–2¾ mm. Segments 134. Colour an equable grey. Prostomium and segment i retractile or vestigial, or fused with ii. First dorsal pore in 11/12. Setæ finely ornamented at tip, widely placed; in general $aa = bc = 1\frac{3}{4}\,ab = 1\frac{1}{4}\,cd$; in clitellar region setæ *a* get nearer the midventral line, so that $aa = 1\frac{1}{4}\,ab = \frac{1}{2}\,bc = cd$. Clitellum constricted, saddle-shaped, ½xiii–xvii (=4½). Male pores between the lines of *a* and *b* on transversely oval papillæ which reach from *a* to near *c*. Female pore unpaired. Spermathecal pores midway between *a* and the middle line, two pairs, small, in 7/8 and 8/9. A rectangular rather elongated cushion often present ventrally on xix–xx, laterally reaching a little beyond *b*; a pair of roundish papillæ usually on 13/14, sometimes additional pairs on 14/15 or 14/15 and 15/16, rarely a pair on 12/13. All these marks may be absent.

Septa 6/7–11/12 slightly thickened, the last very little. Gizzard in vi. One pair calciferous glands, elongated, with narrow stalk, projecting from xvi into the segments in front and behind. Last heart in xiii. Testes and funnels free, in x and xi. Two pairs grape-like seminal vesicles in xi and xii. Prostates branched, with large lobed glandular portion, extending through several segments; duct long, thin, slightly bent. Spermathecal ampulla consisting of ovoid ental and narrower cylindrical ectal portions, the duct being rather short and still thinner; diverticulum from junction of duct and ampulla, short, stoutly club-shaped. No penial setæ.

*Remarks.* The copulatory papillæ and cushions may be entirely absent; their presence and absence in the various situations seem to be characteristic for worms from various places, but not so constantly as to allow us to speak of local races. On the numbering of the segments, compare remarks on *N. stewarti*.

*Distribution.* Colombo (garden of Museum), Peradeniya, Panadhure, Kaniye near Trincomali, Avissavela 30 miles N.E. of Colombo,—all in Ceylon.

### 5. Notoscolex gravelyi *Steph.*

1916. *Notoscolex gravelyi*, Stephenson, Rec. Ind. Mus. xii, p. 325, pl. xxxi, fig. 19; pl. xxxii, fig. 20.

Length 29 mm.; maximum diameter 1¾ mm. Segments 110. Colour in life white; dirty brown when preserved. Prostomium epilobous ½, tongue broad, cut off behind. Dorsal pores apparently



Fig. 71.—*Notoscolex gravelyi* Steph.; spermatheca.

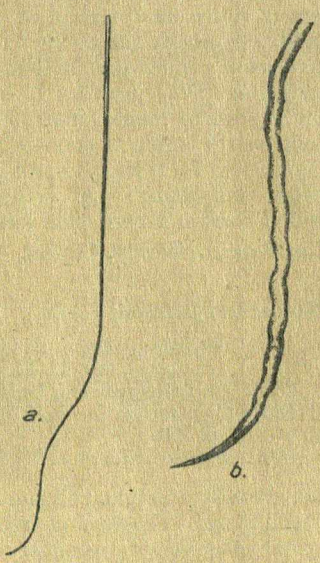


Fig. 72.—*Notoscolex gravelyi* Steph.; penial seta; *a*, slightly magnified, to show the general form; *b*, highly magnified, the distal end only.

from 9/10. Setæ widely paired; in anterior part of body $ab = \frac{3}{8}aa = \frac{3}{5}bc = cd$, and $dd = \frac{1}{2}$ circumference; posteriorly *ab* and *cd* are a little greater relatively to *aa* and *bc*; at the hinder end $bc = cd$ (*i. e.*, the lateral setæ are no longer paired), $ab = \frac{2}{3}aa$, and *dd* is considerably less than ½ circumference. Clitellum xiv-xvi (=3). Male pores in line with *b*, on slightly raised transversely oval areas

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which extend inwards to *a*. Female pores apparently paired, in a whitish groove which in length equals *aa* and is just in front of the setal zone. Spermathecal pores indistinguishable externally, two pairs, in 7/8 and 8/9, a little ventral to *c*. A pair of small papillæ on xvii, in front of the male pores (artefacts?).

A number of septa—8/9–13/14—slightly strengthened. A large barrel-shaped gizzard in vi. No calciferous glands, but the œsophagus is bulged in xv and xvi. Intestine begins in xix. Last hearts in xiii. In most segments from pharynx to prostates a large nephridial tuft on each side; behind this mega- and micronephridia coexist, the former as prominent elongated loops, becoming smaller towards the hinder end and finally indistinguishable from the micronephridia, which become more numerous and prominent towards the hinder end. Testes and funnels free in x and xi. Seminal vesicles small, racemose, in xi and xii. Prostates small and confined to xviii, compact, slightly lobed on the surface; duct relatively long, shining, bent or wavy, directed transversely inwards. Ovisacs in xiv. Spermathecal ampulla elongated, narrowing to form the duct without any sharp demarcation; duct half as long and half as wide as ampulla; diverticulum joins junction of ampulla and duct, and is an ovoid sac with stalk as long as itself, sac and stalk being about one-third as long as the ampulla (text-fig. 71). Penial setæ (text-fig. 72) 0·9 mm. long, 7 $\mu$ thick, the proximal half fairly straight, the distal portion undulating; tip pointed, no ornamentation, but the terminal portion shows small irregularities of outline.

*Distribution.* Kandy, Ceylon.

6. **Notoscolex jacksoni** (*Bedd.*).

1890. *Deodrilus jacksoni*, Beddard, Quart. J. Mic. Sci. xxxi, p. 467, pl. xxxiii, figs. 12–14, pl. xxxiii A.
1895. *Deodrilus jacksoni*, Beddard, Monog. p. 479.
1897. *Cryptodrilus jacksoni*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 190.
1900. *Notoscolex jacksoni*, Michaelsen, Tier. x, p. 196.

Length 330–360 mm. and more; diameter 9–13 mm. Segments 530 and more. Prostomium retractile; segment i traversed by longitudinal grooves; secondary annulation in anterior segments. First dorsal pore in 13/14. Setæ ornamented on distal portion with a number of minute pointed processes, and truncated at the free end; no setæ on first five segments; paired, all ventral; $aa=bc=2ab=2cd$; $dd=\frac{2}{3}$ to $\frac{1}{2}$ circumference. Clitellum swollen, ring-shaped, $\frac{1}{3}$ xiii–xvii ($=4\frac{1}{3}$). Male pores in *a*, on longitudinal ridges which extend in *ab* from the setal zone of xvii to that of xix; the ridges appear as a series of papillæ, separated by the intersegmental furrows. Female pores paired, not far from the middle line, in front of the setal zone of xiv. Spermathecal pores in 7/8 and 8/9, in *ab*. One pair of copulatory cushions, often fused midventrally, over 11/12.

Septa 6/7–12/13 thickened. Gizzard in vi. Three pairs calciferous glands in xv–xvii, bilobed, a deep transverse fissure separating the lobes. Intestine begins in xx. Last hearts in xii. Male funnels in xi. Seminal vesicles in xii. Prostates fairly compact, not greatly transgressing the limits of xviii; duct fairly short, straight. Spermathecal ampulla ovoid, finely ringed; duct short and moderately stout; diverticulum small, nodule-like, containing about four seminal chambers, opening into the upper end of the duct or into ampulla. Penial setæ slightly curved, ornamented at the distal end with numerous transverse striæ.

*Remarks.* Apparently metandric. Neither Beddard nor Michaelsen in their descriptions give the relations of the setal intervals, and Michaelsen is obviously wrong in the ratios he gives in the Tierreich; the only source is Beddard's figure. Beddard found two forms of penial setæ, but Michaelsen obtained only one, and considers that the second form described by Beddard was different only through losing its sculpture.

*Distribution.* Nuwara Eliya and Trincomali, Ceylon (perhaps elsewhere in Ceylon, as no further indication than "Ceylon" is given by Beddard).

### 7. Notoscolex kraepelini (*Mich.*).

1903. *Trinephrus kraepelini*, Michaelsen, Mt. Mus. Hamburg, xxi, p. 128, text-fig.

Length 58 mm.; diameter 2½–3 mm. Segments 216. Colour violet-brown. Prostomium epilobous ½, tongue cut off behind. Dorsal pores from 9/10. Setæ larger at the ends of the animal; in general widely paired; *dd* throughout slightly less than ½ circumference; behind clitellum $ab = \frac{1}{2}aa = cd$, and $aa = 1\frac{1}{3}\,bc$; further forward the ventral pairs are closer and the lateral pairs are wider, so that *ab* is less than *cd*. Clitellum ring-shaped, xiv–xvi (=3), dorsally getting on to xvii (=3¼). Male pores just outside the line *b*, laterally placed within depressions which are included within a common spectacle-shaped wall which touches 17/18 and 18/19. Spermathecal pores two pairs, in 7/8 and 8/9, in *b*. Copulatory organs midventral on 12/13 and 20/21, as spectacle-shaped glandular walls enclosing a pair of transverse glandular areas with groove-like depressions; the depressions slightly more extensive than the interval *ab*; the posterior wall more extensive than the anterior, reaching to *c*, the anterior to midway between *b* and *c*.

A few septa behind the gizzard somewhat thickened. A barrel-shaped gizzard apparently in v. No calciferous glands. Five micronephridia on each side per segment as a rule, in fairly regular longitudinal lines; the ventral two, about half as large as the others, may be fused, thus giving four all about the same size. Two pairs seminal vesicles, in xi and xii, lobed, and the lobes again cut up into small globular lobules, the whole racemose.

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Prostates composed of large loosely connected lobes; duct fairly muscular, slightly curved in an S, narrow at its beginning, somewhat widened ectally. Spermathecal ampulla ovoid, the bent duct separated off by a slight constriction, longer and somewhat narrower than the ampulla; diverticulum tubular, longer than ampulla and duct together, slightly swollen at ental end, with a short, thin, and bent stalk attaching it to ectal end of duct. No penial setæ.

*Distribution*. Central Ceylon.

8. **Notoscolex oneili** (*Steph.*).

1914. *Megascolides oneilli*, Stephenson, Rec. Ind. Mus. viii, p. 377, pl. xxvi, figs. 1, 2.
1916. *Megascolides oneilli*, Stephenson, Rec. Ind. Mus. xii, p. 314, pl. xxx, fig. 8.

Length 185 mm.; maximum diameter 6 mm. Segments ca. 244. Colour a light olive-green. Prostomium proepilobous. Secondary annulation on most of the preclitellar segments. Dorsal pores from 10/11. No setæ certainly visible on ii, very small and difficult to see on all the most anterior segments; rather widely paired; $aa = 2\,ab$ anteriorly, $= 2\frac{1}{2}\,ab$ behind the clitellum, $= 3\,ab$ further back; *bc* slightly or obviously greater than *cd*, and $= 1\frac{1}{2}\,ab$; *dd* approximately $\frac{2}{3}$ circumference; setæ present on

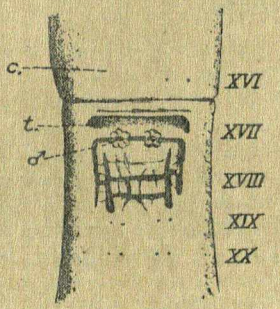


Fig. 73.—*Notoscolex oneili* (Steph.); genital area; *c*, clitellum; *t*, transverse depression; ♂, male aperture.

clitellum, but absent ventrally on xvii and xviii. Clitellum xiii–$\frac{2}{3}$xvi ($= 3\frac{2}{3}$). Male pores on xvii, between *a* and *b*, with tumid lips, and connected by a transverse groove which continues outwards beyond the pores and then turns backwards as far as the middle of xviii; a second pair of longitudinal grooves internal to these in the longitudinal part of their course; transverse grooves in the space between these latter, and a transverse depression in front of the male pores (text-fig. 73). Female pores in the setal zone of xiii, near the middle line. Spermathecal pores two pairs, in *a*, in 6/7 and 7/8.

Septa 6/7–10/11 thickened, the next two slightly so. A large firm cylindrical gizzard in vi. Calciferous glands four pairs, in ix–xii. Intestine begins in xiv. Last heart in xii. Micronephridia exist alone in the anterior part of the body, a large mass on the anterior face of 5/6, and a tuft on and behind a soft white pad which lies internal to the prostatic aperture being specially notable; in the hinder part of the body, along with micronephridia, are meganephridia, of considerable size, each composed of a number of loops, lying on the intestine, to which they are

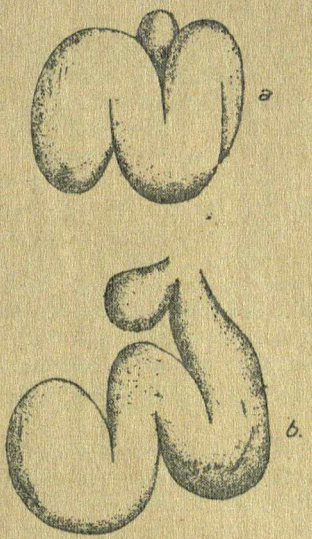


Fig. 74.—*Notoscolex oneili* (Steph.); spermatheca; *a*, in situ; *b*, main portion turned back.

attached in the neighbourhood of the dorsal vessel. Funnels free in x, and somewhat doubtfully present in ix. Seminal vesicles in x, attached to the posterior face of 9/10, flattened and lobed; and in xi, attached to the posterior face of 10/11. Prostates much lobulated, extending through several segments; duct bent once or twice in its course, narrower towards its ectal end. Ovaries and funnels in xii. Spermathecæ (text-fig. 74) not distinguishable into ampulla and duct, tubular, each bent on itself several times, its inner end rather dilated; situated near the middle line; a small subglobular diverticulum attached close to the ectal end. No penial setæ.

*Remarks.* There is an abnormal shifting forwards of the organs in the anterior part of the body by one segment; this occurs in the variety also.

The seminal vesicles in x seem to point to a pair of testes in ix; the testes, however, could not be identified in the specimen.

I have recently made a special re-examination of the single specimen, with regard to this latter point and to the numbering of the segments.

*Distribution.* Janakmukh, Abor Country, E. Himalayas.

*a.* var. **monorchis** *Steph.*

1916. *Megascolides oneilli*, var. *monorchis*, Stephenson, Rec. Ind. Mus. xii, p. 313.

Length 115 mm.; maximum diameter 5 mm. Segments 188. Colour pale buff. Prostomium prolobous. Dorsal pores from 9/10. Setæ very small; behind the clitellum $aa=3$–$4\,ab$, $bc=3\,ab$, $cd=2\,ab$; in front of clitellum $aa$ smaller, $=2\,ab$ or more, $bc$ greater than $aa$, equal to or less than $3\,ab$, $cd$ as before. Clitellum? Ventral surface of xvii thickened; secondary furrows in front of and behind the apertures, somewhat as in the typical form; the anterior two-thirds of xviii also thickened.

Calciferous glands in viii–xii, kidney-shaped. Testes and funnels free in ix. Seminal vesicles in x, xi, and xii, on the anterior wall of each segment, those of x of moderate size, the others small (of xii wanting on one side). Prostate small, tongue-like (perhaps not fully developed); duct considerably coiled, soft, not muscular. Spermathecæ are small ovoid sacs, duct scarcely separately distinguishable; cylindrical diverticulum from base of ampulla, half to two-thirds as long as ampulla. For the rest, as the type form.

*Remarks.* The presence of seminal vesicles in xi (and xii on one side) would seem to imply testes in x, in which case there would scarcely be sufficient reason for keeping this form as a distinct variety. It is possible that if the single specimen had been more fully mature the second pair of testes and funnels would have been identifiable.

*Distribution.* Darjiling to Soom, 7000–5000 ft., E. Himalayas.

9. **Notoscolex ponmudianus** *Mich.*

1913. *Notoscolex ponmudianus*, var. *typicus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 79, text-fig. 1.

Length ca. 170 mm.; diameter $1\frac{2}{3}$–$2\frac{2}{3}$ mm. Segments ca. 280. Body very slender. Prostomium? Setæ enlarged in the most anterior segments, and also at the hinder end; widely paired, $ab=\frac{2}{5}aa=cd$; $bc=aa$ anteriorly, but behind is little more than the distance between the setæ of a pair; the line $d$ in the hinder part of the body is quite irregular, and the width of $cd$ varies, being less or more than $bc$ and $dd$; $dd$ anteriorly = ca. $\frac{1}{3}$ circumference, but behind may be much less. Clitellum

ring-shaped, ½ xiii–½ xvii (=4), indented behind. Male pores probably about in the line *a*, on the sides of a midventral longitudinal groove. Female pore single, on the anterior part of xiv. Spermathecal pores two pairs, just lateral to *a*, in 7/8 and 8/9.

Septa 6/7–13/14 thickened, 8/9–10/11 especially, decreasingly so in front and behind these. A large gizzard in vi. No calciferous glands, but œsophagus very vascular, and with lamellar structure of its walls in viii–xiv. Last heart in xiii. Micronephridial. Funnels free in x and xi, those in x vestigial. Seminal vesicles in xi and xii, the latter normally developed, racemose, the anterior pair apparently vestigial. Prostates lobulated, extending through xvii-xxi, cut up by the septa; duct short, passing with an S-shaped curve transversely inwards, thicker and slightly shiny in its ectal part. Strong muscle strands pass between the inner aspect of the longitudinal depression in this region and the ventrolateral part of the parietes. Spermathecal ampulla pear-shaped, bent at its ectal end, the wall showing low folds internally in its middle third; duct thin and short, not sharply marked off, narrowing to its termination; diverticulum slenderly pear-shaped, about one-third as long as ampulla, joining junction of ampulla and duct. No penial setæ.

*Distribution.* Ponmudi, Travancore, S. India.

10. **Notoscolex scutarius** *Mich.*

1907. *Notoscolex scutarius*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 153, text-fig. 6.
1909. *Notoscolex scutarius*, Michaelsen, Mem. Ind. Mus. i, p. 164, pl. xiii, figs. 4, 5.
1916. *Notoscolex scutarius*, Michaelsen, Mjöberg's Austral. Exp. p. 51.

Length 68–90 mm.; maximum diameter 1⅓–2 mm., middle and hinder parts of body scarcely 1 mm. thick. Segments 120–140. Colour yellowish grey. Prostomium proepilobous. First dorsal pore in 13/14 (or further forwards?). Setæ rather small, widely paired; in front *aa* : *ab* : *bc* : *cd*=12 : 8 : 10 : 9; behind =5 : 3 : 4 : 3; in front *dd*=⅓ circumference, but is less behind. Clitellum distinct only on xiv–xvi, indistinctly extending on to more or less of xiii (and ? on to anterior part of xvii). Male pores in the situation of *b* of xviii, on a trapeze-shaped midventral area with rounded angles, broader in front, its margin raised, its centre sunk or flat, taking up the whole of xviii in length and laterally extending some distance beyond *b* (text-fig. 75). Female pores on a median darker area which extends between setæ *a*. Spermathecal pores two pairs, in *b*, in 7/8 and 8/9; the ventral walls of vii–ix may be swollen and glandular.

Septa 6/7–11/12 somewhat thickened, 12/13 very slightly so. A relatively large gizzard in v. No calciferous glands. Last hearts in xiii. The micronephridia aggregated into tufts on the

lateral body-wall in the anterior half of each segment; in the clitellar region the tufts are more expanded, and spread over nearly the whole ventral and lateral body-wall. One pair of testes and funnels in xi. One pair seminal vesicles in xii, broad, grape-like. Prostates with loosely lobed glandular part, band-like, extending through about six segments; duct about half as long as glandular part, fairly thin, describing one large loop and one or

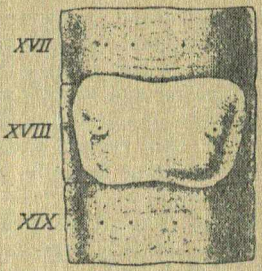


Fig. 75.—*Notoscolex scutarius* Mich.; region of male apertures.

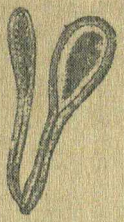

Fig. 76.—*Notoscolex scutarius* Mich.; spermatheca made transparent by acetic acid; × 15.

two smaller ones. Spermathecal ampulla pear-shaped; duct somewhat shorter, thin, not sharply marked off from ampulla; diverticulum club-shaped, slender, about as long as ampulla and duct together, with simple chamber, attached to ectal end of duct (text-fig. 76). No penial setæ.

*Remarks.* Metandric, and thus showing a possible relation to *N. ponnudianus*, in which the anterior pairs of testes and funnels are vestigial; Michaelsen also compares the male field. The nephridial condition is somewhat reminiscent of *Woodwardia sarasinorum*.

*Distribution.* Vilpatti, Palni Hills, S. India.

### 11. **Notoscolex stewarti** *Steph.*

1914. *Notoscolex stewarti*, Stephenson, Rec. Ind. Mus. viii, p. 382, pl. xxvi, figs. 6–8.

Length 85 mm.; maximum diameter 3½ mm. Segments 216; preclitellar segments, except the first few, triannulate. Colour pale olive green, first few segments colourless. Prostomium small, prolobous. First dorsal pore in 9/10 or 10/11. Setæ behind the clitellum on small white transverse ridges; $ab = \frac{2}{5}\,aa$, (more posteriorly $= \frac{1}{3}\,aa$) $= \frac{1}{2}\,bc = cd$ behind the clitellum; in front of clitellum the same, except that $ab = \frac{1}{2}\,aa$; $dd$ very slightly less than $\frac{2}{3}$ circumference. Clitellum ring-shaped, xiii–xv (= 3),

Genital field (text-fig. 77) thickened, marked by short transverse fissures, and by two longitudinal grooves, bent outwards at their ends, extending from xvi to xviii, with small tag-like processes in the bends, the grooves being united in front and behind by transverse shallow depressions without definite margins. Male pores in the longitudinal grooves, at the middle of their length. Female pores paired, just in front of and internal to setæ *a* of xiii. Spermathecal pores small, slit-like, in 6/7 and 7/8, approximately in *a*.

Septa 6/7–8/9 considerably thickened, the three following only slightly. A barrel-shaped gizzard in front of 6/7, moderately stout. Calciferous glands in x, xi, and xii. Intestine begins in xiv. Micronephridial; tufted nephridia at sides of gizzard. Last heart in xii. Testes and funnels free in ix and x. Two pairs

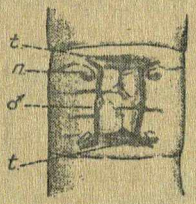


Fig. 77.—*Notoscolex stewarti* Steph.; genital area; *n.*, nodular projection; *t.*, transverse depressions; ♂, male aperture.

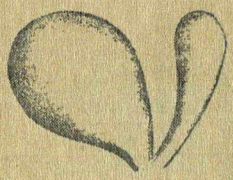

Fig. 78.—*Notoscolex stewarti* Steph.; spermatheca.

seminal vesicles in x and xi, flattened anteroposteriorly, with slightly lobulated edges, arching up from below so as nearly to meet above the gut. Prostates large, cut into two lobes by septum 17/18, each lobe a compact mass somewhat indented into secondary lobes; duct short, with a single U-shaped bend. Ovaries in xii. Spermathecæ (text-fig. 78) in the middle of large nephridial tufts; ampulla a pear-shaped sac, narrowing to be attached to the body-wall with hardly any duct; diverticulum club-shaped, about equal in length to the ampulla, arising in the substance of the body-wall.

*Remarks.* This species, like *N. striatus*, *N. oneili* and its variety, has the organs of the anterior part of the body one segment farther forwards than normal. I have recently re-examined the type-specimens, and find that the setæ begin on segment ii; the condition is thus not quite the same as in *N. decipiens*, where the setæ begin on segment i, and the original first segment is thus either retractile, or vestigial, or has fused with the original second segment (Michaelsen, in his description of *N. decipiens*, adopts the theoretical, not the actual, numbering of the segments).

*Distribution.* Rotung, Abor Country, E. Himalayas.

12. **Notoscolex striatus** *Steph.*

1914. *Notoscolex striatus*, Stephenson, Rec. Ind. Mus. viii, p. 380, pl. xxvi, figs. 3–5.

Length 210 mm.; maximum diameter 5–6 mm. Segments 297; iv and v biannulate, the rest triannulate. Colour pale yellowish or grey, except clitellum which is light brown. Prostomium small, prolobous. First dorsal pore in 9/10. Setæ relatively small, all ventral; behind clitellum $ab = \frac{2}{7} - \frac{1}{3} aa = \frac{2}{5} - \frac{1}{2} bc$, $bc$ is slightly greater than $cd$; in front of clitellum the ratios are variable, $ab$ slightly greater than $\frac{1}{2} aa$, $bc = cd = 1\frac{1}{3} ab$; thus the pairing of the lateral setæ is wide behind and absent in front of the clitellum; $dd = \frac{4}{7} - \frac{2}{3}$ circumference. Clitellum xiii–xv (=3). Genital area (text-fig. 79) extends from the setæ of xvi to those of xviii, is rectangular, laterally reaching $c$ on each side, depressed in the centre, brown in colour; within the area a pair

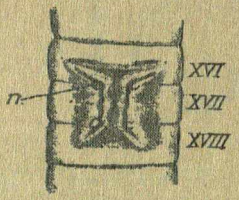


Fig. 79.—*Notoscolex striatus* Steph.; genital area; the shading shows the extent of the brown coloration; *n.*, small nodular elevations at the bend of the grooves.

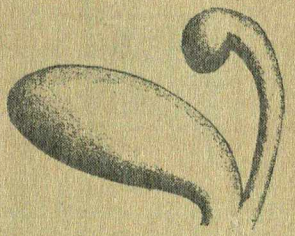

Fig. 80.—*Notoscolex striatus* Steph.; spermatheca.

of longitudinal grooves which bend outwards at their ends; in the angles of the bends are four papillæ, nodular and wart-like. Male pores in the grooves, on xvii in the line of $a$. Female pores paired, in front of setæ $a$ of xiii (?). Spermathecal pores minute, in 6/7 and 7/8, internal to $a$.

Septa 6/7–10/11 much thickened. A large barrel-shaped gizzard in vi. Calciferous glands in ix–xii. Intestine begins in xiv. Last heart in xii. Micronephridial. Testes and funnels free in ix and x. Seminal vesicles in x, xi, and xii, lobulated and flattened anteroposteriorly. Prostates small, lobed; the duct forming a U-shaped loop, the bend being internal. Ovaries and funnels in xii. Spermathecæ (text-fig. 80) situated by the side of the nerve cord; ampulla a small simple sac, ovoid; the duct not sharply marked off, opening near the middle line; diverticulum arises within the body-wall, tubular, slightly dilated at its free end, and as long as or slightly longer than the ampulla. No penial setæ.

*Remarks.* Here also a recent examination showed setæ on segment ii but not on i; compare remarks on the last species.

*Distribution.* Rotung and Renging, Abor Country, E. Himalayas.

13. **Notoscolex tenmalai** (*Mich.*).

1910. *Megascolides tenmalai*, Michaelsen, Abh. Ver. Hamburg, xix, p. 55, pl. fig. 3.
1913. *Notoscolex ponmudianus* var. *nanus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 83, text-fig. 2.
1916. *Notoscolex tenmalai*, Michaelsen, Mjöberg's Austral. Exp. p. 50.

Length ca. 95 mm.; diameter 1–1⅔ mm. Segments ca. 140. Unpigmented, white. Prostomium proepilobous, almost semicircular behind. Setæ fairly small, separated; *aa* : *ab* : *bc* : *cd* : *dd* = 3 : 2 : 2 : 2 : 7 in the anterior part of the body, but *dd* becomes 4 towards the hinder end, the other ratios remaining the same; *dd* is thus rather less than ⅓ circumference in front, but scarcely ½ behind; the setæ *d* are irregularly placed at the hinder end. Clitellum ring-shaped, xiv–xvii (=4). Male pores scarcely perceptible, between the lines *a* and *b*, each on and near the postero-lateral border of a large cushion; the cushions have steep margins and a flat surface, are oval with straight and parallel median sides, only slightly separated in the middle line, laterally reaching to *b*, anteriorly pushing forwards the border of the segment (xviii), and behind not reaching 18/19. Spermathecal pores two pairs, in 7/8 and 8/9, in *b*.

Septa 6/7–12/13 strengthened, especially the middle ones of the series. A large gizzard in vi; the œsophagus segmentally swollen in vii–xv, very vascular, villous internally. Intestine begins in xvii. Micronephridial (no nephridia seen). Testes and funnels free in x and xi. Seminal vesicles two pairs, compact, grape-like, in xi and xii. Prostates extend through 4 or 5 segments, constricted at the septa; in each segment several lateral canals enter the main central canal, which is continuous through the length of the gland; the lateral canals are themselves branched; ducts fairly long, thin, strongly curved. Spermathecal ampulla pear-shaped; duct short and thin; diverticulum given off from the junction of the two, shorter than the ampulla, consisting of a sausage-shaped seminal chamber and a thin, curved stalk; a spermatophore usually in the ectal end of the ampulla; duct and lower part of ampulla surrounded by numerous slender glandular lobes, each composed of a number of pear-shaped cells. No penial setæ.

*Distribution.* Tenmalai and Bonaccord, Travancore, S. India.

*a.* var. **karakulamensis** *Steph.*

1916. *Megascolides tenmalai* var. *karakulamensis*, Stephenson, Rec. Ind. Mus. xii, p. 311, pl. xxx, figs. 6, 7.

Length more than 70 mm.; diameter 1–1½ mm. Segments more than 93. Colour grey. Prostomium ? Dorsal pores from 4/5 (?). In front of clitellum *aa* = 2 *ab* (= 2½ *ab* near anterior end), *bc* = 2 *ab*, *cd* = 1½ *ab* or less; *dd* = ca. ⅓ circumference. Clitellum ventrally xiv–½ xvii (= 3½), dorsally xiv–xvi (= 3). Male pores on

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a pair of oval elevations, longitudinally placed with anterior ends slightly converging, the posterior ends narrower than the anterior; the elevations extend a little beyond the limit of xviii in front and fall slightly short of the limit behind; their anterior ends are

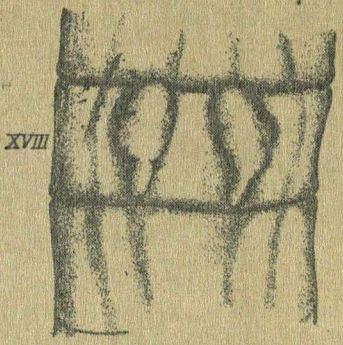


Fig. 81.—*Notoscolex tenmalai* Mich. var. *karakulamensis*; male genital area.

within the line of *a*; the male pores themselves may be on the inner border of the cushions, in line with *a* (text-fig. 81). Female pore or pores in a circular whitish patch, smaller than the interval *aa*, just behind groove 13/14. Spermathecal pores in 7/8 and 8/9, in *b*.

Septa 7/8–10/11 moderately thickened, 6/7 and several behind 10/11 somewhat thickened. Gizzard of moderate size and rather soft, in v; no calciferous glands. Intestine begins in xvii. Last heart in xiii. Tufted nephridia in each segment in front of the clitellum; behind clitellum micronephridia few and relatively large, on body-wall. Testes and funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, those in xi very small. Prostates long, flat,



Fig. 82.—*Notoscolex tenmalai* Mich. var. *karakulamensis*; spermatheca.

and strap-like, with slightly lobed margins, extending back to xxi, much constricted at the septa; microscopically the central duct gives off side branches; duct forms a loop with blind end directed inwards and backwards. Spermathecal ampulla pear-shaped, narrowing to form the duct, which is not marked off; diverticulum

from the middle of the duct, narrow, club-shaped, equal to $\frac{2}{5}$ the length of ampulla and duct together; no spermatophores and no glandular appendages (text-fig. 82). No penial setæ.

*Remarks.* The distinctions from the type-form are the setal intervals, the position of the gizzard, and the absence of glandular lobes round the spermathecæ.

*Distribution.* Karakulam, Cochin State, S. India.

14. **Notoscolex termiticola** *Mich.*

1910. *Notoscolex termiticola*, Michaelsen, Abh. Ver. Hamburg, xix, p. 63, text-fig. A.

Length 38 mm.; diameter 1–1½ mm. Segments ca. 140. Non-pigmented, dirty white. Prostomium proepilobous; tongue rounded, reaching back halfway through segment i. Setæ fairly widely paired, the lateral wider than the ventral; $aa : ab : bc : cd = 12 : 6 : 9 : 7$; *dd* less than ½ circumference; ventral setæ of the anterior end somewhat enlarged. Clitellum xiv–xvii (=4), less marked ventrally, indeed interrupted anteriorly, ring-shaped behind. Male pores just lateral to the line of *b*, on the front of papillæ, each of which curves round the outer end of a transverse depression situated in front of the male pore (these depressions are not to be confused with the male pores). Female pores median to *a*, on anterior part of xiv. One pair spermathecal pores, eye-like, in 8/9, between *b* and *c*, but nearer the latter. Copulatory papillæ one pair, small, transversely oval, situated anteriorly on xix, bearing the setæ *a*; also a single indistinct papilla midventrally on the anterior part of xviii.

Septa 8/9–10/11 relatively strong, those in front and behind successively thinner. A large gizzard in vi. No calciferous glands; the inner surface of the œsophagus folded strongly, with apparently villous projections in parts. Last heart in xiii. Micronephridial. Testes and funnels free in x and xi. Seminal vesicles small, lobed, in xi and xii. Prostates compactly racemose, plate-like; duct fairly thick and muscular, slightly bent, about as long as the diameter of the gland. Spermathecal ampulla ovoid; duct muscular, half as long and half as thick as the ampulla; diverticulum small, club-shaped, a little longer than the duct, joining the lower end of the ampulla. Penial setæ ca. 1 mm. long, 20$\mu$ thick proximally, becoming thinner only very gradually, curved, the curve becoming more marked distalwards, the tip being strongly bent into a hook and fairly sharply pointed; the distal fourth ornamented with transverse rows or irregular circlets of closely-set fine spines.

*Remarks.* The worms were found in the nest of *Termes obscuriceps*; they exude a milky fluid. The species is peculiar in having only one pair of spermathecæ, thus being reminiscent of some Ceylonese *Megascolex*.

*Distribution.* Peradeniya, Ceylon

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15. **Notoscolex trincomaliensis** (*Mich.*).

1897. *Cryptodrilus trincomaliensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 188.
1900. *Notoscolex trincomaliensis*, Michaelsen, Tier. x, p. 190.

Length 135 mm.; diameter 2–3 mm. Segments ca. 210. Colour ? Prostomium and first segment retractile or vestigial. Setæ set widely apart; $aa=2\,ab$, $ab:cd=5:7$, $bc$ is greater than $aa$; $dd$ very little greater than $\frac{1}{2}$ circumference. First dorsal pore at 12/13. Clitellum swollen, ring-shaped, more feebly developed ventrally, xiii–xvii (=5). Male pores in *ab*, immediately in front of the hinder copulatory cushions. Female pore unpaired (?). Spermathecal pores in *a* in 7/8 and 8/9. A pair of copulatory cushions, circular, joined across the middle line by a lower bridge, reaching *c* laterally, and extending from the setal zone of xviii to 19/20; a similar smaller cushion on xvii.

Septa 6/7–12/13 thickened (6/7 and 12/13 only slightly). Gizzard in v or vi; calciferous glands three pairs, kidney-shaped, in xv–xvii. Intestine begins in xix. Last hearts apparently in xii. Micronephridia on each side aggregated into broad tufts between *b* and *d*, on superficial examination resembling a meganephridium on each side. Male funnels in x and xi. Racemose seminal vesicles in xi and xii. Prostates of the Pheretima-type, fairly compact, bulging apart the septa of xviii; duct very fine, short, straight. Spermathecal ampulla ovoid; duct one and a half times as long as ampulla, at first thin, but widening towards ectal end, strongly bent backwards; no diverticulum. No penial setæ.

*Remarks.* Described from a single specimen, not well-preserved. The nephridial condition is somewhat reminiscent of *Woodwardia sarasinorum*.

*Distribution.* Plains N. of Dambulla and Trincomali, Ceylon.

## 8. Genus **MEGASCOLEX** *Templeton.*

1895. *Megascolex*, Beddard, Monog. p. 370.
1900. *Megascolex*, Michaelsen, Tier. x, p. 212.
1907. *Megascolex*, Michaelsen, Fauna S.W. Austral. p. 163.
1909. *Megascolex* + *Lampito*, Michaelsen, Mem. Ind. Mus. i, p. 178.
1916. *Megascolex*, Michaelsen, Mjöberg's Austral. Exp. p. 57.

Setæ, at least in the middle and hinder parts of the body, numerous (more than eight) in each segment. Spermathecal pores usually one to five pairs, between segments iv and ix (the exceptions are constituted by the few cases where the pores are fused in the middle line, or where they are numerous on each side in each segment). One gizzard in v, vi, or vii. Micronephridial. Prostates with branched system of ducts.

*Distribution* (Chart III). Mainly Ceylon and the extreme south of the Indian Peninsula—Cochin and Travancore in particular;

of these localities Ceylon has the greater number of species, and is the home of the genus *par excellence*. Outside these regions the genus is hardly found in the Indian region; one species has travelled up the Malabar coast towards Bombay (*M. konkanensis*); one, a "*Lampito*," is found at Baroda, another in the E. Himalayas, and the common "*Lampito*" *mauritii*, one of the great wanderers, is found all over India.

Outside India the genus is found in Australia, including Tasmania; in the N. Island of New Zealand, and Norfolk Island; "*Lampito*" *mauritii* is peregrine all over the coasts and islands of the Indian Ocean, over S.W. Asia and the Malay Archipelago.

The earlier history of the genus will be found fully set forth in Beddard's Monograph. Of later changes, two may be noted here. Michaelsen separated Kinberg's genus *Lampito* again in 1909, in consequence of finding two other worms which agreed with *L. mauritii* in the possession of a peculiar form of nephridial apparatus (micronephridia throughout the body, and meganephridia in addition in all the postclitellar segments); to these three species I later added two others. Michaelsen again fused the genera in 1916, since he had come to believe that the coexistence of mega- and micronephridia had no special importance;—the peculiarity has arisen at various times, and is found in a number of genera of Megascolecinæ (*Megascolides*, *Notoscolex*, *Megascolex*, *Plionogaster*). With this I agree; there are many varieties of nephridial arrangements in the genus *Megascolex*, and I see no reason for the separation of the worms possessing one particular form of nephridial apparatus as a separate genus; indeed, *M. eschericht* var. *papillifer* has the "Lampito"-arrangement, while the type-form of the species has not. Nor is there anything in the distribution of the "Lampito" forms to suggest a common origin.

The second change in the content of the genus *Megascolex* is the proposed fusion with it of the genus *Notoscolex*. This was hinted at by Michaelsen in 1913 (**70**); again, in 1916 (**83** *a*), he states that "a fusion of the two large genera *Notoscolex* and *Megascolex* appears to me unavoidable;" he does not, however, carry it out in the nomenclature used in the body of the paper, though in the "List of species discussed" at the end of the paper *Notoscolex* and *Megascolex* (s.s.) appear as subgenera of *Megascolex* (s.l.). With this extension, however, I do not agree (*cf.* Introduction to genus *Notoscolex*); the genus as here comprehended therefore includes *Lampito* but excludes *Notoscolex*.

The origin of the genus is, according to Michaelsen's earlier view, to be sought in *Notoscolex*; in 1907, however (**123**), he thought it more likely that it was derived from *Perionychella* (*i. e.*, the less specialized forms of *Perionyx*), and was still doubtful, or inclined to suspect a double origin, in 1909 (**54**). But the difficulty of separating *Megascolex* and *Notoscolex* has led him, as

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we have seen, actually to merge the two genera, and to regard them as successive steps in the evolution of the main line of the Megascolecinæ.

I have myself argued (**95**) that, while the majority of species of *Megascolex* are descended from *Notoscolex* (though at different times and places), a number have their origin in species of *Perionyx*, and still others probably in *Spenceriella*. For the details of the argument, and for the question of polyphyly in general, reference must be made to the original paper.

On the other side, *Megascolex* has given rise to *Pheretima*. Indeed, the separation of these two genera is scarcely defined with absolute clearness; the only thoroughgoing distinction appears to be the position of the gizzard,—in vii or in front in *Megascolex*, in viii or behind in *Pheretima*. Other points help to characterize the genera, though they are not constant characters of either; thus *Megascolex* often has penial setæ, and very rarely has testis sacs or intestinal cæca, while *Pheretima* has the contrary characters.

As to the position of the gizzard, it is in segment vii in several Indian species of *Megascolex*; in one (*bifoveatus*) it is actually in the hinder part of vii, bulging back the septum. It is easy to see how the transfer of the gizzard to segment viii might take place; all students of this family must have noticed how sometimes the septum behind the gizzard adheres to the organ, especially when the septum is thin; and it has then to be peeled off the gizzard in order to demonstrate the true relations. Sometimes it is impossible to peel it off completely,—the septum is attached round the middle of the gizzard; a slight further degree of adherence of the cone-shaped septum to the surface of the gizzard will now cause the transfer of that organ to the segment behind. The shifting of the gizzard backwards is thus a gradual, not a sudden, change.

*Key to the Indian species of* Megascolex.

| | | |
|---|---|---|
| 1. | Spermathecal pores one pair in 7/8 ..... | 2. |
| | ,, ,, one pair in 8/9 ..... | 8. |
| | ,, ,, two pairs in 6/7 and 7/8. | 44. |
| | ,, ,, two pairs in 7/8 and 8/9. | 21. |
| | ,, ,, three pairs in 6/7, 7/8, and 8/9 ..... | 3. |
| | Spermathecal pores, median, unpaired in 7/8 and 8/9 ..... | *M. leucocyclus.* |
| | Spermathecal pores, several or numerous on each side in 7/8 and 8/9 ..... | *M. polytheca.* |
| 2. | Spermatheca with free diverticulum .... | *M. sarasinorum.* |
| | Spermatheca without free diverticulum, with numerous seminal chambers in wall of duct ..... | *M. multispinus.* |
| 3. | Funnels and testes free ..... | 4. |
| | Funnels and testes enclosed in testis sacs .. | 6. |
| 4. | Highest number of setæ per segment not more than 50..... | 5. |
| | Highest number of setæ more than 100 .. | *M. imperatrix.* |

| | | |
|---|---|---|
| 5. | Seminal vesicles in ix and xii; no web between terminal prongs of penial setæ .... | *M. mauritii.* |
| | Seminal vesicles in xii only; a web between terminal prongs of penial setæ ..... | *M. trilobatus.* |
| 6. | Testis sac in x only ..... | *M. escherichi.* |
| | Testis sacs in x and xi ..... | 7. |
| 7. | Spermathecal pores in *c* ..... | *M. brachycyclus.* |
| | Spermathecal pores in *g* ..... | *M. campester.* |
| 8. | Penial setæ absent ..... | 9. |
| | Penial setæ present ..... | 14. |
| 9. | Spermathecal diverticulum without secondary diverticulum ..... | 10. |
| | Spermathecal diverticulum with secondary diverticulum ..... | *M. acanthodriloides.* |
| 10. | Seminal vesicles in ix and xii ..... | *M. hendersoni.* |
| | Seminal vesicles in xi and xii ..... | 11. |
| 11. | Number of setæ in front of clitellum 12, behind 16 ..... | 12. |
| | Number of setæ in front of clitellum 20–22, behind 24–28 ..... | 13. |
| 12. | Male area (xviii and parts of neighbouring segments) thickened; xii not specially characterized ..... | *M. quintus.* |
| | No specially modified male area; a large flat papilla on xii ..... | *M. kempi.* |
| 13. | Transversely elongated paired papillæ on 17/18 and on xix ..... | *M. pattipolensis.* |
| | A thickened male field, on which are a pair of circular depressions anteriorly on xviii, and a pair of large flat papillæ on 18/19.. | *M. hortonensis.* |
| 14. | Accessory prostate glands present ..... | 15. |
| | No accessory prostate glands ..... | 17. |
| 15. | Accessory prostate glands two pairs, one in front and one behind the main gland .. | *M. cingulatus.* |
| | Accessory prostate glands one pair, in front of the main gland ..... | 16. |
| 16. | Apertures of accessory prostates on anterior part of xviii ..... | *M. ceylonicus.* |
| | Apertures in groove 17/18 ..... | *M. spectabilis.* |
| 17. | No copulatory papillæ apart from the male aperture ..... | 18. |
| | Copulatory papillæ present ..... | 19. |
| 18. | Spermathecal diverticulum with two secondary diverticula ..... | *M. nureliyensis.* |
| | Spermathecal diverticulum without secondary diverticula ..... | *M. zygochætus.* |
| 19. | Female pore on xv ..... | *M. varians* var. *insolitus.* |
| | Female pore on xiv ..... | 20. |
| 20. | Penial setæ with two longitudinal rows of coarse blunt teeth ..... | *M. pharetratus.* |
| | Penial setæ with small scattered triangular teeth ..... | *M. varians* var. *simplex.* |
| 21. | Penial setæ present ..... | 22. |
| | Penial setæ absent ..... | 30. |
| 22. | Seminal vesicles in ix and xii ..... | 29. |
| | Seminal vesicles in xi and xii ..... | 23. |
| | Seminal vesicles in xii and xiii ..... | *M. singhalensis.* |

| | | |
|---|---|---|
| 23. | Penial setæ long, over 5 mm. | *M. longiseta.* |
| | Penial setæ less than 3 mm. in length | 24. |
| 24. | Setæ *a* much enlarged, *a* larger than *b*, *b* than *c*, intersetal intervals decrease outwards from midventral line | *M. schmardæ.* |
| | Setæ and setal intervals not decreasing outwards by regular stages | 25. |
| 25. | Gizzard in vii | *M. bifoveatus.* |
| | Gizzard in v or vi or both | 26. |
| 26. | Setæ in anterior part of body fewer than 20 per segment | 27. |
| | Setæ in anterior part of body more than 50 per segment | 28. |
| 27. | Setæ in anterior part of body about 16 per segment | *M. varians* f. *typica.* |
| | Setæ in anterior part of body 8 per segment, in two pairs on each side | *M. willeyi.* |
| 28. | Glandular part of prostate long and band-like | *M. funis.* |
| | Glandular part of prostate racemose, deeply incised | *M. templetonianus.* |
| 29. | A single spermathecal diverticulum | *M. filiciseta.* |
| | Two spermathecal diverticula | *M. curgensis.* |
| 30. | Metandric | 31. |
| | Holandric | 33. |
| 31. | Only micronephridia present | *M. lorenzi.* |
| | Mega- and micronephridia coexisting | 32. |
| 32. | Copulatory organs as a pair of glandular cushions on 17/18 | *M. vilpattiensis.* |
| | Copulatory organ as a single cushion on the anterior part of xix | *M. sylvicola.* |
| 33. | Large calciferous glands in xiv and xv | *M. adami.* |
| | No set-off calciferous glands | 34. |
| 34. | Seminal vesicles in ix and xii | 35. |
| | Seminal vesicles in xi and xii | 36. |
| | Seminal vesicles in xii only | *M. cæruleus.* |
| 35. | Testes and funnels free | *M. pumilio.* |
| | Testes and funnels enclosed in testis sacs | *M. ratus.* |
| 36. | Setæ in anterior part of body 24 or fewer | 37. |
| | Setæ in anterior part of body 30 or more | 38. |
| 37. | Setæ about 24 in anterior segments | *M. eunephrus.* |
| | Setæ 12–16 in most anterior segments | *M. travancorensis.* |
| 38. | Last heart in xiv | *M. kavalaianus.* |
| | Last heart in xiii | 39. |
| 39. | Body extremely long in proportion to its width; anterior end truncated | *M. konkanensis.* |
| | Body has more usual proportions | 40. |
| 40. | Male area limited by a transversely elliptical wall | 41. |
| | Male area not so limited | 42. |
| 41. | Spermathecal pores outside *b*; diverticulum longer than duct plus ampulla | *M. trivandranus.* |
| | Spermathecal pores in *a* or almost so; diverticulum shorter than duct plus ampulla | *M. cochinensis.* |

| | |
|---|---|
| 42. Purely micronephridial, or with tufted nephridia in addition ..... | 43. |
| Mixed mega- and micronephridia present . | *M. dubius*. |
| 43. Spermathecal diverticulum as long as duct and ampulla together ..... | *M. insignis*. |
| Spermathecal diverticulum two-thirds as long as duct ..... | *M. pheretima*. |
| 44. Testes sacs present ..... | *M. sextus*. |
| Testes and funnels free ..... | *M. horai*. |

*Perichæta viridis* Schmarda (Neue wirbell. Thiere, i, pt. 2, p. 13, text-fig., pl. xviii, fig. 161), found in the woods of S. Ceylon, near Belligamme, is, according to Beddard (**23**), indeterminable on account of its immaturity, but is a "Perichæta," *i. e.*, a *Pheretima*. According to Michaelsen (**33**) the number of segments (209) is too many for a "Perichæta," but will do for a *Megascolex*; in the Tierreich it is put down as perhaps belonging to *Megascolex*.

*Perichæta* (*Pleurochæta* ?) *gracilis* A. G. Bourne (P. Z. S. 1886, p. 666) is, according to Michaelsen in the Tierreich, a *Megascolex*; but he does not include it in his Indian lists (**54**, **58**). A single specimen was found at Naduvatam in the Nilgiris; length 400, diameter ca. 2·5 mm., segments 332; setal rings widely broken dorsally and ventrally; clitellum xiv–xviii (=5); female pores paired; spermathecal pores two pairs, in 7/8 and 8/9; gizzard in vii (or ? vi); "two pairs of groups of small nephridia" opening posteriorly on vii and viii (these Michaelsen considers as glands, or possibly spermathecal diverticula); no penial setæ. The bodily proportions of this worm are reminiscent of *Megascolex konkanensis*; but the extent of the clitellum is different in the two, and nothing corresponding to the glands, or nephridia, of segments vii and viii has been noted in the latter species.

A number of small groups of closely related species can be recognized. Thus *M. hortonensis*, *kempi*, *pattipolensis*, and *quintus* are much alike; in common they have the small number of setæ, absence of pigment (colour not stated for *pattipolensis*), gizzard in vi, seminal vesicles in xi and xii, no penial setæ, spermathecal pores in 8/9 in or near *b*, and the characters of the spermathecæ; in size they form a series, from *quintus* (37 mm. long) to *hortonensis* (72 mm.)—all are comparatively small worms. The setal characters form a series corresponding to that arranged for size; in the two smallest the setæ are 12 per segment in the anterior part; in the two largest they are 20 anteriorly, and up to 24 (or 24–28 in *hortonensis*, the largest of all) behind; in three of the species it is noted that certain of the ventral setæ in the anterior part of the body are enlarged. *M. kempi* shows the simplest condition of the male field, and something like a series can be constructed here also, leading up to *hortonensis*. Every one of the four species is unfortunately known only from a single specimen; at present the differences in the setæ and genital areas seem sufficient to warrant their being kept separate, but when other specimens come to hand it is possible that this conclusion will have to be revised. All are Ceylonese forms.

Another group seems to be comprised of *M. cingulatus*, *ceylonicus*, *spectabilis*, *nureliyensis*, and *zygochætus*; these are also all Ceylonese forms.

*M. funis* and *M. templetonianus* are remarkably alike; and I should have felt inclined to unite them, but for the fact that Michaelsen had examples of both under his eyes while writing his paper on the Earthworm Fauna of Ceylon (33), and yet does not hint at any such procedure.

*M. eunephrus* and *M. travancorensis* are closely related, and are distinguishable mainly by the configuration of the male field; the supposed peculiarity of the nephridia of *M. eunephrus* is, I think, of only slight importance. The only other points which can be mentioned are a slight difference in the numbers of the setæ, and perhaps a difference in the length of the spermathecal diverticulum, neither of much moment. These are S. Indian forms.

Another group is constituted by *M. cochinensis*, *insignis*, *kavalaianus*, *konkanensis*, and *trivandranus*. Of these, *kavalaianus* and *insignis* go together, and *cochinensis* and *trivandranus* form another subgroup. It is possible that *kavalaianus* is identical with, or a variety of *insignis*. When one or only a very limited number of specimens are available, it is difficult to know what to do, since there is no indication of the extent of variability. These five forms are a South Indian group.

Of the species previously grouped together as *Lampito*, *M. mauritii* and *M. trilobatus* are connected, and so also are *M. vilpattiensis* and *sylvicola*; there is no very close relation between these two couples, and *M. dubius* stands apart from both.

A word may be added on the relation of the Australian species of the genus to those of India—more especially to those of Ceylon. The Australian species are simpler, at a lower level of evolution, and more uniform; the Ceylonese species are often further advanced, and in many cases approach *Pheretima*. Of simpler forms among the Ceylonese species *M. funis* and *varians* may be mentioned, while of the more advanced forms, which approach *Pheretima*, *multispinus*, *sarasinorum*, and especially *brachycyclus* are examples. It might be allowable, according to Michaelsen, to split up the genus into different groups; but as yet the necessary data for doing this are lacking.

### 1. Megascolex acanthodriloides *Mich.*

1897. *Megascolex acanthodriloides*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 235, pl. figs. 9, 10.
1900. *Megascolex acanthodriloides*, Michaelsen, Tier. x, p. 228.

Length 210–260 mm.; diameter 8–9 mm. Segments 143–149, no secondary annulation. Prostomium epilobous $\frac{1}{2}$. Dorsal pores present. Setal rings with irregular dorsal and ventral breaks; $aa = 1\frac{1}{2}$–$2ab$, $zz = 3$–$4yz$; setæ set wider apart near the dorsal break; numbers 44/v, 56/x, 54/xix, 48/xxvi. Clitellum ring-shaped, including $\frac{3}{4}$xiv–xvii ($=3\frac{3}{4}$), excavated posteriorly and

ventrally, the posterior border being bowed forward there. Male pores on small papillæ, $\frac{1}{5}$ circumference apart, about in line with the eleventh seta; no setæ between the male pores. Female pores paired. Spermathecal pores one pair, laterally placed in 8/9, about in line with the seventeenth seta. Two pairs of copulatory papillæ, one in front of and one behind the male pores, somewhat medial to these, at the anterior and posterior borders of xviii respectively, those of the same side connected by curved longitudinal walls which pass outside the male pores. One median copulatory cushion on 9/10, with two papillæ on its hinder part.

Septa 6/7–12/13 thickened, the anterior ones less than the others. Gizzard in vi. Intestine begins in xv. Last hearts in xiii. Testes and funnels free in x and xi. Seminal vesicles in xi, xii, and xiii; those in xi the largest, those in xiii rudimentary. Prostates very large, with broadly band-like glandular part ca. 15 mm. long, extending back to xxvii; duct ca. 10 mm. long, muscular, almost straight, situated longitudinally, connected with anterior end of gland. Accessory glands, resembling the prostates of some Acanthodrilines, each a flattened cylinder bent on itself, ending in front of and behind the prostates, in situations corresponding to the external papillæ. Spermathecal ampulla an elongated sac; duct of medium length, narrow, half as long as ampulla, set off from the ampulla; diverticulum thickly pear-shaped, with single chamber, arising from middle of duct, bearing on its under side an accessory diverticulum with numerous small seminal chambers, the accessory diverticulum of about the same size as the first. No penial setæ.

*Distribution.* Peradeniya, Ceylon.

## 2. Megascolex adami *Mich.*

1910. *Megascolex adami*, Michaelsen, Abh. Ver. Hamburg, xix, p. 64, pl. figs. 14, 15.

Length 320 mm.; diameter 3–4 mm. Segments ca. 290. Reddish flesh-colour, unpigmented. Body very slender; anterior segments multiannular. Prostomium ? First dorsal pore in 7/8. Setæ very small, especially in the middle and hinder parts of the body; in fairly regular pairs, but the width of the pairs variable; lines *a* and *b* fairly regular throughout the body; in the most anterior segments 10 setæ; then 12, in three pairs on each side, the ventral pair the most regular; at the hinder end 14 or 16; median dorsal interval in the anterior part of the body very large. Clitellum ? Male pores on small roundish papillæ in the setal zone, ca. $\frac{1}{12}$ of the circumference apart. Female pore or pores indicated by a small glandular area in the setal zone. Spermathecal pores two pairs, in 7/8 and 8/9, ca. $\frac{1}{10}$ of the circumference apart. Slight elevations on the four or five segments in front of the male pores (xiii or xiv to xvii), single in each segment, transversely oval, not quite median (possibly due to faulty preservation).

Septa 6/7–11/12 fairly strongly thickened, the next two successively thinner. A large gizzard in v. Two pairs of very large calciferous glands in xiv and xv, those of the same side apparently fused, opening by a common opening into the œsophagus in the hinder part of xiv. Typhlosole fairly thick, angular. Funnels free (?) in x and xi. Seminal vesicles, if present, small and inconspicuous. Prostates rather small, irregularly disc-like, much incised; duct about as long as the glandular part is wide, straight, moderately and equally thick, except that it is rather thinner at both ends, with muscular shimmer. Spermathecal ampulla an elongated cylinder, rounded entally, often with a wart-like outgrowth at one side; duct little narrower than ampulla, short; diverticulum from ectal end of ampulla, regularly cylindrical in shape, half as thick and quite half as long as ampulla.

*Distribution.* Bulutota, above Ratnapura, Adam's Peak, Ceylon.

3. **Megascolex bifoveatus** *Steph.*

1913. *Megascolex bifoveatus*, Stephenson, Spol. Zeyl. viii, p. 266, pl. ii, fig. 9.
1915. *Megascolex bifoveatus*, Stephenson, Mem. Ind. Mus. vi, p. 80.

Length 48–80 mm.; maximum diameter 2–3 mm. Segments 100–126. Colour grey, with purple or pink tinge on dorsal surface anteriorly; mid-dorsal line purple; clitellum browner. Prostomium epilobous $\frac{1}{2}$–$\frac{3}{4}$, tongue cut off behind. Dorsal pores from 4/5 or 5/6. Setæ arranged in fairly regular longitudinal rows; dorsal interval irregular, may be as much as $2yz$ anteriorly; ventrally the break may diminish backwards, from $2ab$ in front to being absent behind; number of setæ in anterior part of body from 34 to 42, the smaller numbers towards the front end. Clitellum xiv–xvi=3. Male pores in *c* or *d*, ca. $\frac{1}{7}$ of the circumference apart. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *e*. Genital marks a pair of oval pits in 19/20, their centre slightly internal to the line of the male pores.

Septum 12/13 and apparently a variable number in front of and behind this are slightly to moderately thickened. Gizzard rather small, short and cylindrical, in the hinder part of vii, bulging back septum 7/8. No calciferous glands. Intestine begins in xv. Last heart in xiii. Micronephridia few or absent on body-wall in front of clitellum, otherwise present throughout; at some point behind clitellum larger nephridia appear, each consisting of a wavy or twisted tube, or of a number of coils, but of no great size; at first these are one on each side per segment, but towards the hinder end they are two or three on each side, some being attached to the anterior septum; these larger nephridia do not seem to be different in kind from micronephridia. Male funnels free in x and xi. Seminal vesicles in xi and xii, large and grape-like

Much lobulated prostates occupy segments xviii–xx; duct straight and stout. Spermathecæ with rounded ampulla; duct fairly thick and short; diverticulum small, of an elongated ovoid shape, arising from the duct, a quarter as long as the ampulla. Penial

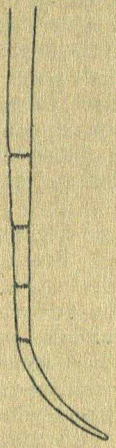

Fig. 83.—*Megascolex bifoveatus* Steph.; distal end of penial seta.

setæ (text-fig. 83) 0·75 mm. long, 15 $\mu$ thick, almost straight except at the distal end which is curved into the quadrant of a circle; proximal to the curve are four circles of finely sculptured dots, at some distance from each other along the shaft.

*Remarks.* The posterior position of the gizzard, and the nephridial condition are interesting; the meganephridia seem not to have completely broken up into micronephridia.

The genital markings may not be depressed, but are still recognizable by their darker colour; the pits may be in 18/19.

*Distribution.* Pattipola and Horton Plains, Ceylon.

### 4. Megascolex brachycyclus (*Schmarda*).

1861. *Perichæta brachycycla*, Schmarda, Neue wirbell. Thiere, i, pt. ii, p. 14.
1892. *Megascolex brachycyclus*, Beddard, Ann. Mag. N. H. (6) ix, p. 125.
1895. *Megascolex brachycyclus*, Beddard, Monog. p. 382.
1897. *Megascolex brachycyclus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 239, text-figs. 28, 29.
1900. *Megascolex brachycyclus*, Michaelsen, Tier. x, p. 227.
1910. *Megascolex brachycyclus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 68.

Length 80 mm.; diameter 3 mm. Segments ca. 213. Colour dorsally in middle and hinder parts of body light reddish-brown,

for the rest an equable grey. Prostomium? Segments in anterior part of body triannular. Dorsal pores from 5/6. Setal rings almost closed; *aa* regularly=$1\frac{1}{2}$–2*ab*, *zz* about the same but irregular; numbers 48/x, 47/xxvi. Clitellum? Male pores small, in setal zone, ca. $\frac{1}{12}$ of the circumference apart, in line with *c*, surrounded by a dark common area which is somewhat narrower in the middle line and laterally ends in a point about in line with *e*. Female pores paired, just in front of setæ *a*. Spermathecal pores three pairs, in 6/7–8/9, in line with *c*, each surrounded by a transverse area, dark in colour, which extends from *a* to *e*. Copulatory areas two pairs, in 17/18 and 18/19, transversely extended and dark in colour, resembling the male area.

Intestine begins in xv; no typhlosole in anterior part. Testis sacs, unpaired, in x and xi. Seminal vesicles four pairs, in ix–xii, the anterior two pairs connected with the anterior, the posterior two pairs with the posterior testis sac. Prostates with small loosely racemose glandular part; duct narrow. Spermathecal ampulla sac-like; duct sharply marked off, fairly thick, about as long as ampulla, half as thick in its ental part, but its ectal half much thinner; diverticulum given off from junction of thicker and thinner parts of duct, club-shaped, about half as long as duct. Penial setæ 1·3 mm. long, 25 $\mu$ in maximum thickness, slightly bowed, and very slightly thinner towards the free end; tip sharply bent and then bent back again; the sides and concavity of the main curve at the tip ornamented with several groups of slender teeth.

*Remarks.* The presence of testis sacs and the relations of the seminal vesicles relate this form to *Pheretima*. The septa in the anterior part of the body were much softened, and the position of the gizzard, which would have been diagnostic, was not determinable; the absence of intestinal cæca, the paired female pores, and the presence of penial setæ, point to *Megascolex*. Nephridia were not recognizable; the species is therefore presumably micronephridial. The prostates were perhaps not fully developed.

The species is to be placed near *M. escherichi*; it also recalls *M. iris* and *M. margaritaceus* from the Philippines. Michaelsen thinks it possible that it may have to be separated as a distinct genus.

*Distribution.* Ratnapura, at the foot of Adam's Peak, Ceylon.

5. **Megascolex cæruleus** *R. Templeton.*

1844. *Megascolex cæruleus*, Templeton, P. Z. S. 1844, p. 89.
1882. *Pleurochæta moseleyi*, Beddard, Tr. Roy. Soc. Edin. xxx, p. 481, pls. 25–27.
1890. *Perichæta cærulea*, Benham, Quart. J. Mic. Sci. xxxi, p 235.
1891. *Megascolex cæruleus*, Bourne, Quart. J. Mic. Sci. xxxii, p. 49, pls. vi–ix.
1895. *Megascolex cæruleus* (part.), Beddard, Monog. p. 386.

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1897. *Megascolex cæruleus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 214.
1900. *Megascolex cæruleus*, Michaelsen, Tier. x, p. 232.

Length 250–1000 mm.; diameter 20–37 mm. Segments 250–290. Colour bluish green. Prostomium prolobous, broad and blunt. Dorsal pores from 6/7. Setæ closer set and larger ventrally; $aa=3$–$4ab$, $zz=3$–$4yz$; numbers 36/v, 140 behind clitellum. Clitellum ring-shaped in front, saddle-shaped behind; $\frac{1}{3}$xiii–xxi ($=8\frac{1}{3}$). Male pores in line with $g$, ca. $\frac{1}{10}$ of the circumference apart, on the edges of a median depression (in preserved specimens). Female pores paired. Spermathecal pores two pairs, in 7/8 and 8/9, in line with $i$. Two pairs of gland pores in 17/18 and 18/19, in line with the male pores or the hinder pair somewhat internal to the male pores.

Septa 8/9–12/13 thickened, all strongly except the first. Gizzard in v. No calciferous glands; œsophagus swollen in x–xv, with ridges and rugæ on inner surface of wall. Well marked paired dorsal pouches on the anterior part of the intestine; typhlosole a simple ridge. Last heart in xiii; the dorsal vessel bifurcates and reunites several times in the anterior segments. Testes and funnels two pairs, free, in x and xi. One pair of racemose seminal vesicles in xii. Prostates small, with fairly smooth glandular part; duct very short, muscular. Accessory glands in connection with the pores in 17/18 and 18/19, small, solid, embedded in the body-wall, not seen in dissection. Spermathecal ampulla pear-shaped; diverticulum very small, embedded in the wall of the duct. No penial setæ.

*Remarks.* Bourne describes a series of kidney-shaped glands on and opening into the intestine in segments cxii to cxxxiii, 22 pairs; Beddard found 15 pairs in lxxxvi to ci. They do not seem to be lymph-glands; their acini are composed of columnar epithelium.

Bourne also gives an exhaustive account of the circulatory system.

Beddard could detect no segmental organs; the worm is therefore presumably micronephridial. He found the pores of the accessory glands on segments xvii and xix.

*Distribution.* Kandy, Peradeniya, Nuwara Eliya, all in Ceylon.

### 6. **Megascolex campester** *Steph.*

1915. *Megascolex campester*, Stephenson, Mem. Ind. Mus. vi, p. 78, pl. viii, figs. 17, 18.

Length 60–74 mm.; maximum diameter 4 mm. Segments 139. Colour a dark slate, slightly lighter ventrally and at anterior end. Prostomium epilobous $\frac{1}{2}$–$\frac{2}{3}$, tongue cut off behind. Dorsal pores from 5/6. Setal rings on whitish lines; dorsally a small break ($zz=2yz$), ventrally closed or nearly so; intersetal distances rather greater dorsally than elsewhere, smallest laterally;

numbers 46/v, ca. 50/ix, 48/xiii, 50/xix, and about 47 in the middle of the body. Clitellum xiii–xvii (=5), purple in colour, otherwise indistinguishable. Male pores small, each in a whitish depressed area, the two areas united across the middle line by a tract of lighter colour than the regions in front and behind; a slight groove in front of and behind each pore; pores in line with *f* or *fg*, $\frac{1}{5}$ or $\frac{1}{6}$ of circumference apart. Spermathecal pores inconspicuous, three pairs, in line with *g* in 6/7–8/9. A pair of small oval flat whitish genital papillæ in 18/19, internal and posterior to the male pores.

No septa notably thickened. Gizzard large, firm, barrel-shaped, in vii. Œsophageal swellings in x–xiii or xi–xiii, not set off, but with striated appearance, and transverse lamellæ internally.



Fig. 84.—*Megascolex campester* Steph.; spermatheca; the appendages on the upper swollen part of the duct are micronephridia.

Intestine begins in xiv. Last heart in xiii. Micronephridia very numerous and minute, on inner surface of whole body-wall and on dorsal wall of pharynx and buccal cavity; longer nephridia from xx backwards, irregularly distributed at first, then usually

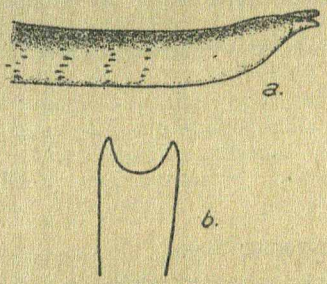


Fig. 85.—*Megascolex campester* Steph.; distal end of a penial seta; *a* represents the tip as seen under the microscope, × ca. 400; *b* represents what would probably be seen if the end could be rotated through a right angle.

two or three on each side in each segment; these larger nephridia are more conspicuous towards the hinder end, each consists of a few loops or a coil of a few turns, and has no connection

with a septum. Testes and funnels in x and xi, in sacs which communicate across the middle line. Seminal vesicles four pairs, the anterior two pairs communicating with the anterior testis sac, the others with the posterior; those in ix attached to the posterior, the others to the anterior wall of their segments; all with lobulated edges. Prostates flattened, lobed, occupying xviii–xix or xx; duct stout, almost straight, shining and of equal diameter throughout. Spermathecal ampulla roughly pear-shaped, the broader end joining the duct; duct separated from ampulla by a constriction, swollen below the constriction, as long as the ampulla, and as broad as the ampulla above, narrowing below; a small diverticulum from side of duct, stalked, swollen at its free end where a few chambers can be indistinctly seen; a number of micronephridia invest the broad part of the duct (text-fig. 84). Penial setæ (text-fig. 85) 1·7 mm. long, 20 $\mu$ thick at middle of shaft, almost straight, with slight curve distally; tip flattened, ending in two points with an incisure between them; about half a dozen irregular rings of fine sculpturings near the free end, not resolvable into spines under the oil immersion.

*Remarks.* This species appears to be related to *M. brachycyclus.*
*Distribution.* Horton Plains, Ceylon.

### 7. Megascolex ceylonicus (*Bedd.*).

1886. *Perichæta ceylonica*, Beddard, Ann. Mag. N.H. (5) xvii, p. 89, pl. ii, figs. 1–3.
1895. *Megascolex ceylonicus*, Beddard, Monog. p. 385.
1900. *Megascolex ceylonicus*, Michaelsen, Tier. x, p. 228.

Length 225 mm.; diameter 10 mm. Black dorsally, dark grey ventrally, except over clitellum, where it is black also. Setal rings closed dorsally, a very slight ventral gap; number in posterior part of body 51. Clitellum ring-shaped, xiv–xvi and a part of xvii (= more than 3). Male pores ca. $\frac{1}{5}$ of circumference apart. A pair of gland pores on xviii in front of the male pores and rather more lateral. Spermathecal pores one pair, widely separated, in 8/9.

Last heart in xiii. Prostates with lobular glandular part extending through several segments; duct narrow, long, somewhat curved. The accessory glands opening on xviii are narrow and tubular. Spermathecæ with a small pear-shaped diverticulum. Penial setæ generally slightly bowed, more strongly so at the distal end, tip rather blunt; distal fourth of shaft with a number of minutely and irregularly denticulate ridges, towards the extreme tip broken up so as to become a series of chevron-shaped ridges with the angle turned towards the tip (*i. e.*, triangular sculpturings).

*Remarks.* The species was described from a singly badly preserved specimen. The position of the gizzard is not recorded.
*Distribution.* Ceylon.

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8. **Megascolex cingulatus** (*Schmarda*).

1861. *Perichæta cingulata*, Schmarda, Neue wirbell. Thiere, vol. i, pt. ii, p. 14, pl. xviii, fig. 162, text-fig.
1892. *Megascolex cingulatus*, Beddard, Ann. Mag. N. H. (6) ix, p. 122, pl. vii, figs. 9–13.
1895. *Megascolex cingulatus*, Beddard, Monog. p. 382.
1897. *Megascolex cingulatus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 229, pl. figs. 7, 8.
1900. *Megascolex cingulatus*, Michaelsen, Tier. x, p. 229.
1910. *Megascolex cingulatus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 80.
1916. *Megascolex cingulatus*, Stephenson, Rec. Ind. Mus. xii, p. 329, pl. xxxii, fig. 21.

Length 220 mm. or less; diameter 3–6 mm. Segments 157. Colour bluish to reddish violet in life. Prostomium epilobous $\frac{3}{5}$, tongue cut off behind. First dorsal pore in 5/6. Setal rings almost closed, $aa=zz=1\frac{1}{2}$–$2ab$; numbers 31/v, 38/x, 33/xiii, 48/xix, 40/xxv. Clitellum xiii–xvii (= 5); ring-shaped, but interrupted ventrally in the hinder half of xvii. Male pores in setal zone about $\frac{1}{3}$ of circumference apart, each surrounded by a prominent lip; no setæ intervening. Female pores paired, in front of setæ *a* of xiv. Spermathecal pores one pair, in 8/9, $\frac{1}{3}$ of circumference apart. Two pairs of pits with slightly elevated margins in 17/18 and 18/19, rather wider apart than the male pores.

Septum 6/7 very thin; 7/8–11/12 or 13/14 thickened. Gizzard in vi or vii or both. Intestine begins in xiv or xv. Last heart in xiii. Funnels two pairs, in testis sacs, in x and xi. Seminal vesicles two or three pairs. Prostates with long, broadly

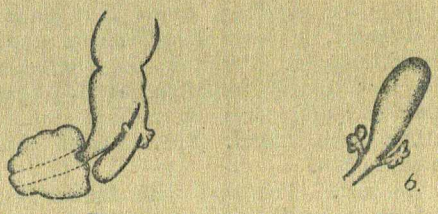


Fig. 86.—*Megascolex cingulatus* (Schmarda); spermatheca; *a*, whole organ, the dotted lines showing course of duct behind ampulla; *b*, diverticulum only, from another organ, showing a rather different condition of the secondary diverticula, rather more highly magnified.

band-shaped, loosely lobed glandular part, extending back to segment xxv or xxx; duct long, muscular, coiled. Two pairs accessory glands, opening in the pits in 17/18 and 18/19. Spermathecal ampulla somewhat pyramidal or irregular; duct begins from the apex of the pyramid, passes at first under the ampulla, where it is narrow; then emerging from under the ampulla dilates and becomes much stouter; diverticulum given

off from ectal portion of duct, club-shaped; one or two secondary diverticula from near base of primary diverticulum, small, stalked, each with one or more grape-like seminal chambers (text-fig. 86). Penial setæ 1·7 mm. long, with sharp tip, bowed shaft, and thick (75 $\mu$) proximal end; ornamentation of numerous denticulated transverse lines on the concave side of the tip.

*Remarks.* I found calciferous glands in segments x–xiii; these are not mentioned by other authors, and were probably œsophageal swellings only, not distinctly marked off.

The seminal vesicles are variously stated to be two pairs in xii and xiii, racemose, or three pairs in x, xi, and xii not racemose.

Michaelsen found the concave side of the tip to be sharp, like a knife; I did not see any indication of this in my specimen.

*Distribution.* E. of Badulla, Avissavela, Kandy, and probably Peradeniya, all in Ceylon.

### 9. **Megascolex cochinensis** *Steph.*

1915. *Megascolex cochinensis*, Stephenson, Mem. Ind. Mus. vi, p. 96, pl. ix, figs. 32, 33.

Length 175–220 mm.; diameter 4 mm. Segments 224. Colour grey, non-pigmented. Prostomium epilobous $\frac{1}{3}$ to $\frac{1}{2}$, tongue cut off behind. Dorsal pores from 5/6. Setæ closer set ventrally; $aa=2ab$ in front of and $3ab$ behind clitellum, $zz=2yz$; numbers 41/v, 54/ix, 57/xii, 48/xix, 36–38 in middle of body. Clitellum xiv–$\frac{2}{3}$xvii ($=3\frac{2}{3}$). Male pores as oblique wavy slits, the posterior ends of which approach each other, each on a white oval elevation, also oblique, which touches or almost touches its

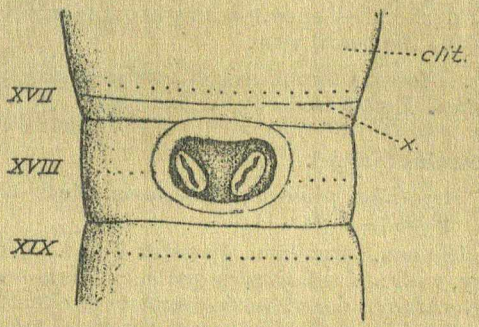


Fig. 87.—*Megascolex cochinensis* Steph.; male genital area; *clit.*, clitellum; *x*, its posterior border.

fellow in the middle line; the area surrounding the papillæ depressed, and the whole surrounded by an oval wall; centres of male pores ca. $\frac{1}{12}$ circumference apart; the whole area in longitudinal extent takes up nearly the length of segment xviii (text-fig. 87). Female pore apparently single. Spermathecal pores in 7/8 and 8/9, in line with *a*.

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Septa 6/7–11/12 moderately thickened, the following two slightly so. Gizzard large and barrel-shaped, in v. Œsophagus swollen and vascular in xii–xiv. Intestine begins in xix. Last heart in xiii. In front of clitellum nephridia only as tufts by the side of œsophagus; behind clitellum they form a band (but not a single line) in the anterior half of each segment. Testes and



Fig. 88.—*Megascolex cochinensis* Steph.; spermatheca.

funnels free in x and xi. Seminal vesicles, moderately large, racemose, in xi and xii. Prostates limited to xviii, each a mass of small rounded lobules; duct passing straight inwards, wider at its termination. Spermathecal ampulla ovoid; duct as long as ampulla and less than half as wide; diverticulum arising from ectal end of duct, club-shaped, reaching about to middle of ampulla (text-fig. 88). No penial setæ.

*Remarks.* I found a second pair of ovaries in one specimen.
*Distribution.* Forest tramway, Cochin State.

*a.* var. **phaseolus** (*Steph.*).

1915. *Megascolex phaseolus*, Stephenson, Mem. Ind. Mus. vi, p. 93, pl. ix, figs. 28, 29.

Length 180 mm.; maximum diameter 3 mm. Segments 270. Colour grey, with a bluish tinge in parts, clitellum orange. Setæ closer set ventrally; dorsal break decreases backwards from $3yz$ to $1\frac{1}{2}yz$, ventral break $= 2ab$ in front of clitellum, $4ab$ in middle of body, $3ab$ towards hinder end; in front of clitellum setæ on dorsal and lateral surfaces arranged in pairs, in the middle of body the intersetal intervals are very irregular; numbers 34/v, 35/ix, 36/xii, 38/xix, and 26–28 in middle of body. Clitellum xiv–xvii (= 4). Male genital field (text-fig. 89) marked by a kidney-shaped elevation, transversely placed on xviii, the concavity backwards; the elevation surrounded by a groove, and this again by an elliptical ridge which is cleft behind in the middle line.

Male pores as fine grooves, oblique in position, beginning in front on the kidney-shaped elevation, and ending behind near the middle line on the elliptical raised ring. In some, a small circular papilla anteriorly on xix, bordering the groove.

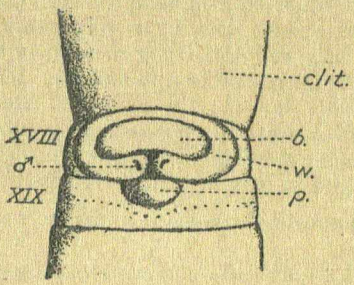


Fig. 89.—*Megascolex cochinensis* Steph. var. *phaseolus*; male genital area; *b.*, bean-like elevation on xviii; *w.*, the ring-like wall, cleft behind; *p.*, papilla on xix; *clit.*, clitellum.

*Remarks.* I have re-examined the original specimens. The smaller number of setæ, and the configuration of the male field, are the distinguishing marks. Michaelsen (70) considers that the state of contraction or relaxation has much to do with the appearance of the male area, and when the worms are otherwise similar makes one a variety of the other; thus the several varieties of *Megascolex travancorensis* are distinguished by little more than the male fields.

*Distribution.* Parambikulam, Cochin State.

### 10. Megascolex curgensis *Mich.*

1921. *Megascolex curgensis*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 64, text-figs. 8 *a*, *b*, *c*.

Length 125–130 mm.; maximum diameter 4·5 mm. Segments ca. 115. Colour yellowish white. Prostomium epilobous ca. $\frac{1}{4}$; a middorsal longitudinal furrow passes back from the prostomium to groove 1/2. Dorsal pores from 5/6. Setæ enlarged at ends of body; dorsal break irregular; $aa=2ab$, $zz=2$–$3yz$; numbers 24/v, 33/x, 34/xix, 36/xxvi, 28/xc. Clitellum ring-shaped, $\frac{1}{2}$xiii–$\frac{1}{2}$xviii ($=5$). Male pores inconspicuous, in the setal zone of xviii, $\frac{1}{10}$ of the circumference apart. Female pores inconspicuous, ? paired. Spermathecal pores two pairs in 7/8 and 8/9, $\frac{1}{3}$ of the circumference apart. No other genital marks.

Septa 7/8–12/13 thickened, the middle ones of the series fairly strongly. Gizzard in vi. No calciferous glands. No typhlosole. Last heart in xiii. Micronephridial tufts united to form bushy rosettes in the anterior part of the body; behind this are arranged in the form of a fan. Testes and funnels free in x and xi, the testes apparently on the posterior wall of the segment. Seminal vesicles in ix and xii, racemose. Prostates take up about three

segments, their border slightly indented; duct one-fifth as long as glandular part, small, cylindrical, muscular. Spermathecæ with irregularly spindle-shaped ampulla; duct not sharply marked off, short, thin, almost entirely embedded in the body-wall; diverticula two, one above the other, considerably shorter than the ampulla, opening into ental end of duct by a very short common stalk, each broad at the base and narrowing to its apex which is bent or spirally coiled. Penial setæ thin and delicate, 2·7 mm. long, 26$\mu$ thick in the middle, bowed; tip somewhat flattened at right angles to plane of curvature, spoon-shaped, ending in three or four irregular teeth; the hollow of the spoon furnished with small teeth, arranged in part in transverse rows.

*Remarks.* The nephridial condition apparently resembles that in *M. filiciseta*.

*Distribution.* Madapur and Somavarpatna, Coorg.

11. **Megascolex dubius** (*Steph.*).

1916. *Lampito dubius*, Stephenson, Rec. Ind. Mus. xii, p. 315, pl. xxxi, fig. 9.

Length 106 mm. (originally more, hinder end regenerated); diameter 6 mm. Segments 134 (or more originally). Colour slate-blue, slightly lighter on ventral surface. Prostomium epilobous $\frac{1}{2}$, tongue almost closed behind, sides converging at an obtuse angle. Dorsal pores from 6/7. Setæ set more closely, and smaller, ventrally than dorsally; no ventral break, dorsal break=$2yz$, irregular or sometimes absent; numbers 91/v, 88/ix, ca. 81/xix, 82/xxvi. Clitellum? Midventral portion of xviii pale in colour. Male pores small and slit-like, close to midventral line, in a small transverse groove just behind the setal zone; the line of the setæ is on the sloping anterior wall of the groove, a few setæ missing in the neighbourhood of the pores. Female pore probably in a slight transverse depression midventrally on xiv, a little in front of the setal zone. Spermathecal pores close together, though slightly wider apart than the male pores, in 7/8 and 8/9.

Septa 5/6–7/8 slightly strengthened, 8/9 moderately, 9/10–15/16 considerably; thereafter the thickening gradually diminishes. Gizzard large and firm, in v and vi. Œsophagus laterally bulged in x–xiv, and villous internally. Intestine begins in xix; typhlosole in middle of body low, with transverse folds. Last heart in xiii. In the most anterior segments nephridia as a tuft with a single stalk; behind xiii one loop of the tuft, longer than the rest, stretches outwards on the body-wall; from x onwards a number of small micronephridia make their appearance, scattered further out on the body-wall; in the middle of the body a transverse line of micronephridia on each side, and a meganephridium (text-fig. 90) with about six funnels, and two loops which stretch outwards on the body-wall, one shorter, stout and

conspicuous, the other extremely fine and reaching nearly to the middorsal line. Testes and funnels free in x and xi. Seminal vesicles single in xi and xii, large in xi, small in xii. Prostate

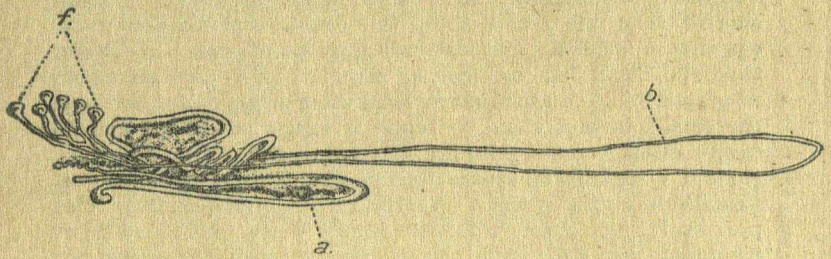


Fig. 90.—*Megascolex dubius* Steph.; a meganephridium from the middle of the body, to show the general relations of the parts, the funnels, the stout and slender loops; *a*, stout loop; *b*, slender loop; *f.*, funnels.

very small, consisting of a number of finger-like processes, almost sessile on the body-wall, and without visible duct. Spermathecæ not visible internally. No penial setæ.

*Remarks.* The single specimen was possibly immature. The condition of the nephridia is interesting; the meganephridia seem to be here caught in the act of dividing up. The species is probably to be derived from a *Perionyx*, its origin being independent of that of other species of the genus (*cf.* Stephenson, 95).

*Distribution.* Kurseong, E. Himalayas.

### 12. Megascolex escherichi *Mich.*

1910. *Megascolex escherichi*, Michaelsen, Abh. Ver. Hamburg, xix, p. 66, text-fig. B.

Length 43–45 mm.; maximum diameter 3 mm. Segments 104–119. Colour dorsally a dark brown-violet, laterally lighter, ventrally yellowish-white. Prostomium epilobous ca. $\frac{2}{3}$; tongue open behind. First dorsal pore in 5/6. Setæ small, ventrally much closer set than dorsally; the rings broken ventrally to a very slight extent and irregularly, dorsally more distinctly interrupted but the interval again small; numbers 40/v, 36/x, 38/xix, 40/xxv. Clitellum xiv–xvii (= 4). Male pores close together on a common transversely oval papilla which takes up the whole length of xviii. Female pores paired. Spermathecal pores fused in the middle line or almost so, in 6/7–8/9, contained almost wholly in the space between the lines *a*.

Septa 8/9–12/13 very little thickened, 10/11 and 11/12 most distinctly so. Gizzard large, in vii. Œsophagus widened in viii–xiii(?), with folded and vascular wall, but no set-off calciferous glands. No intestinal cæca. No typhlosole. One pair testes and funnels in x, enclosed in an unpaired testis sac, transversely placed, narrowed in the mid-ventral line; a large lateral prolongation on

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each side (=seminal vesicle of x), and from this an extension into ix (=seminal vesicle of ix); these latter (in ix) are split up into a number of indistinctly separated pear-shaped chambers. Prostates irregularly disc-shaped; duct fairly thick, muscular, straight, shorter than the diameter of the gland. Spermathecæ with egg-shaped ampulla; duct fairly abruptly set off, somewhat longer than and about half as thick as ampulla. Diverticulum arises near ectal end of duct, about as long, when straightened, as duct; the ectal half is a stalk, the ental is somewhat dilated and its cavity often constricted near the ental end. The duct may contain a cylindrical spermatophore-like mass of spermatozoa. Penial setæ almost straight, ca. 0·65 mm. long and ca. 20 $\mu$ thick proximally, not much thinner towards distal end; distal end narrowed just above the tip, rather flattened and chisel-like between the narrowing and the end, the truncated end being slightly hollowed out (like *M. mauritii*, but in a much feebler degree); this terminal portion is beset with about five irregular rings of long and slender spines.

*Remarks.* In life the worm moves with a strong, almost springing action.

The species has affinities with *M. brachycyclus*, though there are many very distinct differences. It stands alone in the genus in being proandric (though *M. fielderi* and *M. frosti* are metandric); the possession of a testis sac is shared with a few Australian and Ceylonese species. These peculiarities show that this species is approximating to *Pheretima*; the posterior position of the gizzard (in vii) is also a step in the same direction; this last feature is only found in Ceylonese and Indian species (in the Australian *M. collinus* it occupies parts of vi and vii).

*Distribution.* Hidana, near Peradeniya, Ceylon.

*a.* var. **papillifer** *Steph.*

1915. *Megascolex escherichi*, var. *papillifer*, Stephenson, Mem. Ind. Mus. vi, p. 77, pl. viii, fig. 16.

Length 55 mm.; diameter 3 mm. Segments 121. Colour much as in the type form. Prostomium epilobous $\frac{1}{3}$, tongue either cut off behind or not; segment i divided ventrally by a longitudinal cleft. Setal rings broken dorsally and ventrally; $zz=2$–$2\frac{1}{2}$ $yz$, $aa=1\frac{1}{2}$ $ab$; numbers 36–44. The oval raised area or papilla on which the male pores are situated (text-fig. 91) may be marked by one or more of the following grooves:—a transverse near its anterior border, a similar groove near its posterior border, and a longitudinal in the middle line. The spermathecal apertures are not fused in the middle line, though close to it. Genital papillæ present or not; one, in 19/20, or more rarely two, in 19/20 and 20/21, small and transversely oval, never quite in the middle line, always somewhat to either the right or left side.

Gizzard partly in vi; the septum (6/7) is attached round its anterior part, behind the anterior third. Micronephridia through-

out the body; in addition, nephridial tufts by the side of the alimentary canal in v–ix; and a large nephridium on each side in each segment from xvii backwards, wavy or coiled tubes, in maximum length equal to half the diameter of the intestine,

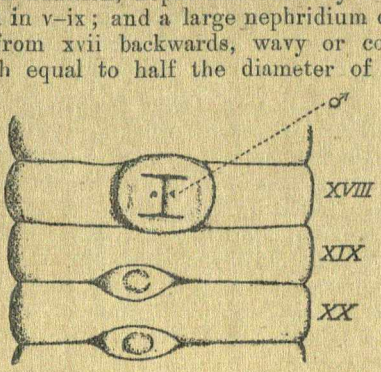


Fig. 91.—*Megascolex escherichi* Mich. var. *papillifer*; male genital area.

smaller towards the hinder end, and may be absent here from one or both sides of a segment. The spermathecal diverticulum may be cylindrical, and not stalked; or it may be attached separately to the body-wall. Penial setæ narrower at the truncated distal end than in the type form; spines, in 6–7 rings, do not stand off so much from the shaft as in the type form.

*Distribution.* Horton Plains, Ceylon.

### 13. Megascolex eunephrus *Cogn.*

1911. *Megascolex eunephrus*, Cognetti, Ann. Mag. N. H. (8) vii, p. 498, pl. xiii, figs. 5–7.

Length more than 85 mm. (hinder end wanting); maximum diameter (anteclitellial) 3 mm. Segments 195. Colour a uniform lilac-grey. Prostomium proepilobous. No secondary annulation. First dorsal pore in 8/9. Nephridiopores in 3/4–8/9 in line with setæ *e*. Setæ nearly constant in number, ca. 24; ventral break regular but not large, $=2ab$, dorsal break a little larger. Clitellum ring-shaped, xiv–xvii (= 4). Ventrally on xviii a few large papillæ, which, joining together, form a triangular figure enclosing a depression, one angle of the triangle pointing forwards and reaching 17/18; male pores near the lateral angles, in line with *b*. Spermathecal pores in *b* in 7/8 and 8/9.

Septa 6/7–8/9 moderately thickened. Gizzard in v. Intestine begins in xxi. No calciferous glands. Last heart in xiii. Nephridia in iii–ix as conspicuous tufts, with thin-walled ribbon-like duct, which increases in length from the first to the seventh pair, and passes through the body-wall at the extreme anterior margin of the segment; from x onwards the nephridia are diffuse and small, but in xiv and xv a pair of the larger nephridia are present in addition. Testes and funnels free in x and xi. Sperm vesicles grape-like, in xi and xii. Prostates with glandular part

much lobed, in xvii–xx; duct curved with convexity forwards. Spermathecæ with club-shaped main pouch; diverticulum finger-shaped, opening into ectal end of duct, in length one-third of main pouch (ampulla plus duct). No penial setæ.

*Remarks.* I do not think the "meganephridia" are here anything else than the usual tufted nephridia of the anterior segments, though they seem to extend further back than usual. The author notes that nephridia like the larger ones of the present species have been found by Benham in *M. laingii* (113), where they probably perform the office of peptonephridia. On peptonephridia see Cognetti (117) and Bahl (90).

This species comes very close to *M. travancorensis* and its varieties; the spermathecal diverticulum is much smaller, according to the figure.

*Distribution.* Coorloon, Travancore, S. India.

### 14. Megascolex filiciseta *Steph.*

1915. *Megascolex filiciseta*, Stephenson, Mem. Ind. Mus. vi, p. 94, pl. ix, figs. 30, 31.

Length 63–70 mm.; diameter 2–3 mm. Segments 118. Colour dorsally bluish grey behind, purplish in front; ventrally a



Fig. 92.—*Megascolex filiciseta* Steph.; penial seta, lateral view of distal end, showing a relatively small number of pinna-like spines; × ca. 500.

slaty grey; a fine dark middorsal stripe. Prostomium epilobous ¼, tongue closed behind, and marked by a median groove. First dorsal pore in 5/6. Setal rings broken dorsally, $zz \doteq 2yz$, or a little more or less; ventrally the ring closed anteriorly as far as xi, but thereafter soon becomes moderately widely interrupted, so that $aa = 2\frac{1}{2}ab$; seta *a* as a rule smaller than the rest, and *ab*

rather less than *bc*; numbers 33/v, 41/ix, 37/xii, 42/xix, and 36 or 38 in middle of body. Clitellum xiv-xvi (?). Male pores inconspicuous, on very small papillæ, between lines *a* and *b*. Spermathecal pores minute, close to the middle line, in 7/8 and 8/9.

Septa 8/9–11/12 moderately thickened, 7/8 and 12/13–13/14 slightly so. Gizzard barrel-shaped, in vi. Intestine begins in xv. No calciferous glands. Nephridia as bushy tufts, one on each side per segment, attached by a narrow base or by a common stem; towards the posterior end one loop gains increased prominence, but no part is attached to the septum. Testes and funnels free in x and xi. Seminal vesicles small, lobed and flattened, in

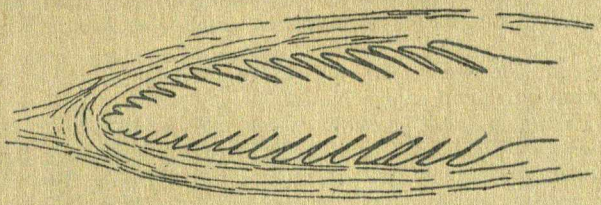

Fig. 93.—*Megascolex filiciseta* Steph.; distal end of a penial seta still in its sheath, with numerous spines, about 16 on each side; × ca. 500.

ix and xii. Prostates small, flattened, and confined to xviii, with lobed margins; duct not visible as a separate structure. Spermathecæ close by side of nerve-cord; ampulla ovoid; a separate duct not distinguishable; diverticulum half as long as main pouch, arises along with the latter from a common base. Penial setæ 1·3 mm. long, 22 $\mu$ thick, shaft bent in a bow, tapering towards distal end, tip slightly recurved; on each side of distal end a row of straight stout teeth arranged like the pinnæ of a fern, the longer teeth 20 $\mu$ long and 5–6 $\mu$ broad, the number of teeth on each side 8–16.

*Remarks.* The prostates and spermathecæ were perhaps not fully developed. The nephridial condition resembles that in *Woodwardia hastata*. Strictly speaking, it is meganephridial throughout, each tufted nephridium being developmentally a branched meganephridium (*cf.* remarks in introduction to the genus *Woodwardia*). The condition in the anterior segments of *M. eunephrus* is here continued throughout the body.

*Distribution.* Parambikulam, Cochin State, S. India.

15. **Megascolex funis** *Mich.*

1897. *Megascolex funis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 210, text-figs. 1, 2.
1900. *Megascolex funis*, Michaelsen, Tier. x, p. 228.
1909. *Megascolex funis*, Michaelsen, Mem. Ind. Mus. i, p. 186, pl. xiii, fig. 24.

Length 255 mm. and probably more; diameter 3–5 mm. Segments 386, triannular in anterior part of body. Colour an indefinite bluish grey (? due to mode of conservation). Prostomium

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small, retractile. First dorsal pore in 12/13. Setæ in general very small, *a* a little larger than the rest, especially in the anterior part of the body; ventral interval in front of clitellum $=3\,ab$, behind clitellum $=12\,ab$ (setæ *a* and *b* closer together behind clitellum than in front); dorsal interval $=3$–$5\,yz$; numbers 56/iii, 63/v, 65/x, 61/xiii, 75/xxvi. Clitellum not distinguished. Male pores on small prominent papillæ, apparently close behind the setal zone, ca. $\frac{1}{5}$ of circumference apart; lateral to each pore are two papillæ, one in front of the other, forming with the papilla of the male pore a triangular area; in addition there may be one pair of papillæ ventrally situated on the anterior part of xix, almost contiguous in the middle line. Spermathecal pores two pairs, in 7/8 and 8/9, about $\frac{1}{8}$ of circumference apart, between the lines of *d* and *e*.

Septum 5/6 very thin, 6/7–13/14 thickened. Gizzard in v. Intestine begins in xvii. No calciferous glands. Last hearts in xiii. Funnels (and probably testes) free, two pairs. Seminal vesicles two pairs, in xi and xii. Prostates with long band-like glandular part, much cut up; duct thin, straight. Spermathecæ with narrow tongue-like ampulla, without distinct duct; club-shaped diverticulum arising from ectal end, three-fourths as long as main pouch, dilated ental portion consists of a large number of small pear-shaped seminal chambers opening into a central channel. Penial setæ 2 mm. long, 50 $\mu$ in maximum thickness, with slightly bowed and bluntly double-pointed distal end (the points not separately visible as a rule, since in the usual position they cover each other) ornamented with numerous finely toothed transverse ridges.

*Remarks.* Not improbably to be united with *M. templetonianus*.
*Distribution.* Kandy, Ceylon (perhaps Peradeniya also).

### 16. **Megascolex hendersoni** *Mich.*

1907. *Megascolex hendersoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 162, text-fig. 10.
1909. *Megascolex hendersoni*, Michaelsen, Mem. Ind. Mus. i, p. 184, pl. xiii, figs. 22, 23, text-fig. 16.

Length 140–230 mm.; maximum diameter 6–8 mm. Segments 110–152. Colour dorsally bluish grey anteriorly, passing into a brownish or reddish grey behind; ventrally yellowish grey. Prostomium tanylobous, tongue rather broad, its sides converging backwards. Segments of anterior part of body triannular. Dorsal pores from 5/6. Setæ fairly large, somewhat larger on anterior part of body than elsewhere, ornamented with irregular toothed transverse ridges; ventral break regular, $=1\frac{1}{2}$–$2\,ab$; dorsal break irregular, $=1$–$2\,yz$; numbers 28/v, 33/viii, 38/xii, 36/xx, 40/xxvi. Clitellum saddle-shaped, xiii–xix (=7), less distinct on xiii and xix; darker in colour than rest of surface, not well-marked otherwise, segments biannulate, setæ present on hinder annulus. Male pores ca. $\frac{1}{10}$ of circumference apart, on small papillæ in line with *b*,

behind the setal zone. Spermathecal pores one pair, in 8/9, ca. $\frac{1}{8}$ of circumference apart, between the lines *b* and *c*. Copulatory papillæ (text-fig. 93 *a*) three pairs, small and transversely oval, situated between the lines *b* and *c*, at the hinder borders of xvii, xviii, and xix, or in the grooves; the first pair smaller than the others, the middle pair united to the porophores; the ventral parts of xvii and xx swollen, glandular, and somewhat overhanging the region between them; the lateral ends of these thickenings connected by a pair of longitudinal walls which run outside the papillæ; the male area between the walls somewhat depressed.

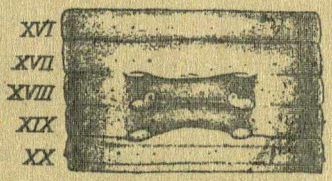


Fig. 93 *a*.—*Megascolex hendersoni* Mich.; male genital field; × 5.



Fig. 93 *b*.—*Megascolex hendersoni* Mich.; spermatheca made transparent by acetic acid; × 8.

Septa 7/8–13/14 (or ? 14/15) thickened, especially 10/11 and 11/12; the rest gradually thinner. Gizzard very large, in front of 6/7. Œsophagus swollen in xii, xiii, and xiv; in xiv the swellings, though not definitely set off from the œsophagus, resemble calciferous glands; the wall of the swellings in all the segments has the lamellated structure of calciferous glands. Intestine begins in xvi; no distinct typhlosole. Last hearts in xiii. Funnels free (?) in x and xi. Vesiculæ seminales two pairs, loosely racemose, in ix and xii, the hinder pair the larger. Prostates confined to xviii, glandular part irregularly disc-shaped or broadly tongue-shaped, much incised; duct rather thick and short, straight, muscular, hardly as long as the glandular part. Egg-sacs (?) in xiv. Spermathecæ with oblong sac-like ampulla; duct abruptly set off, one-third as long and one-third as thick as ampulla; diverticulum indistinctly stalked, with 3–5 oval or rounded seminal chambers, hanging down and pressed against duct, half as long as duct and much thinner (text-fig, 93 *b*). No penial setæ.

*Distribution.* Tiger Shola, near Kodaikanal, Palni Hills, S. India.

### 17. Megascolex horai *Steph.*

1922. *Megascolex horai*, Stephenson, Rec. Ind. Mus. xxiv, p. 432.

Length 110 mm.; diameter 2·5 mm. Segments 188. Colour yellowish grey. Prostomium slightly epilobous (?). Dorsal pores

from 10/11. Setæ in fairly regular longitudinal lines; $aa$=3-4 $ab$ in front of male pores, =$2\frac{1}{2}$-3 $ab$ in middle and hinder parts of body; $zz$=2-3 $yz$ anteriorly, =$1\frac{1}{4}$-$1\frac{1}{2}$ $yz$ behind genital region; numbers 26/v, 27/ix, 32/xii, 32/xix, and 28 in middle of body. No clitellum or genital markings present. Male pores on xvii, on papillæ, about $\frac{1}{5}$ of circumference apart, in line with $b$. Spermathecal pores in 6/7 and 7/8, in or just internal to the line $b$, $\frac{1}{5}$ of circumference apart.

Septa 7/8-13/14 very slightly strengthened; 6/7 and 7/8 attached to body-wall ventrally behind normal position. Gizzard in vi, firm and barrel-shaped. Calciferous glands in x, xi, and xii, stalked. Last heart in xii. Micronephridia in a single transverse row in each segment. Testes and funnels free in ix and x. Seminal vesicles in xi only. Prostates deeply bifid on the outer border; duct bent round sharply at its ectal end. Ovaries in xii. Spermathecæ as small sacs sessile on body-wall, no separate duct; a single diverticulum, narrow and tubular, about as long as ampulla, from junction of sac with body-wall. No penial setæ.

*Remarks.* This species is closely related to an Assamese group of species of *Notoscolex* (*N. oneilli*, *stewarti*, and *striatus*), and has doubtless arisen from some species of this group, independently of the great majority of species of *Megascolex*. The organs in the anterior part of the body are one segment further forwards than usual.

*Distribution.* Cherrapunji, Assam.

18. **Megascolex hortonensis** *Steph.*

1915. *Megascolex hortonensis*, Stephenson, Mem. Ind. Mus. vi, p. 83, pl. viii, figs. 19, 20.

Length 72 mm.; maximum diameter 3 mm. Segments 141. Colour light grey throughout. Prostomium prolobous. Dorsal pores from

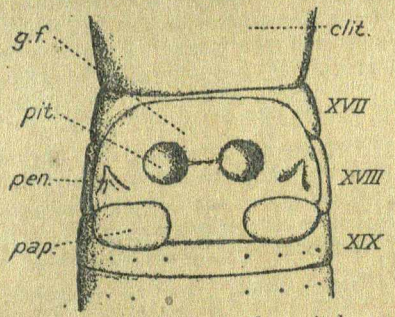


Fig. 94.—*Megascolex hortonensis* Steph.; male genital area; *clit.*, clitellum; *f.*, the surface of the thickened genital field; *pap.*, flat slightly raised papillæ; *pen.*, penis; *pit.*, depression on xviii.

8/9 or in front of this (the single specimen was injured near the anterior end). Setal rings broken dorsally and ventrally, $zz$=2 $yz$, $aa$=2 $ab$; setæ larger in front of viii, and also somewhat enlarged

at hinder end; arranged in fairly regular lines, especially *a*, *b*, and *c*, but not in pairs; $ab = 2\frac{1}{2}\ bc$; numbers 20/iv and v, 22/vii, 22/xii, behind clitellum 24, in hinder part of body 28. Clitellum xiv–xvi (=3), smooth, delimited by a constriction at each end. Male area (text-fig. 94) an almost rectangular thickened patch, taking up ventral surface of xvii, xviii, and $\frac{1}{2}$xix; on this are a pair of conical pointed penis-like projections near the lateral border of xviii, $\frac{1}{3}$ of circumference apart; a pair of circular depressions on the anterior part of xviii, internal to and rather in front of the penes and connected together by a transverse fissure; and a pair of flat oval areas at the postero-lateral corners of the patch, well delimited but not much raised. No setæ on the male area. Female pore single. Spermathecal pores one pair in 8/9, ca. $\frac{1}{3}$ of circumference apart. A thickened area on viii, comprising nearly all the ventral surface of this segment, extending slightly on to ix; this area includes a pair of darker oval patches in the posterior half of viii, the outer border of each in line with the spermathecal pore.

Septa 6/7–13/14 slightly thickened. Gizzard subspherical, in vi. No calciferous glands. Intestine begins in xix. Last heart in xiii. Funnels in x and xi. Seminal vesicles in xi and xii, lobulated, meeting their fellows dorsally. Prostates of moderate size, flattened, and compact, occupying xviii and xvii; duct moderately stout, muscular, almost straight, and of same diameter throughout.



Fig. 95.—*Megascolex hortonensis* Steph.; spermatheca.

Spermathecæ (text-fig. 95) with elongated ovoid ampulla; duct short and relatively wide, a third to a quarter as wide as ampulla; diverticulum finger-like, about as wide as duct, two-fifths as long as main pouch, arising near ectal end of duct. No penial setæ.

*Remarks.* Closely related to *M. kempi* and *quintus*. The chief difference from both is the larger number of setæ; the male field is not at all unlike that of *quintus*; while the absence of calciferous glands is more like *kempi*; the genital area of segment viii is not represented in either *kempi* or *quintus*.

*Distribution.* Horton Plains, Ceylon.

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### 19. Megascolex imperatrix (*A. G. Bourne*).

1894. *Mahbenus imperatrix*, Bourne, Quart. J. Mic. Sci. xxxvi, p. 12, pl. ii, pl. iv, fig. 33, pl. v, figs. 34–41.
1900. *Megascolex imperatrix*, Michaelsen, Tier. x, p. 233.

Length 650 mm.; diameter 11 mm. Segments 200. Colour dark brown. Prostomium epilobous, encroaches very slightly on peristomium. First dorsal pore in 5/6. Setal rings almost closed; numbers 52/ii, 80/v, 110/ix. Clitellum not definitely limited, xiv to part of xx ($=6\frac{1}{n}$); setæ present. Male pores small and close together; in the preserved specimens, though not in the living, on an oval midventral papilla. Female pores paired. Spermathecal pores very small, three pairs, in 6/7, 7/8, and 8/9, very close together. Two pairs of pores of accessory glands, on the hinder part of xvii and in groove 19/20, about in line with *f*.

Gizzard in vii. No calcareous glands; œsophagus dilated segmentally in xi–xiv. Dorsal vessel double in vii and onwards for some distance. Two pairs of testes and funnels, free in x and xi. Seminal vesicles in ix and xii. Prostates with large rounded glandular portion. Spermathecæ sausage-shaped, duct short; small diverticulum embedded in body-wall; first pair of spermathecæ smaller than second, second smaller than third. No penial setæ.

*Remarks.* Bourne used this species in his investigations on the development of the setæ and of the micronephridia.

*Distribution.* Lamb's Rock, Coonoor, in dense forest or jungle, also on the Hulikal Droog opposite, on the other side of the ravine (oral communication from Bourne,—the locality is not stated in the original).

### 20. Megascolex insignis *Mich.*

1910. *Megascolex insignis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 78, pl. fig. 8.
1916. *Megascolex insignis*, Stephenson, Rec. Ind. Mus. xii, p. 329, pl. xxxii, fig. 22.

Length 45–83 mm.; maximum diameter 2–2$\frac{1}{3}$ mm. Segments 115–145. Colour yellowish grey, clitellum light orange yellow. Prostomium epilobous $\frac{2}{3}$, tongue open behind. Dorsal pores from 10/11 (perhaps a vestigial pore in 9/10). Setæ small; setal rings regularly broken ventrally, $aa=2$–$3\,ab$; irregularly broken dorsally; setæ more closely set ventrally; numbers 36/v, 40/viii, 40/xix, 42/xxv (or somewhat smaller numbers may be found). Clitellum xiii or $\frac{1}{2}$xiii–xvii ($=4\frac{1}{2}$–5). Male pores about in line with *b*, ca. $\frac{1}{8}$ of circumference apart, at the lateral limits of a median transverse depression, or in pits which are bounded on their outer sides by semicircular walls. Spermathecal pores two pairs, in 7/8 and 8/9, about in line with *b*, $\frac{1}{8}$ of circumference apart.

Septa 6/7–13/14 thickened, the middle ones most, but none much. Gizzard in v (or ? vi). No calciferous glands. Intestine begins in xiv; no typhlosole. Last heart in xiii. Testes and funnels free in x and xi. Seminal vesicles two pairs, fairly large, compactly racemose, in xi and xii. Prostates small, much incised, lobes fairly loosely arranged; duct moderately thick, a little



Fig. 96.—*Megascolex insignis* Mich.; spermatheca.

shorter than the glandular portion, straight, slightly thinner at the extreme ectal end. Ovisacs or similar structures may be present in xiv. Spermathecæ (text-fig. 96) with sac-like ampulla; duct fairly distinctly set off, length variable, may be quite short or as long as or longer than ampulla; diverticulum from ectal end of duct, narrow but somewhat thicker at its ental end, as long as or rather longer than main pouch. No penial setæ.

*Remarks.* In my specimens the dorsal pores appeared to begin in 5/6 or 6/7; and I found the lobes of the prostate closely pressed together. In one of Michaelsen's specimens the spermathecal diverticulum was forked some distance below its ental end.

The species is related to *M. konkanensis*, and especially to *M. kavalaianus*.

*Distribution.* Trivandrum, Nedumangad, and Kerumaadi in Travancore; Karakulam, Cochin State; Panadhure, Ceylon.

### 21. Megascolex kavalaianus *Steph.*

1915. *Megascolex kavalaianus*, Stephenson, Mem. Ind. Mus. vi, p. 91, pl. ix, fig. 27.

Length 57 mm.; maximum diameter 1½ mm. Segments 94. Colour pinkish grey, anterior end purplish. Prostomium small, epilobous ½. First dorsal pore in 5/6. Setæ often small and difficult to see: $zz=2\,yz$, $aa=4\,ab$ in front of clitellum, 3 *ab* behind, and 3½ *ab* further back; numbers 40/ix, 38/xii, ca. 32/xix, and 28 in middle of body. Clitellum ½xiii–¾xvii (=4¼). Male pores as minute white dots, each in the centre of a circular slightly raised area; the areas, white with a darker centre, take up the greater part of the length of xviii, and touch each other in the middle line; the pores are in the setal zone and in line

with *b*. Female pore single. Spermathecal pores minute, two pairs, in 7/8 and 8/9, near the middle line, about in line with *b*.

No septa noticeably thickened. Gizzard barrel-shaped, in vi. Œsophagus bulged in xv, xvi, and xvii, with transverse vascular striations, and small folds internally. Intestine begins in xix. Last hearts in xiv; these are smaller than those in xiii. Funnels in x and xi. Vesiculæ seminales in xi and xii, racemose, each meeting its fellow dorsally. Prostates confined to xviii, cut up



Fig. 97.—*Megascolex kavalaianus* Steph.; spermatheca.

into lobes which are tightly compacted together; duct straight, muscular, directed transversely inwards, the ental part narrow, the rest stout. Ovisacs or similar structures present in xiv. Spermathecal ampulla flattened ovoid; duct well marked off, moderately wide, about half as long as ampulla; diverticulum a long narrow glistening tube, with dilated ental end, longer than main pouch, given off from ectal end of duct (text-fig. 97). No penial setæ.

*Remarks.* The species was described from a single specimen; it is difficult to know what to do in such cases, when there is no indication of the extent of variability. It may ultimately have to be united with *M. insignis*. The chief difference is in the male field and the hearts (the last in xiv in this form); other details in which the two differ are the œsophageal swellings, the point of commencement of the intestine, and the absence of thickened septa in the present form. The apparent differences in the spermathecæ are perhaps not very important, as this organ is variable in *M. insignis*.

*Distribution.* Kavalai, Cochin State, S. India.

22. **Megascolex kempi** *Steph.*

1915. *Megascolex kempi*, Stephenson, Mem. Ind. Mus. vi, p. 84, pl. viii, fig. 21.

Length 44 mm.; diameter 2 mm. Segments 115. Colour grey, clitellum rather lighter than the rest. Prostomium prolobous. Dorsal surface flattened, slightly grooved in middle and posterior thirds. First dorsal pore in 6/7. Setæ in regular longitudinal

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lines, but not grouped in pairs; ventral setæ larger at ends of body; rings broken dorsally and ventrally, $aa=2\,ab$, $zz=2\,yz$; numbers in front of clitellum 12 (6 on each side), behind 16 per segment. Clitellum xiv–$\frac{1}{3}$xvii ($=3\frac{1}{3}$). Male pores on relatively large conical papillæ, in line with *b*, and rather more than one-fourth of circumference apart. Female pore single. Spermathecal pores inconspicuous, in 8/9, in line with *b*. A genital area on xii, mesial, transversely oval, raised in the form of a large flat papilla, its transverse diameter about twice the longitudinal; limited behind by 12/13, in front extending slightly on to xi, laterally extending as far as the line *b* on each side.

No septa markedly thickened. Gizzard in vi, barrel-shaped, well developed. No calciferous glands. Last heart in xiii. Micronephridia in regular transverse rows behind the clitellum; in front of gizzard as large tufts at the sides of the œsophagus. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, the anterior small, of a few rounded lobules, the posterior

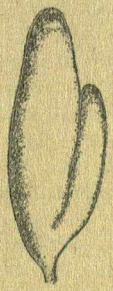

Fig. 98.—*Megascolex kempi* Steph.; spermatheca.

racemose, nearly meeting above the œsophagus. Prostates forming rectangular masses, only slightly incised; duct short, narrow, almost straight, of equal diameter throughout. Spermathecal ampulla much elongated, fusiform; duct very short and narrow; diverticulum finger-shaped, two-thirds to three-quarters as long and half as wide as ampulla, given off from base of ampulla (text-fig. 98). No penial setæ.

*Remarks.* Very closely related to *M. quintus*; the differences are in the genital fields, the presence or absence of calciferous gland-like swellings, and the thickening or absence of thickening of the septa.

*Distribution.* Horton Plains, Ceylon.

### 23. Megascolex konkanensis *Fedarb.*

1898. *Megascolex konkanensis*, Fedarb, J. Bombay Soc. xi, p. 434, pl. ii, figs. 1, 6–8, 10.
1900. *Megascolex konkanensis*, Michaelsen, Tier. x, p. 221.
1910. *Megascolex konkanensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 75, pl. fig. 13.

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1916. *Megascolex konkanensis*, Stephenson, Rec. Ind. Mus. xii, p. 328.
1921. *Megascolex konkanensis*, Stephenson, Rec. Ind. Mus. xxii, p. 759.
1921. *Megascolex konkanensis*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 68.
1922. *Megascolex konkanensis*, Stephenson, Rec. Ind. Mus. xxiv, p. 431.

Extremely long in relation to diameter; a large example 415 mm. long, 2–3 mm. thick, 370 segments; a moderate-sized specimen 165 mm. long, ca. 2 mm. thick, 218 segments. Anterior end blunt, the worms being thickest at segment ii. Colour whitish or yellowish grey. Prostomium epilobous ca. $\frac{1}{3}$, tongue narrow and small. First dorsal pore in 4/5. Setæ fairly small; ventral break distinct and regular, $aa$=ca. $3ab$; dorsal break irregular; towards posterior end there may be no breaks; setæ more closely set ventrally than dorsally in anterior part of body, often arranged in regular longitudinal lines; numbers ca. 35 in anterior part of body, ca. 24 at 200th segment. Clitellum ring-shaped, xiv–xvi or $\frac{1}{2}$xvii (=3–3½). Male pores each in a special area, which when fully developed is oval, with its axis directed forwards and a little inwards, and approaches its fellow towards the middle line; each is depressed, with clean cut margins and a transverse ridge passing across the floor, and occupies xviii, encroaching also on xvii and xix; male pores on the transverse ridge, ca. one-fourth of the circumference apart. Female pores paired. Spermathecal pores two pairs, in 7/8 and 8/9, ca. $\frac{3}{10}$ of the circumference apart, situated ventro-laterally.

Septa 6/7–12/13, thickened, the anterior ones as far as 9/10 fairly strongly, the rest gradually less so. Gizzard large, in vi. No calciferous glands. Intestine begins in xvi. Last heart in xiii. Funnels free in x and xi. Seminal vesicles compactly racemose, the lobules almost spherical, in xi and xii. Prostates with very large glandular part consisting of numerous branched lobules, the end branches long and finger-shaped, the whole being "mop-like"; duct thick, fairly long, muscular, thinner at the ends; no copulatory sacs. Spermathecæ with stalked pear-shaped main pouch, the ectal part being perhaps morphologically part of the ampulla, and the vestigial duct contained in the body-wall; diverticulum given off from main pouch where this joins body-wall, elongated, slightly swollen at ental end, with simple lumen, length about half that of main pouch; in many spermathecæ a spermatophore, filling the narrower part of the ampulla and projecting upwards into the dilated portion. No penial setæ.

*Distribution*. Trivandrum, Shasthancottah, Kulattapuzha, Maddathoray, Kerumaadi, Quilon, Kottayam, all in Travancore; Ernakulam and Chitoor in Cochin; Palghat, Calicut, Tiruvallur and Tirur in Malabar; Mangalore in S. Kanara; Laccadive Is., N. Konkan.

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*a.* var. **longus** *Steph.*

1915. *Megascolex konkanensis*, var. *longus*, Stephenson, Mem. Ind. Mus. vi, p. 97, pl. ix, figs. 34, 35.

Length 345–570 mm.; maximum diameter 3–4 mm. Segments ca. 400–550. Anterior end truncated in appearance; body becomes much narrower (2 mm. only) behind the anterior third. Prostomium proepilobous, with the addition of two short grooves on dorsal surface of segment i. First dorsal pore in 5/6. Dorsal break in setal ring ca. 3 *yz* in front of clitellum, 1½ *yz* behind, and still further back ring is closed; in front of clitellum ventral break = 2 *ab*, behind clitellum = 3–4 *ab*; setæ in front of clitellum mostly very small, ventral setæ of xii–xvii enlarged; in anterior part of body *ab* = 1½ *bc*; numbers 30–33 in front of clitellum, 30 at end of first third of body, 28–30 near hinder end. Male pores probably on a pair of transversely oval papillæ which are joined across the middle line, the whole having the shape of a dumbbell. Female pore single. Spermathecal pores small, in 7/8 and 8/9, in line with *d* or *de*.

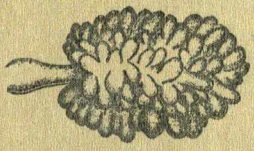

Fig. 99.—*Megascolex konkanensis* Fedarb var. *longus*; prostate.



Fig. 100.—*Megascolex konkanensis* Fedarb var. *longus*; spermatheca.

Gizzard in v. Prostates (text-fig. 99) small, confined to xviii, bushy, composed of many lobules of various shapes from finger-shaped to spherical; duct passes straight inwards, is soft, slightly glistening, thin at first and dilated in its terminal portion. Spermathecal ampulla ovoid; duct half as wide and half as long again as ampulla; diverticulum given off from ectal end of duct, small, club-shaped, half as long as duct or less (text-fig. 100).

*Remarks.* The differences from the type form are the greater length, the conformation of the male field, the single female pore

the smaller size of the prostate, and different shape of spermatheca. If Michaelsen's supposition regarding the true relations of ampulla and duct in the type form are correct (v. ant.), these relations are still further obscured in the present variety.

Though there was no distinguishable clitellum in the specimens, the one dissected appeared to be mature, since copulation had occurred, the spermathecal diverticulum being full of glistening spermatozoa.

*Distribution.* Parambikulam, Cochin State.

### 24. Megascolex leucocyclus (*Schmarda*).

1861. *Perichaeta leucocycla*, Schmarda, Neue wirbell. Thiere, I, pt. ii, p. 13, pl. xviii, fig. 160, text-fig.
1892. *Megascolex cœruleus* (part.), Beddard, Ann. Mag. N. H. (6) ix, p. 122.
1895. *Megascolex cœruleus* (part.), Beddard, Monog., p. 386.
1897. *Megascolex leucocyclus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 215, pl. fig. 4.
1900. *Megascolex leucocyclus*, Michaelsen, Tier. x, p. 233.

Length 240–370 mm.; diameter 10–12 mm. Segments 133–174. Colour bluish grey, with shining white ridge-like setal zones; ventral surface yellowish white. Prostomium epilobous $\frac{2}{5}$. First dorsal pore in 5/6. Setæ more closely set ventrally than dorsally; rings irregularly and shortly broken both dorsally and ventrally, $aa = 2\,ab$, $zz$ anteriorly $= 3$–$4\,yz$; numbers 24/ii, 55/v, 67/xii, 63/xx, 67/xxvi. Clitellum ring-shaped, swollen, xii or xiv–xviii or $\frac{1}{2}$xix ($=5$–$7\frac{1}{2}$). Male pore single, midventral, on a cone-shaped papilla. Female pores paired, close together in front of setæ, not always at the same horizontal level. Spermathecal pores median, in 7/8 and 8/9. A transversely oval copulatory cushion midventrally on the hinder part of xvii, showing sometimes a transverse series of dots, perhaps the openings of glands; rarely a similar cushion on the hinder part of xix.

Septum 8/9 slightly, 9/10–12/13 more strongly thickened. Gizzard in vii, large and barrel-shaped. No calciferous glands. Intestine begins in xv, with large lateral swellings in xxix confined to that segment. Last hearts in xiii. Testes and funnels free in x and xi. Seminal vesicles three pairs, small, sausage-shaped, in xi, xii, and xiii; segments viii–xii occupied by free sperm-masses. Prostates paired, with small glandular portion; duct fairly thick, straight. Spermathecæ unpaired, the ampulla an irregular sac; duct sharply marked off, shorter than ampulla, sausage-shaped; diverticula two, arising from duct, broad, short, hanging down, each with several seminal chambers. Penial setæ 3 mm. long, 50 $\mu$ thick at base, slightly bowed, tapering gradually, distal end bent backwards and hollowed out in spoon fashion, tip slightly bent forwards; ornamentation of numerous thickly set rings of teeth.

*Remarks.* The original description was altogether incomplete, and the worm would have been unrecognizable if the type had not been preserved. Beddard, who was not allowed to dissect Schmarda's material, concluded that the worm was *M. cæruleus*; but Michaelsen on dissection found that this was a mistake.

The worms apparently fragment easily, losing the hinder end. The lateral swellings of the intestine in xxix may be the beginnings of the cæca of *Pheretima*.

*Distribution.* Kandy and Nuwara Eliya, Ceylon.

### 25. Megascolex longiseta *Mich.*

1907. *Megascolex longiseta*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 163.
1909. *Megascolex longiseta*, Michaelsen, Mem. Ind. Mus. i, p. 182, pl. xiii, figs. 20, 21.

Length 180 mm.; diameter 5–6 mm. Segments 240. Colour yellowish or in parts brownish grey. First dorsal pore in 7/8. Setal rings with rather large and regular ventral gap, and rather larger and apparently irregular dorsal gap; in anterior part of body ventral setæ somewhat enlarged and setal intervals greater; numbers in front of clitellum and back to about xxvi, 16;



Fig. 101.—*Megascolex longiseta* Mich.; spermatheca, cleared in acetic acid (ampulla somewhat flattened in preparation); × 12.

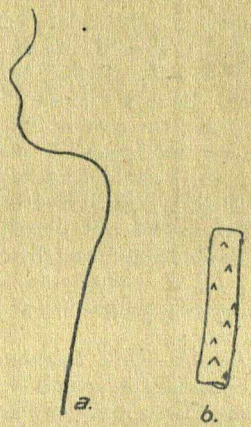


Fig. 102.—*Megascolex longiseta* Mich.; penial seta: *a*, whole seta, × 10; *b*, a part of the shaft, × 250.

thenceforward more numerous, about 40 or even more (?). Male pores ventro-lateral, $\frac{2}{7}$ of circumference apart. Spermathecal pores two pairs, in 7/8 and 8/9, about one-fourth of circumference apart.

Septa 6/7–12/13 rather strong, 13/14 scarcely thickened. Gizzard large, in v. No calciferous glands. Funnels free in x

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and xi. Seminal vesicles in xi and xii, rather small, racemose. Prostates with rather small, rather loose grape-like glandular portion; duct about as long as glandular part, irregularly bent, moderately thick, narrower at ectal end. Spermathecæ (text-fig. 101) with elongated ovoid ampulla; duct not abruptly set off, about half as thick and half as long as ampulla; diverticulum given off from ectal end of duct, club-shaped, about as long as and half as thick as ampulla, with four tube-like undulating seminal chambers in its ental portion, which cause longitudinal protuberances on the surface of the diverticulum. Penial setæ (text-fig. 102) ca. 7 mm. long, very slender, ca. 25 $\mu$ thick at proximal end, 8 $\mu$ at distal end, strongly and irregularly bent; shaft ornamented by small irregularly scattered triangular closely adpressed teeth, tip plain and rather blunt.

*Distribution.* Nuwara Eliya, Ceylon.

26. **Megascolex lorenzi** *Rosa.*

1894. *Megascolex lorenzi*, Rosa, Atti Ac. Torino, xxix, p. 5, pl. fig. 4.
1900. *Megascolex lorenzi*, Michaelsen, Tier. x, p. 230.
1910. *Megascolex lorenzi*, Michaelsen, Abh. Ver. Hamburg, p. 70, pl. fig. 9.

Length 27–60 mm.; diameter 1–2 mm. Segments 121. Colour (in alcohol) white. Prostomium proepilobous. Dorsal pores from 4/5; that of 9/10 very large, that of 8/9 only a little smaller. Setæ set closer dorsally than ventrally; setæ *a* a little larger than the rest in the anterior part of the body, in regular lines; ventral break of moderate size, no dorsal break; number in xii, 50. Clitellum including xiv–xvi and parts of xiii and xvii. Male field a transverse median depression, rectangular with rounded angles, its length that of segment xviii, the lateral margins thickened and bowed inwards; male pores on the lateral slopes of the depression, about between the lines of *b* and *c*. Spermathecal pores two pairs, in 7/8 and 8/9, between the lines *b* and *c*.

Septa 5/6–13/14 thickened, the middle ones of the series most so. Gizzard very small but not vestigial, in v. No calciferous glands. Œsophagus swollen segmentally in viii–xiii. Metandric, funnels free in xi. Seminal vesicles a single pair, much incised, in xii. Prostates may be short or of the length of 4 or 5 segments, tongue-shaped, margin rather lobed; duct straight or slightly sinuous. Spermathecal ampulla sac-like, ovoid; duct not abruptly set off, short, moderately stout; diverticulum shortly stalked, of 2, 3, or 4 seminal chambers bound together in a common mass, about one-third as long as main pouch. No penial setæ.

*Distribution.* Kandy and Peradeniya, Ceylon.

27. **Megascolex mauritii** (*Kinb.*).

1883. *Perichæta armata*, Beddard, Ann. Mag. N. H. (5) xii, p. 216, pl. viii, figs. 5–7.
1886. *Perichæta bivaginata*+*P. salettensis*, Bourne, P. Z. S. 1886, pp. 666, 669.
1888. *Megascolex armatus*, Rosa, Ann. Mus. Genova, (2*a*) vi, p. 159.
1895. *Megascolex armatus*, Beddard, Monog. p. 384.
1897. *Megascolex armatus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 5.
1898. *Megascolex armatus*, Michaelsen, Zool. Jahrb. Syst. xii, p. 144.
1900. *Megascolex mauritii*, Michaelsen, Tier. x, p. 227.
1903. *Megascolex mauritii*, Beddard, Fauna Laccad. Archip. p. 375.
1909. *Lampito mauritii*, Michaelsen, Mem. Ind. Mus. i, p. 179.
1910. *Lampito mauritii*, Michaelsen, Abh. Ver. Hamburg, xix, p. 62.
1911. *Lampito mauritii*, Cognetti, Ann. Mag. N. H. (8) vii, p. 498.
1913. *Lampito mauritii*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 79.
1914. *Lampito mauritii*, Stephenson, Rec. Ind. Mus. x, p. 340.
1915. *Lampito mauritii*, Stephenson, Mem. Ind. Mus. vi, p. 75.
1916. *Lampito mauritii*, Stephenson, Rec. Ind. Mus. xii, p. 315.
1916. *Lampito mauritii*, Prashad, J. Bombay Soc. xxiv, p. 504, pl. i, figs. 6, 15, pl. ii, fig. 8.
1917. *Lampito mauritii*, Stephenson, Rec. Ind. Mus. xiii, p. 385.
1920. *Lampito mauritii*, Stephenson, Mem. Ind. Mus. vii, p. 222.
1921. *Megascolex mauritii*, Stephenson, Rec. Ind. Mus. xxii, p. 759.
1922. *Megascolex mauritii*, Stephenson, Rec. Ind. Mus. xxiv, p. 432.

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1916. *Megascolex mauritii*, Michaelsen, Mjöberg's Austral. Exp. p. 52.

Length 80–210 mm.; diameter $3\frac{1}{2}$–5 mm. Segments 166–190. Colour dark yellow with purplish tinge at anterior end. Prostomium prolobous or epilobous $\frac{1}{2}$. Segments v and vi biannulate, the rest of those in front of the clitellum triannulate. First dorsal pore 10/11 or 11/12. Setal rings interrupted ventrally, $aa = 1\frac{1}{2}$–$2\frac{1}{2}$ $ab$; dorsal break absent or extremely small; setal intervals decrease from the ventral end; seta $a$ is enlarged, especially in the anterior part of the body, and ornamented; numbers 38/vi, 44/x, 34/xxi, and 33 in the middle of the body. Clitellum xiv–xvii (=4), ring-shaped. Male pores on large round papillæ, ca. one-fourth of circumference apart, which take up the whole length of the segment and press aside the furrows in front and behind; no setæ between the pores. Female pores double, but very near each other, anteriorly on xiv. Spermathecal pores three pairs, in 6/7, 7/8 and 8/9, in line with seta $h$.

Septa 7/8–12/13 thickened. Gizzard in v (? vi). No calciferous glands. Last heart in xiii. Meganephridia accompany the

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micronephridia from about xx onwards. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, irregularly cut up into small lobes. Prostates much lobulated, occupying xviii and xix. Spermathecæ with elongated ampulla, constricted in the middle, and narrowing towards the external opening; duct not distinctly marked off; two diverticula, club-shaped, opposite each other, one-third as long as ampulla. Penial setæ 1½–2 mm. long, with a single curve, tip horseshoe-shaped with semicircular concavity, flattened; numerous rings of large slender spines standing off somewhat from the shaft.

*Distribution.* Very widely distributed; has been recorded from all parts of India, except apparently the United Provinces. Lahore and Kapurthala, in the Punjab; Calcutta, Raniganj, Bhogaon, Rajshahi, Saraghat, Betracona, and Siliguri, in Bengal; Sur Lake, Orissa; Bombay, Broach, Surat, Ahmedabad, Nadiad, Sirvai Madhopur, Dhanu, Baroda, Palchar, Joshachivir, and Godhra, in the Bombay Presidency; Portuguese India; Nemar Kheri, Katni, Gwalior, and Jubbulpore, in Central India and Central Provinces; Dungarpura and Banswara, in S. Rajputana; Hyderabad, in the Deccan; Madras, Salem, Ennur, Pondicherry, Ramnad, Cochin State, and Travancore State, in S. India; Dowlaishweram, Godaveri Dist., on the E. Coast; Mandalay, in Burma; from many places in Ceylon; from the Andaman Islands, the Maldives, and Laccadives.

Outside India it has spread in the region of the Indian Ocean, in the Malay Archipelago, and in S. and S.E. Asia generally. Its original home cannot be determined.

*a.* var. **zeylanicus** (*Steph.*).

1913. *Lampito mauritii,* var. *zeylanica,* Stephenson, Spol. Zeyl. viii, p. 262.

Length 100 mm.; diameter 3½ mm. Segments 147. Colour grey. Prostomium prolobous. Dorsal pores from 12/13. Male pores in large round sucker-like depressions with raised and swollen margins, one-fourth of the circumference apart. Female pore median. The breaks in the setal rings are more marked than in the type form; ventrally $aa=3ab$ in front of and $3\frac{1}{2}\ ab$ behind the clitellum; dorsally $zz=2–2\frac{1}{2}\ yz$.

Septa 6/7–13/14 thickened, 8/9–12/13 most. Gizzard in vi. Œsophagus bulged in xi and xii, but no calciferous glands. Intestine begins in xv. Prostates comparatively small; duct thick and S-shaped. Accessory prostates near the main glands, one on each side, situated either in front of or behind the main gland, each with a short stalk, and of the same texture as the prostate. Spermathecal ampulla fusiform, no distinctly separate duct; diverticula one or two, minute, club-shaped, from an eighth to a quarter as long as the ampulla. Penial setæ 0·83 mm. long, 22–27 $\mu$ thick, resembling those of the type form.

*Distribution.* Anuradhapura, Ceylon.

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### 28. **Megascolex multispinus** *Mich.*

1897. *Megascolex multispinus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 221, pl. fig. 27.
1900. *Megascolex multispinus*, Michaelsen, Tier. x, p. 231.

Length 150–195 mm.; maximum diameter 5½–7 mm. Segments 115–145, not definitely multiannular. Prostomium prolobous. Colour an equable bluish grey (? caused by method of preservation). First dorsal pore in 5/6. Setæ all very small; rings only broken ventrally for a short distance, $aa=2$–$3ab$; setæ more closely set on each side of the midventral line; numbers 58/ii, 84/v, 82/x, 81/xiii, 72/xx, 68/xxvi, 72/xxxvii. Clitellum saddle-shaped, ¾xiv–½xviii (=4¼). Male pores on prominent papillæ, one-third of circumference apart, no setæ between them. Three pairs copulatory pits, small, deep, transverse in direction, on 16/17, 17/18, and 19/20 (some may be absent), slightly internal to line of male pores; may be everted and appear as papillæ. Female pores paired. Spermathecal pores one pair, in 7/8, one-third of circumference apart.

Septum 5/6 thin, 7/8–13/14 thickened. Gizzard in v and vi, 5/6 attached to its middle. No calciferous glands. Intestine begins in xv or xvi. Last hearts in xiii. Two pairs funnels, enclosed in testis sacs, in x and xi; those in x rather larger. Two pairs seminal vesicles, simple in form, in ix and xii. Prostates with medium-sized glandular portion; duct thin, almost straight. Spermathecal ampulla large; duct thick, uneven, with numerous seminal chambers in its wall. No penial setæ.

*Distribution.* Ceylon (probably Peradeniya).

### 29. **Megascolex nureliyensis** *Mich.*

1897. *Megascolex nureliyensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 232, pl. figs. 12, 13.
1900. *Megascolex nureliyensis*, Michaelsen, Tier. x, p. 229.
1915. *Megascolex nureliyensis*, Stephenson, Mem. Ind. Mus. vi, p. 75.

Length 133–155 mm.: maximum diameter 6½–7 mm. Segments 109–127, triannular owing to elevation of setal ridges. Almost colourless (sublimate preservation). Prostomium epilobous ⅓. First dorsal pore 5/6. Setal rings with irregular dorsal break, $zz=1\frac{1}{2}$–$3yz$: ventrally in front of clitellum $aa$=up to $1\frac{1}{2}ab$, behind clitellum=2–$3ab$; in the most anterior segments the first few intersetal intervals decrease on passing outwards from the middle line both dorsally and ventrally, while ventrally the setæ themselves also become smaller on passing outwards; other specimens show an enlargement of the ventral setæ in segments iii or iv to viii or ix, while those of x may be markedly small; numbers 29/v, 34/x, 38/xix, 52/xxvi. Clitellum indefinite, may be absent in fully mature individuals, about xiii–xvii (=5); marked only by a more pronounced purple colour on the dorsal

surface. Male pores about in line with *f*, $\frac{1}{3}$ of circumference apart, surrounded by broad ring-shaped walls which fuse midventrally. Female pores paired. Spermathecal pores one pair, in 8/9, about in line with *g*, $\frac{2}{5}$ of circumference apart.

Septa 8/9–13/14 thickened, especially 9/10–10/11. Gizzard firm and barrel-shaped, in vi (or vii?). No calciferous glands; œsophagus dilated and inner surface of wall lamellated in xii, swollen and probably similar internally in xiii. Intestine begins in xv. Last hearts in xiii. Testes and funnels in testis sacs of characteristic form; a thin membrane extends from the anterior to the posterior wall of each of these segments, enclosing alimentary canal and hearts, as well as testes and funnels. Seminal vesicles varying in number; four pairs, in xi–xiv, those in xi contained within the testis sac, those in xii the largest; or there may be one pair only, in xii; each vesicle is pear-shaped, the lower end being the broader, the surface mammillated all over, or mammillated over the upper and smooth over the lower portion. Prostates with long band-shaped glandular portion, much lobulated, extending backwards on intestine to xxiii or xxv; duct short, stout, irregularly bent, passing outwards and backwards from antero-external end of gland. No accessory prostate glands. Spermathecal ampulla very irregular in shape; duct variable in length, as long as ampulla or much shorter, shining, stout, broader towards ectal end; diverticulum given off near ectal end of duct, club-shaped, varying in size,—as thick as or thicker than duct, as long as or not so long as ampulla; two accessory diverticula from near base of the primary, stalked, each with two or three seminal chambers. Penial setæ 1·6–2·5 mm. long, 45–57 $\mu$ thick at middle of length, bowed, more so at distal end; tip tapering and bluntly pointed; the distal more curved portion ornamented by numerous small zigzag lines, which, however, leave the extreme end free for a little distance.

*Remarks.* This species is near *M. cingulatus*.
*Distribution.* Nuwara Eliya, Horton Plains, both in Ceylon.

30. **Megascolex pattipolensis** *Steph.*

1913. *Megascolex pattipolensis*, Stephenson, Spol. Zeyl. viii, p. 265, pl. ii, fig. 8.

Length 50 mm.; diameter 2½ mm. Segments 129. Prostomium combined pro- and epilobous $\frac{1}{3}$. First dorsal pore 5/6. Setæ *a* and *b* in regular longitudinal lines; ventral break=2–2½*ab*, dorsal break decreasing backwards, =3*yz* anteriorly, 2*yz* at xiii, 1½*yz* behind middle third, and is absent at hinder end; numbers 20/xiii, 20 in middle of body, and 24 at junction of middle and posterior thirds. Clitellum? Male pores in the line of *b*, $\frac{1}{3}$ of circumference apart, on papillæ which are connected by a transverse ridge. Spermathecal pores in 8/9, in line with *b*. Genital papillæ (text-fig. 103) two pairs, in 17/18 and on xix; the

posterior pair transversely oval, with their centre in the line of *b*, abutting on 18/19 in front but not reaching the hinder border of the segment; the anterior pair smaller, also transversely elongated, bordering the anterior edge of the male papillæ.

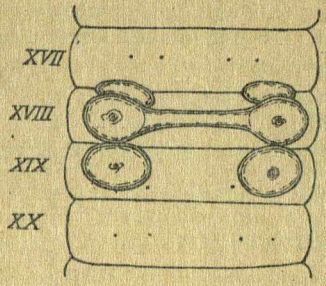


Fig. 103.—*Megascolex pattipolensis* Steph.; male genital area.

Septa 7/8 and 8/9 moderately and 9/10 and 10/11 considerably strengthened. Gizzard large, in vi. Calciferous glands (? only lateral swellings of the œsophagus) in xv and xvi. Male funnels free in x and xi. Seminal vesicles in xi and xii, lobulated, surrounding alimentary canal. Prostates of moderate size, simple rounded masses, not lobulated, with stout ducts, the whole resembling a mushroom. Spermathecæ one pair, fusiform, with short thick duct; diverticulum finger-shaped, as long as ampulla, attached to duct at its ental end. No penial setæ.

*Distribution.* Pattipola, Ceylon.

### 31. Megascolex pharetratus *Rosa.*

1894. *Megascolex pharetratus*, Rosa, Atti Ac. Torino, xxix, p. 3, pl. figs. 1–3.
1900. *Megascolex pharetratus*, Michaelsen, Tier. x, p. 231.

Length 50 mm.; maximum diameter 3 mm. Segments ca. 150. Colour in alcohol white. Prostomium epilobous. First dorsal pore in 6/7. Setal break regular ventrally, and very large; dorsal break irregular; setal intervals decrease outwards from the middle line at first, both on the dorsal and ventral sides; numbers 18/xii, 30–40 behind the clitellum. Clitellum xiv–xvii or xviii (=4 or 5). Male pores in line with *b*, on small papillæ. Female pore single. Spermathecal pores one pair, in 8/9, in line with *b*. A pair of large transversely oval papillæ on x, extending between *a* and *b*; a single papilla on 12/13, the largest of all; another, also unpaired, on 15/16; in addition 11 others, much smaller, some paired, others unpaired, on xvii, xviii, and xix, as well as on grooves 17/18 and 18/19; amongst these small papillæ winds on each side a glandular line, which fuses with the one on the other side in the middle line of xix.

Septa of the anterior part of the body as far as 9/10 much

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thickened. Gizzard elongated. Prostates much lobulated; duct of moderate thickness. Spermathecal ampulla pear-shaped; duct not set off; diverticulum tubular, somewhat contorted, a little shorter than ampulla and duct combined. Penial setæ a little more than 1 mm. long, bowed, with a narrow and pointed smooth distal end, proximal to which are two longitudinal rows of coarse, blunt, slightly projecting teeth.

*Remarks.* The ventral setal break is said to be $\frac{6}{10}$ of the circumference, which of course is a mistake, perhaps for $\frac{1}{10}$; the figure does not seem to show an extraordinarily large interval.

*Distribution.* Kandy, Ceylon.

32. **Megascolex pheretima** *Mich.*

1921. *Megascolex pheretima*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 66, text-fig. 8 *d*.

Length 65 mm.; diameter 2–3·5 mm. Segments 85. Colour dorsally reddish or brownish grey; setæ on pale circular ridges. Prostomium epilobous ca. $\frac{2}{5}$; tongue open behind, but bounded in front by a transverse furrow (combined pro- and epilobous). Dorsal pores from 5/6 (?4/5). Setæ set rather wider apart dorsally; $aa$=4–5 $ab$, $zz$=ca. 3–4 $yz$; numbers 52/xii, 49/xix. Clitellum ring-shaped, $\frac{1}{2}$ xiii–xvii (= $4\frac{1}{2}$). Male pores on slightly raised rather indefinitely limited porophores, in or perhaps slightly in front of the setal zone, ca. $\frac{1}{10}$ of circumference apart. Spermathecal pores two pairs, near each other ($\frac{2}{3}$ mm. apart), in 7/8 and 8/9.

Septa 6/7–14/15 thickened, those of the testis segments strongly so. Gizzard very large, cylindrical, in vi. Œsophagus swollen segmentally in vii–xiii, the walls with lamellæ projecting internally in xi–xiii. No typhlosole (in anterior part of intestine). Micronephridia diffuse; in many places larger tufts present. Funnels free in x and xi. Seminal vesicles reniform, racemose, in xi and xii. Prostates confined to xviii; duct thin, straight, of equable thickness throughout. Spermathecal ampulla elongated, wider towards its ental end; duct fairly well marked off, much thinner than but almost as long as ampulla; diverticulum single, club-shaped, small, given off from ectal end of duct, two-thirds as long as duct. No penial setæ.

*Distribution.* Manakoti, Coorg.

33. **Megascolex polytheca** *Steph.*

1915. *Megascolex polytheca*, Stephenson, Mem. Ind. Mus. vi, p. 89, pl. viii, fig. 25.

Length 160–250 mm.; maximum diameter $3\frac{1}{2}$ mm. Segments 264 or more. Colour a uniform grey, except at anterior end, which is darker with a purplish tinge. Body stout and cylindrical as far as xi; anterior half behind genital segments is flattened, with a dorsal groove. Prostomium proepilobous or

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epilobous ½, tongue open behind. Dorsal pores from 4/5. Setal rings almost closed dorsally (may be quite closed behind clitellum); ventral break anteriorly=3*ab*, behind male pores 4 *ab*, and further back may be as much as 5 *ab*; setæ of v–ix set on raised rings, giving a triannulate appearance to the segments; *ab* greater than *bc*; *a* and *b* are in regular longitudinal lines, and are larger than the other setæ; *c*, *d*, and *e* may also be in regular lines behind the genital region; setæ of preclitellar region smaller and more numerous than those behind; numbers 54/ix, ca. 46/xix, and 46–48 further back. Clitellum ? Male pores in line with *bc*, on circular white papillæ which take up nearly the whole length of the segment. Spermathecal pores numerous, in 7/8 and 8/9, appearing as a row of white points on each side, 6 to 9 in number, extending outwards from between *b* and *c*, the intervals between successive apertures rather greater than the intersetal intervals.

Septa 7/8–11/12 considerably thickened, 7/8–9/10 most of all; those in front and behind slightly thickened. Gizzard barrel-shaped, in v. No calciferous glands, but the œsophagus is dilated, with large transverse vascular striations. in xii–xiv. Intestine begins in xix. Funnels free in x and xi. Seminal vesicles racemose, in xi and xii. Prostates composed of small

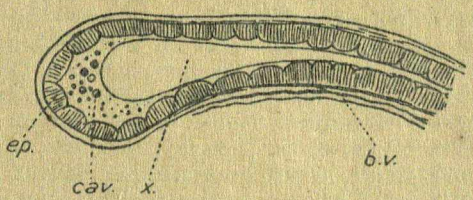


Fig. 104.—*Megascolex polytheca* Steph.; spermatheca, after clearing; *b.v.*, blood-vessel running along its side; *cav.*, portion of its cavity containing only granular matter; *ep.*, epithelial lining; *x*, transparent mass, filling greater part of cavity; × 90.

lobes closely compacted together, confined to xviii, but causing a bulging forwards and backwards of the septa; duct short, shining, and stout, widened near its termination. Spermathecæ (text-fig. 104) small and numerous, disposed in a row on each side of the segment (viii and ix), each a club-shaped organ, with a long stalk, the ental end dilated; length of each up to 1 mm., breadth at the wider end ca. 0·2 mm. No penial setæ.

*Distribution.* Kavalai, Cochin State.

*a.* var. **zonatus** *Steph.*

1915. *Megascolex polytheca*, var. *zonatus*, Stephenson, Mem. Ind. Mus. vi, p. 90, pl. ix, fig. 26.

Length 110 mm.; diameter 2¾ mm. Segments 145. Colour a medium grey, with darker middorsal groove over the greater part

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of the length; clitellum browner. Prostomium epilobous $\frac{1}{2}$, the sides of the tongue converging behind, but the hinder end open. No appearance of secondary annulation in the anterior segments. Dorsal pores from 5/6. Dorsal setal gap diminishing backwards, from $2\frac{1}{2}$ *yz* in front to complete absence at the hinder end; ventral gap $2\frac{1}{2}$–3 *ab* in front of clitellum, $3\frac{1}{2}$ *ab* behind this;



Fig. 105.—*Megascolex polytheca* Steph. var. *zonatus*; spermatheca.

setæ of pregenital region on the whole smaller than the rest; *a* and *b* not larger than the others, *ab* not regularly greater than *bc*, and *a* and *b* not in regular lines; numbers 45/ix, 45/xiii, 39/xix, 35 and 38 further back. Clitellum well delimited, from xiv to nearly hinder end of xvii (=nearly 4). Male pores on small whitish papillæ in line with *b*; the surface depressed between the pores. Female pore single. Spermathecal pores 4–6 on each side in each groove, beginning from the line *b* or interval *ab*; intervals between successive pores about equal to the intersetal intervals.

Prostatic duct somewhat wavy, notably broader at the ectal end. Spermathecæ 4–6 on each side in each row; ampulla and duct distinguishable, ampulla ovoid, duct cylindrical, rather longer than and about half as wide as ampulla; usually a diverticulum from the terminal portion of the duct, slightly club-shaped, from half as long to nearly as long as duct, glistening, with simple cavity.

*Distribution.* Parambikulam, Cochin State.

### 34. **Megascolex pumilio** *Steph.*

1916. *Megascolex pumilio*, Stephenson, Rec. Ind. Mus. xii, p. 333.

Length 54 mm.; maximum diameter $1\frac{1}{3}$ mm. Segments 109. Colour an equable grey, clitellum a marked reddish brown. Prostomium epilobous $\frac{1}{3}$, tongue not cut off behind. Dorsal pores from 5/6. Setæ throughout the greater part of the body 12 per segment, in front of clitellum as three pairs on each side; near the hinder end 16, 17, or 18 per segment, irregularly arranged

dorsal interval considerable, $=4\,yz$ in front of clitellum, $3\,yz$ behind. Clitellum xiv-xvi (= 3). Male pores faintly indicated in or just outside the line of *b*. The ventral surface of xviii shows a transversely elongated thickened patch extending from outside the line *b* on one side to a corresponding point on the other. Female pore single. Spermathecal pores in 7/8 and 8/9, in line with *b*.

Septa 7/8–9/10 considerably thickened, 6/7 somewhat so, 10/11–14/15 becoming progressively thinner. Gizzard in v. No calciferous glands. Intestine begins in xv. Testes and funnels free in x and xi. Seminal vesicles in ix and xii. Prostates extending from xviii to xxi, most bulky in xviii and xix, thinner and dorsally situated in xx and xxi; duct relatively stout and sharply curved. Spermathecæ with relatively large ovoid ampulla; duct not sharply demarcated, as long as and nearly half as thick as ampulla, slightly curved; diverticulum club-shaped, arising from ental end of duct, as long as and half as wide as ampulla.

*Remarks.* Penial setæ are not mentioned in the original.
*Distribution.* Trivandrum, S. India.

### 35. **Megascolex quintus** *Steph.*

1913. *Megascolex quintus*, Stephenson, Spol. Zeyl. viii, p. 268, pl. ii, figs. 11, 12.

Length 37 mm.; diameter 2·5 mm. Segments 139. Colour light grey. Prostomium epilobous $\frac{1}{2}$. Dorsal pores from 6/7. Setal ring interrupted irregularly dorsally, regularly ventrally; $aa=3\,ab$; setæ 12 per segment in front of clitellum, usually 16 behind; *a* to *f* form a series of regular longitudinal lines, the

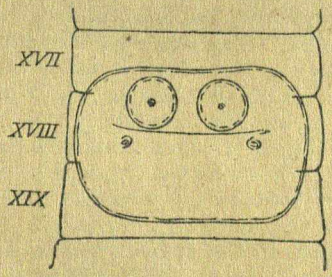


Fig. 106.—*Megascolex quintus* Steph.; male genital area.

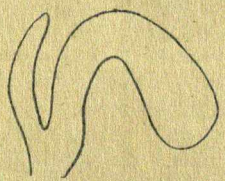

Fig. 107.—*Megascolex quintus* Steph.; spermatheca.

remainder, when there are more, being irregular; $ab=bc$ and *de*, but these are rather greater than *cd* and *ef*, *i.e.*, there is an indication of pairing; setæ of segments ii–vi enlarged, especially *a* and *b*. Clitellum ? Male pores in line with *b*, on very small papillæ. Spermathecal pores inconspicuous, a single pair, in 8/9, just external to the line of *b*. A male genital area (text-fig. 106)

embraces xviii, half of xvii, and two-thirds of xix; it includes the whole of the ventral surface, is slightly raised, and carries a pair of flat circular patches, each with a dark dot in the middle, situated in front of and internal to the male pores over the position of 17/18 (this groove being obliterated ventrally).

Septa 8/9–13/14 considerably, 7/8 and 14/15–17/18 moderately thickened. Gizzard in vi. Calciferous glands as dilatations of the œsophagus in xv and xvi, very vascular, with lamellated walls internally. Intestine begins in xviii. Testes and funnels free in x and xi. Seminal vesicles racemose, in xi and xii. Prostates small, confined to xviii; duct thick, and straight except for a bend at its ental end. Spermathecal ampulla elongated, somewhat dilated at its ental end; duct not marked off, simply the prolongation of the narrower end of the ampulla; diverticulum finger-shaped, $\frac{2}{3}$ as long as the main pouch or more, arising near the junction of the latter with the body-wall (text-fig. 107). No penial setæ.

*Remarks.* The formulæ for the intersetal distances are misprinted in the original paper. The calciferous glands are more probably gland-like swellings of the œsophagus; it is not implied that they are set off from the œsophagus at all.

*Distribution.* Pattipola, Ceylon.

### 36. **Megascolex ratus** *Cogn.*

1911. *Megascolex ratus*, Cognetti, Ann. Mag. N. H. (8) vii, p. 500, pl. xiii, figs. 8–10.
1913. *Megascolex ratus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 87.
1916. *Megascolex ratus*, Stephenson, Rec. Ind. Mus. xii, p. 327.

Length 230–315 mm.; maximum diameter 7–10 mm. Segments 162–218. Colour dorsally violet-brown or dark violet, ventrally grey. Prostomium tanylobous, epilobous $\frac{1}{2}$, or proepilobous. Segments x–xiii biannular. Setæ closer set ventrally than dorsally; in front of clitellum no dorsal break, or dorsal break irregular, while ventral break $=2\,ab$; behind clitellum $aa=2$–$4\,ab$, $zz=2$–$4\,yz$; numbers about 180 in x, about 135 in middle of body. Clitellum saddle-shaped, xiv–xviii. Male pores each on a whitish tubercle, which is supported on a swollen papilla, in line with *h*; setæ absent between the pores. Female pores paired. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *f*. Paired papillæ, all close to the midventral line, on 16/17, 19/20, 20/21, and 21/22, sometimes on 14/15, 15/16, and 22/23 in addition: those on 16/17 may be larger than the rest, and those on 21/22, or 20/21 and 21/22, may be absent.

Septa 7/8–12/13 much thickened. Gizzard in v (or vi?). Intestine begins in xiv. Testes and funnels in x and xi, in large and lobulated sacs, which fuse dorsally to the œsophagus. Seminal vesicles finger-shaped, smaller than the testis sacs, in ix and xii. Prostates occupy xix–xxii, lobed at the margins; duct strong, cylindrical, passing first forwards and then inwards. Spermathecal

ampulla transversely striped, more or less ovoid, but wider towards the ectal end; duct abruptly marked off, about one-third as broad and long as ampulla; diverticulum enclosed in duct-wall, but projects on its surface, small, with 4–7 oval seminal chambers, opening into ental end of duct. No penial setæ.

*Distribution.* Coorloon, Chimungi, and Trivandrum, in S. India.

### 37. **Megascolex sarasinorum** *Mich.*

1897. *Megascolex sarasinorum*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 224, pl. fig. 5.
1900. *Megascolex sarasinorum*, Michaelsen, Tier. x, p. 231.
1910. *Megascolex sarasinorum*, Michaelsen, Abh. Ver. Hamburg, xix, p. 83.

Length 140–190 mm.; diameter 5½–7 mm. Segments 136–148. Colour? (destroyed by preservative). Prostomium prolobous. Segments triannular in consequence of setal zone forming a circular ridge. First dorsal pore in 5/6. Setæ more closely set dorsally in anterior part of body; setal rings almost closed; numbers 85/v, 94/x, 84/xix, 70/xxvi. Clitellum much swollen, saddle-shaped, xiv or ½xiv–⅓ or ⅔ xviii (= ca., 4 or more); if clitellum includes whole of xiv the cushion which bears the female pores joins its two sides, so that it appears ring-shaped on the anterior part of xiv. Male pores ventrally situated, on the mesial sides of prominent broad papillæ. Female pores paired, on a transversely elongated cushion. Spermathecal pores one pair, in 7/8. Sucker-like copulatory cushions, transversely oval, paired, in 9/10, 17/18, and 19/20; there may be others in 16/17 and 20/21; those in front of the male pores the largest.

Septum 6/7 very thin, 7/8–13/14 thickened, gradually more so towards the middle of the series. Gizzard in vi. No calciferous glands. Intestine begins in xvi. Last hearts in xiii. Two pairs of testes and funnels in x and xi, enclosed in testis sacs. Two pairs seminal vesicles, large, compressed racemose, in ix and xii. Prostates compressed racemose; duct S-shaped, muscular. Spermathecal ampulla flatly ovoid, or in younger specimens tongue-shaped; with broad scale-like bulging,—an evagination of the cavity of the ampulla at its ectal end; duct as broad as long, narrower than ampulla; diverticulum in angle between ampulla and duct, small, globular, containing a few seminal chambers; also in wall of duct are numerous small canals, widened to form small seminal chambers at their blind ends.

*Remarks.* The similarity of this form to *M. multispinus* is so great that I should have considered it a variety only, if Michaelsen had not described them both in the same paper, and presumably, therefore, had them under his observation about the same time, with an opportunity of comparing them.

*Distribution.* Trincomali, N. of Dambulla and Trincomali, Kaniya near Trincomali, Mahavali Ganga,—all in Ceylon.

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38. **Megascolex schmardæ** *Mich.*

1897. *Megascolex schmardæ*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 208, pl. figs. 30, 31.
1900. *Megascolex schmardæ*, Michaelsen, Tier. x, p. 226.

Length ca. 60 mm.; diameter 3–3½ mm. Segments ca. 190. Colour grey to yellowish-grey. Prostomium? Dorsal pores present in front of clitellar region. Setæ *a* enlarged, *b* less so, *c* less so again, etc.; $aa = 2$–$2\frac{1}{2}\ ab$, $ab = 2\ bc$, *bc* greater than *cd*, *cd* greater than *de*, *de* greater than or equal to *ef*, thenceforward spaces equal; dorsally the ring irregularly broken; lines *a*, *b*, and *c* regular, the rest more or less irregular. Clitellum? (not developed). Male pores in the line of *b*, on transverse papillæ which extend between *a* and *d*. Spermathecal pores two pairs, in 7/8 and 8/9, between the lines of *b* and *c*. Three copulatory papillæ, transversely elongated, taking up the space between setæ *a*, longitudinally of the length of a segment, on x, xvii, and xix, midventral.

Septa 7/8–12/13 thickened. Gizzard in front of 7/8. Intestine begins in xv or xvi. Two pairs racemose seminal vesicles in xi and xii. Prostates racemose; duct narrow, straight. Spermathecal ampulla irregularly pear-shaped, often kinked; duct short, narrow, not sharply marked off; diverticulum slenderly club-shaped, about as long as ampulla, opening into duct. Penial setæ 1·2 mm. long, maximum diameter 16 $\mu$, distally scarcely narrowed, distal fourth bent at an angle, tip flattened and hollowed, without ornamentation, the lateral margins of the flattening thickened.

*Remarks.* Described from a single specimen of Schmarda's collection, preserved along with the type of *M. brachycyclus*. The specimen was mutilated, and without clitellum; the segment which contained the gizzard was not exactly determined.

*Distribution.* Ratnapura, at the foot of Adam's Peak, Ceylon.

39. **Megascolex sextus** *Steph.*

1913. *Megascolex sextus*, Stephenson, Spol. Zeyl. viii, p. 270, pl. ii, figs. 13, 14.
1915. *Megascolex sextus*, Stephenson, Mem. Ind. Mus. vi, p. 88, pl. viii, fig. 24.

Length 100 mm.; diameter 2 mm. Segments 114. Colour brown dorsally, setæ implanted on whitish rings; light grey ventrally. Prostomium epilobous ⅔, tongue faintly cut off behind. Dorsal pores in anterior part of body in front of the grooves, the first on the posterior part of segment v. Setal rings almost closed dorsally, ventrally $aa = 2\ ab$, or often $2\frac{1}{2}\ ab$ in front of clitellum; intersetal intervals approximately the same in all parts of the ring; numbers 36/v, 40/ix, 36/xv, 50/xix, and 50 posteriorly. Clitellum ½xiv–xvi (=$2\frac{1}{2}$), not marked. Male pores on papillæ one-fourth of circumference apart, no setæ between the pores. Spermathecal pores in 6/7 and 7/8, nearly half the circumference apart. Genital

papillæ two pairs; one in 9/10, transversely oval with eye-like markings in the centre, a little more than $\frac{1}{5}$ of circumference apart; the other pair in 17/18, as small whitish elevations slightly

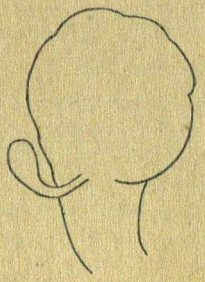

Fig. 108.—*Megascolex sextus* Steph.; spermatheca.

internal to the line of the male pores; sometimes an additional pair, in 18/19, almost circular, eye-like, in line with the male pores.

Septa 9/10–13/14 may be slightly thickened. Gizzard in vii. Intestine begins in xiv or xv. Micronephridia in two rows in each segment, one in front of and the other behind the setal zone. Testes and funnels in x and xi, enclosed in testis sacs which approach, or actually fuse with, each other above the œsophagus. Seminal vesicles in xi and xii, comparatively small, not lobulated. Prostates occupy xviii–xxi, lobulated; duct stout,

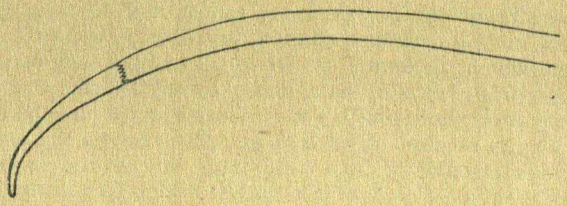

Fig. 109.—*Megascolex sextus* Steph.; distal end of penial seta.

originating in xix, and running forwards obliquely to end in xviii. Spermathecal ampulla somewhat flattened, irregularly circular; duct very broad, nearly as long as ampulla, not sharply marked off; diverticulum very small, club-shaped, arising from middle or ental end of duct. Penial setæ 1 mm. long, 15 $\mu$ thick at the middle; shaft, straight in its proximal two-thirds, distal third sometimes with wavy outline, tip curved through a quadrant and sharply pointed; about 0·08 mm. from the end there is a slight swelling at the situation of a ring of tooth-like sculpturings which do not stand off from the shaft, and there may be one or two similar swellings more proximally, with rudimentary sculpturings.

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*Remarks.* The testis sacs and the posterior situation of the gizzard represent an approach to *Pheretima*; these, with the position of the spermathecal pores, form a distinctive combination of characters.

*Distribution.* Pattipola, Ceylon.

40. **Megascolex singhalensis** *Mich.*

1897. *Megascolex singhalensis*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 227, pl. figs. 16, 17.
1900. *Megascolex singhalensis*, Michaelsen, Tier. x, p. 230.

Length 115 mm.; diameter 5 mm. Segments 136, triannular, through setal zone being elevated to form a ridge. Colour whitish or grey (due to sublimate). Prostomium epilobous $\frac{1}{2}$. No dorsal pores. Setal rings almost closed; the interval *aa* greater than *ab*, *ab* than *bc*, etc., *zz* very irregular, $=1\frac{1}{2}$–$4\,yz$; in the anterior part of body seta *a* larger than *b*, *b* than *c*, *c* than *d*, etc.; numbers 28/vi, 33/viii, 34/xiii, 40/xix, 41/xxvi. Clitellum ring-shaped, xiv–xvii (=4). Male pores scarcely one-fourth of circumference apart, behind the setal zone; no setæ between the pores. Female pores paired. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *d*.

Septum 6/7 very fine, 7/8 rather stouter, 8/9–13/14 thickened. Gizzard in front of 7/8 (? in vii). No calciferous glands. Intestine begins in xv. Last hearts in xiii. Two pairs of testis sacs, in x and xi. Two pairs of racemose seminal vesicles, in xii and xiii. Prostates with long loosely racemose glandular portion, extending through xviii–xxvi; duct long, thin, and evenly curved. Ovisacs present in xiv. Spermathecal ampulla an ovoid sac; duct well set off, two-thirds as long and one-third as thick as ampulla; diverticulum tubular, thinner than duct basally, and twice as long as duct, which it enters at its ectal end; numerous seminal chambers in the swollen ental end of diverticulum; and a small accessory diverticulum with two or three seminal chambers, on the ental portion of chief diverticulum. Penial setæ 6·5 mm. long, 80 $\mu$ thick proximally, 50 $\mu$ near distal end, bowed to form the third of a circle, with laterally rather widened, bluntly rounded smooth tip; proximal to tip numerous fine, narrow, not closely adpressed teeth.

*Distribution.* Nuwara Eliya, Ceylon.

41. **Megascolex spectabilis** *Mich.*

1910. *Megascolex spectabilis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 80, pl. figs. 10–12.

Length 235–320 mm.; diameter $5\frac{1}{2}$–9 to 7–10 mm. Segments 157–174. Colour dorsally bluish to violet grey, fading ventralwards to a light yellowish-grey. Prostomium epilobous $\frac{1}{3}$, tongue open behind. First dorsal pore 9/10 (or perhaps 8/9). Setæ on ridges, small in anterior part and middle of body, fairly large towards

hinder end; ventral break indistinct in anterior part, distinct but small further back; dorsal break in general distinct and fairly wide; numbers 58/x, 50/xix, 59/xxv, 30–40/cl–clx. Clitellum ring-shaped, xiv–xvii (=4). Male pores on small transversely oval papillæ, or sometimes depressed, about one-fourth of circumference apart; no setæ between the pores. Female pores paired. Spermathecal pores one pair, ventro-lateral, in 8/9, about $\frac{3}{10}$ of circumference apart. A pair of small grey circular glandular areas in 17/18, surrounded by a whitish wall; they lie in front of the male papillæ, their centres a little lateral to the lines of the pores; they bear the openings of the accessory glands.

Septa 7/8–13/14 thickened, those in the middle of the series most. Œsophagus with calciferous gland-like swellings segmentally in x–xiii. Funnels in x and xi, these segments being filled out by masses of spermatozoa; if testis sacs are present, they must be extremely delicate structures. Seminal vesicles small, apparently vestigial, in xi and xii. Prostates large, occupying a number of segments, thickly tongue-shaped, compactly racemose, consisting of closely adpressed lobules; duct of the same thickness throughout, bent, muscular. An accessory gland in front of each prostate, opening in 17/18 (v. sup.); each is about half as long and thick as the prostate, with a smooth surface, and consists apparently of a tube with closely adpressed undulations; the duct, or narrower ectal end, is not distinctly marked off. Spermathecæ with very large ampulla; duct very short and cone-shaped, concealed by the ampulla; diverticulum ovoid, with indistinct stalk, small, attached to ental end of duct; a still smaller secondary diverticulum, unstalked and roundish, comprising several seminal chambers, on under side of primary diverticulum. Penial setæ 2 mm. long, 85 $\mu$ thick proximally, almost straight in the proximal half, curved in the distal half and most so at the distal end; this end flattened in a plane at right angles to that of the curve of the shaft, though not broadened; the distal fourth, except the extreme tip, ornamented with very fine, closely set, slightly curved zigzag striæ.

*Remarks.* The gizzard is not mentioned. Accessory prostatic glands occur also in *M. acanthodriloides*, *cingulatus*, and *ceylonicus*; *M. nureliyensis* also has relations to this group; compare the penial setæ of that and the present form.

*Distribution.* Vaxvella, Ceylon.

### 42. **Megascolex sylvicola** (*Mich.*).

1907. *Lampito sylvicola*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 161, text-fig. 9.
1909. *Lampito sylvicola*, Michaelsen, Mem. Ind. Mus. i, p. 181, pl. xiii, fig. 19, text-fig. 15.

Length 185 mm.; diameter $2\frac{1}{2}$–$3\frac{1}{2}$ mm. Segments ca. 200. Colour a uniform light grey. Prostomium epilobous $\frac{1}{2}$, tongue

narrow. First dorsal pore in 9/10. Setæ small, rather enlarged in the anterior half of the anteclitellar region; rings irregularly but broadly interrupted dorsally, especially at the anterior end; regularly broken ventrally, $aa$=ca. 2 $ab$; setæ $a$ and $b$ regularly placed throughout the body; numbers 10/iii, 12/iv, 11/v, 15/xiii, 21/xvii, 27/xxiv, and ca. 30 at the hinder end. Clitellum ? Male pores between the lines $a$ and $b$, on minute papillæ, the papillæ surrounded by a common whitish wall of dumbbell shape. Spermathecal pores in the line of $a$, in 7/8 and 8/9. A large rectangular cushion with rounded corners, broader transversely, on the anterior part of xix, laterally reaching about to the line $d$, and pressing back somewhat the setal zone, which is at its hinder margin.

Septa 6/7–13/14 thickened, especially 7/8–9/10. Gizzard large, in vi (? v). Œsophagus simple, without set-off calciferous glands, a little swollen in xiii (? and in some neighbouring segments). Typhlosole small and indistinct. Last heart in xiii. Behind clitellum in each segment a pair of meganephridia as well as a number of micronephridia; in front of this only micronephridia. Funnels free in xi. Seminal vesicles, racemose, in xii. Prostates



Fig. 110.—*Megascolex sylvicola* (Mich.); spermatheca made transparent by acetic acid; × 15.

split into two parts, each part with some more or less deep incisures; duct fairly long and thin, irregularly undulating. Spermathecal ampulla pear-shaped, passing without break into the duct; duct twice as long and at its beginning half as thick as the ampulla, but becomes thinner towards its ectal end; two diverticula, club-shaped or nearly cylindrical, about half as long and thick as the duct, opening opposite to each other into the duct below its middle, each with a single seminal chamber (text-fig. 110). No penial setæ.

*Distribution.* Tiger Shola, near Kodaikanal, Palni Hills, S. India.

43. **Megascolex templetonianus** *Rosa.*

1892. *Megascolex templetonianus*, Rosa, Boll. Mus. Torino, vii, no. 131, p. 1.

1893. *Megascolex templetonianus*, Ude, Z. wiss. Zool. lvii, p. 65, pl. iv, figs. 13, 14 *a*, 14 *b*, 15.
1897. *Megascolex templetonianus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 213, pl. fig. 11.
1900. *Megascolex templetonianus*, Michaelsen, Tier. x. p. 232.

Length 250–560 mm.; diameter 10–12 mm. Segments 240–570. Colour yellowish to greenish grey. Prostomium without dorsal process. First dorsal pore in 11/12 or 12/13. Setal rings interrupted dorsally and ventrally; $aa$=ca. 4 $ab$ and = 2 $zz$; numbers 62/xii, and further back up to 112. Clitellum ½xiv–½xvii (=3)? Male pores ventrally situated, on small papillæ in a rectangular depressed area, which has swollen lateral borders and extends over ½xvii, xviii, and xix. Female pore single. Spermathecal pores in 7/8 and 8/9, ventrolateral, in line with *h* or *i*. Copulatory papillæ flat, transversely elongated, in line with the male pores, on the hinder part of xvii, both anteriorly and posteriorly on xix, and often on the anterior part of xx—three or four pairs in all; sometimes also a number of circular, less distinct spots on xviii.

Septa 5/6 or 6/7–14/15 thickened, especially the four or five anterior of these. Gizzard in v. Two pairs of funnels in x and xi. Two pairs of seminal vesicles in xi and xii. Prostates racemose, glandular portion deeply incised, cleft into two. Spermathecæ tubular, duct thin and very short; small finger-shaped diverticulum arising from the ectal end. Penial setæ 1·6 mm. long, 80 $\mu$ in maximum diameter; distal end slightly bent, sharpened in chisel-fashion, and slightly excavated (*i. e.*, the terminal edge cut out in an arc); ornamentation of numerous fine zigzag transverse ridges.

*Remarks.* The two points of the penial setæ are not seen separately in the usual position, since they cover each other.

This species is remarkably similar to *M. funis*; I should have been tempted to unite the latter with the present species, but for the fact that Michaelsen had examples of both under his eyes while he was writing his paper (Mt. Mus. Hamburg, xiv).

*Distribution.* Colombo, Ceylon.

### 44. **Megascolex travancorensis** *Mich.*

1910. *Megascolex travancorensis* f. *typica*, Michaelsen, Abh. Ver. Hamburg, p. 72, pl. fig 16.
1913. *Megascolex travancorensis* var. *typicus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 85, text-fig. III *b*.

Length 125 mm.; diameter 1½–2 mm. Segments 280. Colour grey, nonpigmented. Prostomium indistinctly epilobous. First dorsal pore in 4/5. Setæ on ii–vi enlarged, distinctly paired in the first two, three or four seta-bearing segments; rings interrupted fairly widely both dorsally and ventrally, the ventral interval very regular; the setæ form more or less regular longitudinal lines, especially those on the ventral surface on the

anterior part of the body; numbers—3 pairs on each side in ii and iii, 3 or 4 pairs on each side in iv, 4 pairs or 9 setæ on each side in v, ca. 20/vii and ix, 23–25/x–xxv. Clitellum? Male pores in the setal zone in the line of *b*, on slightly raised cushions, which are egg-shaped, their inner borders approximated and parallel, their narrower poles directed forwards; both cushions together almost fill up a somewhat depressed median area, which is bounded laterally and in front by a slight wall. Female pores paired. Spermathecal pores two pairs, between *a* and *b*, in 7/8 and 8/9, about $\frac{1}{5}$ of the circumference apart.

Septa 6/7–12/13 thickened, the last slightly, the rest more strongly. Gizzard large, in vi. No calciferous glands. Funnels free in x and xi. Seminal vesicles fairly small, compactly racemose, in xi and xii. Prostates fairly large, rather long, irregularly rectangular, with deeply incised and uneven surface; duct fairly long, its ectal portion longitudinal in direction, fairly thick, with muscular shimmer; the longer ental portion winding, about half as thick, less glancing, especially at the beginning, where it is concealed by the gland. No copulatory sacs. Spermathecal ampulla large, pear-shaped, much narrowed and usually much bent at its ectal end; duct still thinner, very short, mostly concealed in the body-wall; diverticulum enters the ectal end of ampulla, is narrowly club-shaped and somewhat bent at its ectal end; a mass at the ectal end of ampulla seems to represent an incompletely formed spermatophore. No penial setæ.

*Remarks.* The form of the spermathecæ relates this form to *M. konkanensis*.

*Distribution.* Pallode, Travancore, S. India.

*a.* var. **quilonensis** *Mich.*

1910. *Megascolex travancorensis* var. *quilonensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 74, pl. figs. 17, 18.
1913. *Megascolex travancorensis* var. *quilonensis*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 85, text-fig. III C.

Length 85 mm.; diameter 1–2 mm. Segments 186. Colour light grey, non-pigmented. Prostomium epilobous $\frac{1}{2}$. Pairing of setæ in anterior segments not distinguishable; numbers 12/ii–vii, 16/xi, 20/xiii, 22/xxv. Clitellum ring-shaped, including $\frac{1}{3}$ of xiii and $\frac{1}{3}$ of xvii ($= 3\frac{2}{3}$). Male pores ca. $\frac{1}{8}$ circumference apart, in a common transverse groove; in front of this, in 17/18, a transversely oval, indistinctly limited glandular cushion. Spermathecal pores in 7/8 and 8/9, in line with *a*, ca. $\frac{1}{10}$ of circumference apart. Prostates extend through ten segments; the duct is very thin in its ental third. Spermathecal ampulla broad and flat, irregularly bulged; diverticulum very long, longer than in the type-form of the species; spermatophores in ectal part of ampulla spherical (once two spermatophores in one ampulla).

*Distribution.* Shasthancottah, near Quilon, Travancore.

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*b.* var. **ghatensis** *Mich.*

1910. *Megascolex travancorensis* var. *ghatensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 75.
1913. *Megascolex travancorensis* var. *ghatensis*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 85, text-fig. III D.

Length ca. 80 mm.; diameter 1–1½ mm. Segments ca. 185. Colour light to dark grey, unpigmented. Setæ not paired in anterior segments; numbers 12/ii–iii, 16/iv, 18/v-xiii, 20/xxv. Clitellum ring-shaped, xiv–⅓ xvii (=3⅓)? Male pores in setal zone, ca. $\frac{1}{10}$ of circumference apart, on small roundish papillæ; a median ventral male field, somewhat depressed, shield-shaped, extending backwards to setal zone of xix; the male pores appear as mesially projecting swellings of the prominent border of the area. Spermathecal pores in 7/8 and 8/9, medial from the line of *a*, ca. $\frac{1}{15}$ of circumference apart. Prostates and spermatheca as in var. *quilonensis*; for the rest as in the typical form of the species.

*Distribution.* Maddathoray, Travancore.

*c.* var. **bonaccordensis** *Mich.*

1913. *Megascolex travancorensis* var. *bonaccordensis*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 84, text-fig. III A.

Length 250 mm.; diameter 2½–3¾ mm. Segments ca. 300. Colour pale, non-pigmented. Body extremely long and thin. Ventral setæ in anterior region enlarged (as far as vi); rings distinctly and regularly broken ventrally, *aa*=2 *ab*, setæ *a* in regular longitudinal lines; dorsally rings not broken; setæ not in pairs; numbers 12/ii, 16/iii, 20/xvi, 25/xxvi, 45/cclxxx (*i.e.*, the numbers are much greater posteriorly). Clitellum ring-shaped, ½ xiii–½ xvii (= 4). Male field trapeze-shaped, with rounded angles, broader than long, flat and sucker-like, projecting at the sides of the animal, extending from a little behind the setal zone of xvii to a little behind that of xviii; the heart-shaped centre and anterior and lateral borders of the area are raised, a depressed portion being left on each side of the heart-shaped figure, and a deeper depression, transverse in direction, behind, at the posterior border of the area; the lateral depressions are almost filled up by flat elevations, so that the actually depressed portion is confined to a groove around these and to the transverse depression at the posterior border. The posterior ends of the lateral borders are turned in towards the middle line as papillæ, which are doubtless the male porophores. Female pore single. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *b*.

Septa 5/6–14/15 thickened, the middle ones of the series most. Gizzard large, in v. Prostates lobed and uneven, in xvii–xxi, much constricted by the septa; duct S-shaped, fairly thick and muscular in its ectal, thinner and not shining in its ental part. Spermathecal ampulla sac-like in its ental, narrow in its ectal

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portion; duct small, a little thinner than the ectal part of the ampulla; diverticulum narrowly club-shaped, opening into the duct, about half as long as main pouch.

*Distribution.* Bonaccord, Travancore.

*d.* var. **pentagonalis** (*Steph.*).

1916. *Megascolex pentagonalis*, Stephenson, Rec. Ind. Mus. xii, p. 331, pl. xxxii, figs. 23, 24.

Length more than 108 mm.; diameter 3 mm. Segments more than 94. Colour a uniform medium grey. Secondary annulation in segments vii–ix. Anterior end truncated; prostomium small, triangular, the posterior angle pointed. First dorsal pore in 5/6. Ventral setal gap = 2 *ab* in front of clitellum, $2\frac{1}{2}$ *ab* behind it; dorsal gap large, 4–5 *yz* in front of clitellum, 6 or even 8 *yz* posteriorly; ventral setæ in fairly regular longitudinal lines, dorsal setæ not; ventral setæ of viii and ix remarkably small; numbers 14/v, 16/x, 14/xii, 13/xix, 19/xxii, 20 or 22 further back, 32 at hinder end of the (incomplete) specimen.

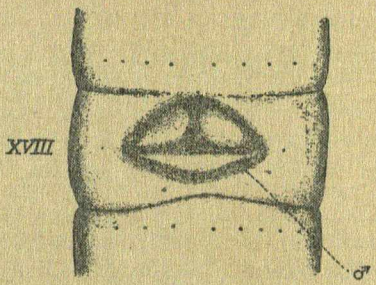


Fig. 111.—*Megascolex travancorensis* Mich. var. *pentagonalis*; male genital field.

Clitellum not definitely limited, xiv–$\frac{1}{4}$xvii (=$3\frac{1}{4}$). Male field (text-fig. 111) on xviii, pentagonal in shape, with the base forwards, the whole occupying the anterior two-thirds of the segment; the lateral angles produced outwards, and the whole area surrounded by a groove and marked by an inverted T-shaped depression. Male pores under the overhanging posterior sides of the pentagon, near the lateral angles, in line with setæ *b*. Spermathecal pores small, in 7/8 and 8/9, in line with *b*.

Septa 6/7–10/11 considerably thickened, the next few moderately so, and then gradually thinner as far as 16/17. Gizzard in v, firm and barrel-shaped. No calciferous glands. Intestine begins in xvi. Prostates long, band-like, much incised, extending from xvii to xx; duct sinuous or curled, passing backwards to its opening, its ental portion being the thinnest. Spermathecal ampulla sausage-shaped, bent near its ental end, the ental end being slightly dilated; duct short, half as thick as ampulla;

diverticulum from junction of duct and ampulla, more than half as long as ampulla, thin, tubular, with a slight dilatation at its ental end (text-fig. 112).

*Distribution.* Trivandrum, Travancore.

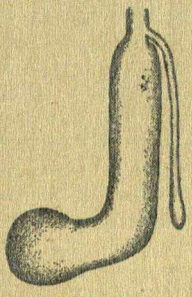

Fig. 112.—*Megascolex travancorensis* Mich. var. *pentagonalis*; spermatheca.

*Remarks on the several forms belonging to the species.* The forms constitute an almost unbroken series, *bonaccordensis*, the largest, being at one end, *ghatensis*, the smallest, at the other; the next largest, *typica* and *pentagonalis*, come near *bonaccordensis*, and the second smallest, *quilonensis*, near *ghatensis*. The male field of Michaelsen's forms are illustrated by a series of diagrams in Michaelsen's paper of 1913, and that of *pentagonalis* in mine of 1916 (reproduced here as text-fig. 111); all can be reduced more or less to a common type; it is possible that the differences are to some extent unreal, and due to varying states of contraction.

A renewed examination of var. *pentagonalis* does indeed seem to show that the male pores are as described above; but from internal inspection they appear to be in line with setæ *c*, about in the setal zone; there is no outward indication of a pore here, this position corresponding to the extreme outer angle of the marginal groove.

### 45. Megascolex trilobatus (*Steph.*).

1914. *Lampito trilobata*, Stephenson, Rec. Ind. Mus. x, p. 340, pl. xxxvi, figs. 2–4.

Length 86 mm.; maximum diameter 4 mm. Segments 160. Colour light brown dorsally, with mid-dorsal purple streak behind clitellum. Ventral surface flattened. Prostomium combined pro- and epilobous $\frac{1}{2}$, tongue not cut off behind. Dorsal pores from 11/12. Setal rings almost closed dorsally, but the interval irregular; ventrally $aa = 2\frac{1}{2}$–$3\,ab$, or even $4\,ab$ in front of clitellum; the largest interval is *ab*, and the largest setæ are *a*; numbers 28/v, 40/ix, 44/xii, 34/xix, and 32–34 more posteriorly. Clitellum extends over $\frac{2}{3}$ xiv–xvii ($=3\frac{2}{3}$) Male pores between

*b* and *c*, nearly a quarter of circumference apart, each pore on, and near the outer border of, a raised flat glandular area; the area takes up the whole length of the segment, and has a semicircular inner border and an indented outer margin the outline of which forms three lobes. Female pore apparently single. Spermathecal pores small, in 6/7, 7/8, and 8/9, about in the lateral line of the body.

Septa 6/7–8/9 considerably and 9/10–11/12 greatly thickened, the thickening rapidly diminishing behind this. Gizzard in v, semi-ellipsoidal, its anterior end joined to a soft wide portion of the œsophagus. No set-off calciferous glands; œsophagus with lamellated internal wall in some of the anterior segments, where it is slightly dilated. Intestine begins in xx. Last heart in xiii. Meganephridia and micronephridia coexist behind xx; in xx and in front only micronephridia, which are in numbers on the septa, and extremely dense on the body-wall in xv–xvii, but are rare or absent on the parietes elsewhere. Funnels free in x and xi. Seminal vesicles in xii, lobulated, curving round the gut so as to meet dorsally. Prostates of considerable size, confined to xviii, lobulated; duct stout, white and shining, short and only slightly bent. Spermathecal ampulla large, irregularly shaped, variable in form; no distinct duct, only a narrowing of ampulla where it reaches body-wall; two diverticula, small, elongated, and rather club-shaped, opposite each other, given off from the ectal end of the main pouch. Penial setæ 1·2 mm. long, 36 $\mu$ in maximum thickness, gently curved; distal end of shaft armed with triangular teeth of some size, extending further up the shaft on the outside of the curve than on the inside; tip scooped out like a horseshoe, with a web spanning the concavity.

*Distribution.* Baroda.

### 46. **Megascolex trivandranus** *Steph.*

1916. *Megascolex trivandranus*, Stephenson, Rec. Ind. Mus. xii, p. 330, pl. xxxii, figs. 25, 26.

Length 72 mm.; diameter 2 mm. Segments 136. Colour grey, with darker mid-dorsal line; clitellum reddish-brown. Prostomium epilobous $\frac{1}{3}$ to $\frac{1}{2}$. Dorsal pores from 5/6. Dorsal setal gap=2–3 *yz*, ventral=3 *ab*, or it may be 4 *ab* behind the clitellum; the intersetal distances increase towards the sides, *ab* being the smallest; numbers 36/v, 43/ix, 41/xii, 34/xix, and 29 in the middle of the body. Clitellum xiv–xvii (=4). Male pores on small papillæ in line with *c*, or *bc*, at the ends of a transversely elongated depression deepest at the ends and slightly convex forwards; the depression is surrounded by a whitish lip, and with the lip takes up the whole length of the segment (text-fig. 113). Spermathecal pores on minute papillæ, in 7/8 and 8/9, just external to the line of *b*.

Septum 7/8 slightly thickened; thenceforward septa moderately thickened up to 11/12, thence decreasingly so to 15/16.

Gizzard with a smaller portion in v, a larger portion in vi, subspherical, anterior end flattened. Œsophagus segmentally swollen and vascular in ix–xiv. Intestine begins in xvi. Last heart in xiii. Nephridia behind clitellum arranged in a single row just behind the septum in each segment; in front of clitellum none on parietes, but stalked tufts by the side of œsophagus, the first of the series large and connected with hinder angle of pharynx. Funnels free in x and xi. Seminal vesicles, racemose, in xi and

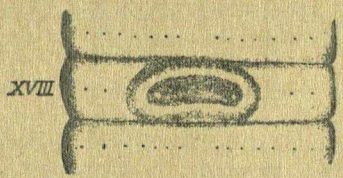


Fig. 113.—*Megascolex trivandranus* Steph.; male genital field.



Fig. 114.—*Megascolex trivandranus* Steph.; spermatheca.

xii, the posterior pair the larger. Prostates small, confined to xviii, lobules closely compacted; duct relatively stout, passing transversely inwards, thinner at its ental end and gradually widening. Spermathecal ampulla smooth and ovoid; duct relatively stout, two-thirds as long and half as broad as ampulla; diverticulum two-thirds as long again as duct and ampulla together, tubular, coiled and twisted, arising from ectal end of duct, at its free end a small spherical chamber with simple cavity (text-fig. 114). No penial setæ.

*Remarks.* There is a mistake as to the length of the diverticulum in the original text—see the figure, which shows it correctly.

The species is closely related to *M. cochinensis* with its var. *phaseolus*. It is a smaller worm, however, the gizzard is more posterior, the length of the spermathecal diverticulum is much greater, and the male field has a different conformation.

*Distribution.* Trivandrum, Travancore.

### 47. Megascolex varians *Mich.*

1897. *Megascolex varians*, Michaelsen, Mt. Mus. Hamburg, xiv. p. 201, pl. figs. 24, 25.
1900. *Megascolex varians*, Michaelsen, Tier. x, p. 220.

Length 85–290 mm.; maximum diameter 3–7 mm. Segments 136–252, triannular or still further subdivided. Prostomium prolobous. First dorsal pore in 6/7 (? 5/6). Setæ in anterior part of body mostly in 16 regular longitudinal rows, behind the

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clitellum up to 20, further back up to 24 per segment; in the posterior part only *a* and *b* in regular lines; ventral gap = 2–2½ *ab*; dorsal gap in front = 4½ *yz*, behind is irregular, but mostly smaller. Clitellum swollen, ring-shaped, xiv–xvii (=4). Male pores in line with *b*, on papillæ which are accompanied laterally by curved longitudinal walls. Female pore single. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *b*. Copulatory cushions with central pit, mostly unpaired, seldom paired, but when unpaired not always median, on segments viii–xiii, xv–xvii, xix–xxii or some of these, taking up the whole length of the segment; they are the rule on xii and xiii, but are very often absent on x and xi; very variable, seldom altogether wanting; on the clitellum they are flat, not raised.

Septum 5/6 very thin, 6/7–11/12 thickened, the first less than the rest. Gizzard in v (and ? ½ vi). No calciferous glands. Intestine begins in xix. Last hearts in xiii. Testes and funnels two pairs, free. Seminal vesicles racemose, in xi and xii. Prostates with small glandular portion; duct narrow, forming a single spiral turn. Spermathecal ampulla an irregular sac; duct short, narrow; diverticulum finger-shaped, somewhat thinner and longer than the duct, which it joins at the ectal end of the latter. Penial setæ in two sacs on each side, representing setæ *a* and *b*, several setæ in each sac; 2·5 mm. long, 35 $\mu$ thick in the middle, almost straight, bowed at each end, bluntly pointed, ornamented with numerous broad and not very closely adpressed teeth, irregularly placed.

*Remarks.* There are astonishing variations in the size of the mature worms.

*Distribution.* Nuwara Eliya, and probably Peradeniya, both in Ceylon.

*a.* var. **simplex** *Mich.*

1897. *Megascolex varians* var. *simplex*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 207, pl. fig. 23.
1900. *Megascolex varians* var. *simplex*, Michaelsen, Tier. x, p. 221.
1913. *Megascolex annandalei*, Stephenson, Spol. Zeyl. viii, p. 263.
1913. *Megascolex curtus*, Stephenson, Spol. Zeyl. viii, p. 267, pl. ii, fig. 10.
1915. *Megascolex varians* var. *simplex*, Stephenson, Mem. Ind. Mus. vi, p. 88.

Length 62–90 mm.; maximum diameter 2½–3 mm. Segments 114–184. Colour light grey or olive. Prostomium prolobous, or epilobous ⅓. First dorsal pore 9/10. Setal rings broken dorsally and ventrally; *zz* = 2 *yz* anteriorly and 4 *yz* behind, *aa* = 3 *ab* in front of and 4 *ab* behind clitellum; in front of clitellum setæ arranged in regular longitudinal lines, in 6 pairs on each side; in the hinder part, while the number of setæ is about the same, those in the lateral region are more irregularly distributed. Clitellum xiv–xvii (=4). Male pores in line with *b*, on small papillæ ⅕–⅐ of circumference apart, the surrounding area

thickened and wrinkled. Spermathecal pores one pair, in line with *b*, in 8/9. Copulatory cushions variable; behind the clitellum none, one (most usually), or two, on xx . . . . xxiv; and one, a pair, or three in front of this, on ix . . . . xii, or on xv.

Some of the septa 7/8–10/11 thickened. Gizzard in vi. Prostates small and compact; duct thin and straight. Spermathecal ampulla of an inverted pear-shape; duct of moderate thickness; diverticulum very long, 3–4 times as long as ampulla,



Fig. 115.—*Megascolex varians* Mich. var. *simplex*; distal end of penial seta.

tubular, coiled or bent on itself. Penial setæ (text-fig. 115) up to 7·25 mm. long, 24 $\mu$ thick, tapering to a blunt point; distal end slightly broadened and flattened; ornamentation of small triangular teeth irregularly distributed all round.

*Distribution.* Nuwara Eliya and Pattipola, Ceylon.

*b.* var. **insolitus** *Steph.*

1915. *Megascolex varians* var. *insolitus*, Stephenson, Mem. Ind. Mus. vi, p. 86, pl. viii, figs. 22, 23.

Length variable, up to 70 mm.; maximum diameter 3 mm. Segments 111. Colour light grey, both dorsally and ventrally. Prostomium prolobous. Dorsal pores from 6/7. Dorsal break in front of clitellum $=2–2\frac{1}{2}\,yz$, behind $=3–3\frac{1}{2}\,yz$; ventrally in front of clitellum $aa=2\frac{1}{2}\,ab$, behind $=3\,ab$, and more posteriorly $=4\,ab$; the intervals *ab* and *bc* are larger than the rest, and *a* and *b* are arranged in regular lines; setæ *a* and *b* larger than the rest, and

the setæ of segments ii–vii larger than those of other segments; numbers 22/v, 24/ix, 22/xii, 27/xix, and 31 further back. Clitellum xiv–xvii (=4). Male pores in line with *b*, ca. one-fifth of circumference apart, on slight papillæ which are partly surrounded by grooves in front and behind. Female pore single, on xv, rather in front of setal zone, in a darker slightly depressed area. Spermathecal pores one pair, in 8/9, in line with *b*, a quarter

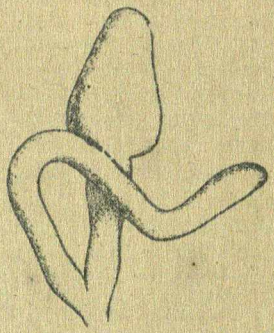

Fig. 116.—*Megascolex varians* Mich. var. *insolitus*; spermatheca.



Fig. 117.—*Megascolex varians* Mich. var. *insolitus*; distal end of penial seta (the whole of the portion which is beset with spines is shown); ×220.

of circumference apart. A papilla constantly on xii, transversely oval, taking up the whole length of the segment; others may be present, *e.g.*, one on xx, or one on xiii; these may or may not be median.

Septum 8/9 slightly thickened, 9/10 considerably, thence diminishingly so as far as the prostatic region. Gizzard large, barrel-shaped, in v and vi (?). No calciferous glands; paired ovoid swellings of the œsophagus in xiv–xvi, and also less markedly in xvii. Ovaries in xiii, large, flattened and plate-like; funnels in xiii; oviducts converge and meet underneath the nerve cord, then enter body-wall just in front of the attachment of septum 14/15.

Spermathecal apparatus variable; ampulla large, egg-shaped; duct proceeds from wider pole of ampulla, varies in length, may be fully as long as ampulla or considerably shorter, stout, narrowest at ectal end, where it gives origin to diverticulum; diverticulum tubular, longer than ampulla and duct together, and about as thick as the duct. Penial setæ 5 mm. long, 27$\mu$ thick near the tip, nearly straight; the free end slightly expanded, transversely cut across at the tip, and thinned in the middle, so as to give a web stretching between the two limbs of a fork; a number of irregularly arranged spines project from the distalmost portion of the shaft; the penial sacs are enormously long, extending back to be attached in xxvi.

*Remarks.* The name *insolitus* is given to this variety on account of the anomalous situation of the female pore.

*Distribution.* Horton Plains, Ceylon.

48. **Megascolex vilpattiensis** (*Mich.*).

1907. *Lampito vilpattiensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 160, text-fig. 8.
1909. *Lampito vilpattiensis*, Michaelsen, Mem. Ind. Mus. i, p. 179, pl. xiii, fig. 18.
1916. *Megascolex vilpattiensis*, Michaelsen, Mjöberg's Austral. Exp. p. 52.

Length 70–90 mm.; maximum diameter 2–2½ mm. Segments 154–178. Colour a uniform light grey. Prostomium indistinctly epilobous ca. ⅔, tongue narrow. First dorsal pore in 10/11. Setæ enlarged at ends of body, especially ventrally; rings regularly interrupted dorsally and ventrally, $aa = 1\frac{1}{2}$–$2\,ab$, $zz = 2$–$3\,yz$; setæ *a* and *b* regularly disposed throughout the body, paired, *ab* being mostly smaller than *bc*; in ii, iii, and sometimes iv, the setæ are in four pairs, the ventral pairs much closer than the lateral; numbers 8/ii–iii, 8 or 9/iv, 9 or 10/v, 9–11/ix, ca. 11/xiii, ca. 21/xix, ca. 24/xxvi, at hinder end ca. 26. Clitellum ring-shaped, xiii–xviii (=6). Male pores between the lines *a* and *b*, about one-tenth of circumference apart, on small papillæ which are directed forwards. Female pores paired. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *a*, about one-eighth of circumference apart. A pair of glandular cushions, shortly oval or egg-shaped, their long axes converging posteriorly, on 17/18, extending nearly as far as the setal zones of xvii and xviii, and laterally approximately from the line *a* to the line *c*.

Septa 6/7–12/13 thickened, especially 8/9 and 9/10. Gizzard large, cylindrical, in v. No calciferous glands. Last heart in xiii. In the postclitellar segments at least, a pair of mega- as well as a number of micronephridia. One pair of funnels free in xi. One pair seminal vesicles, broad, racemose, in xii. Prostates with flat, broad, almost band-like glandular part, with some deep incisures and lobes, and numerous fine furrows; duct from the middle of the inner border, very long, irregularly coiled, thin, but increasing

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in thickness towards the ectal end. Spermathecal ampulla oval; duct fairly abruptly set off, about twice as long and half as thick as ampulla; two diverticula, opposite each other, nearly straight,



Fig. 118.—*Megascolex vilpattiensis* (Mich.); spermatheca made transparent by acetic acid; × 18.

sausage-shaped, half as long or nearly as long as and half as thick as the duct, into the ectal end of which they open (text-fig. 118). No penial setæ.

*Distribution.* Vilpatti, Palni Hills, S. India.

49. **Megascolex willeyi** *Mich.*

1909. *Megascolex willeyi*, Michaelsen, Spol. Zeyl. vi, p. 96, text-figs. 1, 2 *a*, 2 *b*, 3.
1910. *Megascolex willeyi*, Michaelsen, Abh. Ver. Hamburg, p. 68, pl. figs. 19, 20.

Length 40–55 mm.; diameter 2½–3 mm. Segments ca. 140. Colour yellowish-grey, nonpigmented; clitellum brownish-grey; the living animals whitish. Prostomium combined pro- and epilobous ½, tongue almost square, open behind. Dorsal pores begin from 9/10. Setæ at the ends of the body somewhat enlarged; setæ *aa* in regular lines on each side, the others not so regular, or not regular for long distances; numbers of setæ in anterior part 8, in middle and hinder parts 12, in anterior part arranged in wide pairs, while $aa=2\,ab$ and $dd=5\,cd$; further back *aa* still$=2\,ab$, but the median dorsal distance varies, *e. g.*, $=2\,ef$ or $4\,ef$. Clitellum ring-shaped, xiv–xvii (= 4). Male pores in or a little lateral to the line of *b*, at the tip of apparently non-retractile penes, which arise on each side from the hinder part of segment xviii, and are flattened antero-posteriorly, and of the shape of an equilateral triangle. Female pores either paired, or single and median. Spermathecal pores two pairs, in 7/8 and 8/9, in the line of *b*, about one-third of circumference apart. A pair of flat transversely oval papillæ usually on the anterior part of xviii in the line of the ventral pair of setæ; these may be represented by a single median papilla; sometimes a pair of rounder papillæ on xix, in front of the pairs of ventral setæ; occasionally paired papillæ in a similar position on ix and x.

Septa 7/8–11/12 slightly thickened. A large gizzard in vi (or perhaps v). No calciferous glands. Funnels free in x and xi.

Seminal vesicles compactly racemose, in xi and xii. Prostates small, glandular part racemose or rather villous, the lobules being loosely compacted; duct about as long as glandular portion, straight, fairly thick, spindle-shaped, with muscular shimmer. Spermathecal ampulla pear-shaped; duct not sharply marked off, short and thin; diverticulum arising from duct, very small, tubular, a quarter as long as ampulla and duct together, consisting of a number of minute seminal chambers without central lumen. Penial setæ slender, ca. 1 mm. long, proximally 13 $\mu$ thick, at distal end 5 $\mu$; proximal two-thirds of shaft slightly bowed, the distal third forming a semicircle with the curve in the reverse direction to that of the bowing of the shaft, tip bent back once more, simply pointed; on the concave side of the semicircle are numerous transverse rows of fine hairs, standing off obliquely and so giving a brush-like appearance.

*Remarks.* This species forms a transition from *Notoscolex* to *Megascolex*; the anterior end resembles *Notoscolex* exactly, the hinder end resembles the obsolete genus *Trichæta* (with six pairs of setæ per segment throughout the body).

*Distribution.* Labugama in Ratnapura Dist., Ceylon.

50. **Megascolex zygochætus** *Mich.*

1897. *Megascolex zygochætus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 199, pl. figs. 21, 22.
1900. *Megascolex zygochætus*, Michaelsen, Tier. x, p. 217.
1909. *Megascolex zygochætus*, Michaelsen, Spol. Zeyl. vi, p. 101.

Length 50 mm.; diameter 3 mm. Segments 134, no secondary annulation. Colour a fairly bright light brown, with faint red shimmer. Prostomium ? First dorsal pore in 9/10. Setæ in the anterior segments regularly paired, in ii and iii three pairs on each side, $ab = cd = ef = \frac{3}{4}\,bc = \frac{3}{4}\,de$, $aa = 2\,ab$, $ff = 3\,ab$; further back indistinctly paired, number of setæ in iv–xvi is 16, in xxvi is 20; the lines of *a* and *b* regular throughout the body, *aa* greater than *ab*, *ab* less than *bc*; setæ *a* much enlarged, *b* less so. Clitellum ? Male pores on transverse oval papillæ, which extend from the line of *a* to that of *c*, the pores in line with *b*. Spermathecal pores one pair, in 8/9, in line with *c*.

Septum 5/6 very thin, 6/7–13/14 slightly thickened. Gizzard in v. Last hearts in xiii. Nephridia diffuse, aggregated in places into denser clumps. Seminal vesicles racemose, in xi and xii. Prostates with loosely racemose glandular part; duct thin, narrow and straight. Spermathecal ampulla, of an inverted pear-shape, attached to the short broad duct in common with a finger-shaped diverticulum, which is almost as large as the ampulla; ampulla and diverticulum diverge at about a right angle. Penial setæ $2\frac{1}{2}$ mm. long, 40 $\mu$ in maximum thickness, with flattened distal end slightly broadened lancetwise and bent at an angle, the extreme tip slightly bent back; the flattened part transversely ridged, and above this many irregular rings of very slender fairly closely adpressed teeth.

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*Remarks.* This species follows *M. willeyi* in the transition from *Notoscolex* to *Megascolex*; while *M. willeyi* resembles *Notoscolex* at the anterior end, and the obsolete genus *Trichæta* at the posterior, this species resembles *Trichæta* at the anterior end, and the ordinary *Megascolex* further back.

The original specimen was single, and was found by Michaelsen in Schmarda's collection, along with the original specimen of *Perichæta brachycycla* (*Megascolex brachycyclus*).

*Distribution.* Ratnapura, at the foot of Adam's Peak, Ceylon.

## 9. Genus **PHERETIMA** *Kinb.*

1895. *Perichæta*, Beddard, Monog. p. 388.
1900. *Amyntas*, Beddard, P. Z. S. 1900, p. 609.
1900. *Pheretima*, Michaelsen, Tier. x, p. 234.
1907. *Pheretima*, Michaelsen, Fauna S.W. Austral. p. 164.

Setæ numerous on each segment. Spermathecal pores 1–6 pairs between iii and ix. One gizzard in viii, or between 7/8 and 10/11. Micronephridial. Testes and funnels enclosed in testis sacs. Prostates with branched system of ducts. Penial setæ almost always wanting.

The history and synonymy of the genus may be gathered from Beddard's Monograph, and from Michaelsen's volume in the Tierreich. The genus was revised by Beddard in Proc. Zool. Soc. 1900 up to that date.

*Pheretima* forms the end of the main line of descent from *Plutellus*,—of the axis of the Megascolecine tree. The genus has evolved from *Megascolex*, from which it differs in the more posterior position of the gizzard. Testis sacs, present throughout the genus, are usually absent in *Megascolex*; penial setæ, often present in *Megascolex*, are usually absent in *Pheretima* (described in one Indian species, *P. osmastoni*); the setal rings are often closed in *Pheretima*, while they are usually or always open in the dorsal and ventral middle lines in *Megascolex*. But no feature except the position of the gizzard is absolutely diagnostic.

Other general features of the genus are the position of the ring-shaped clitellum, which usually covers segments xiv–xvi; the female pore is almost always single and median; septa 8/9 and 9/10, or one of these, are absent; the intestine gives off a pair of conical cæca, directed forwards, in segment xxvi or thereabouts; the testes and funnels are usually two pairs, in x and xi, and their testis sacs communicate across the middle line with their fellow in the segment; the seminal vesicles are two or three pairs, in xi and xii, or x, xi and xii, and communicate with the testis sacs.

*Distribution* (Chart III). The genus is one of the commonest throughout India, but this is in virtue of its peregrine species, such as *P. posthuma*, *hawayana*, *heterochæta*, *houlleti*; the only parts where *Pheretima* is endemic are Burma, the Andamans, Lower Bengal (one or two species), and possibly the Nilgiris and the extreme South (perhaps two or three species).

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Outside India the genus has spread so as to become world-wide; but its proper home is S.E. Asia and the Malay Archipelago, China, and Japan; there is a single endemic species in Queensland, and perhaps one in the Comoro Islands (Michaelsen, **123**).

*Key to the Indian species of* Pheretima.

| | | |
|---|---|---|
| 1. | No spermathecal pores | 2. |
| | One pair spermathecal pores in 7/8 | *P. taprobanæ.* |
| | Two pairs spermathecal pores in 5/6 and 6/7 | 3. |
| | Two pairs spermathecal pores in 7/8 and 8/9 | *P. andamanensis.* |
| | Three pairs spermathecal pores in 5/6-7/8 | 4. |
| | Three pairs spermathecal pores in or near 6/7–8/9 | 5. |
| | Four pairs spermathecal pores in 5/6–8/9 | 10. |
| | Five pairs spermathecal pores in 4/5–8/9 | *P. bicincta.* |
| 2. | Male pores on xx | *P. anomala.* |
| | Male pores on xviii | *P. elongata* (part.). |
| 3. | Copulatory papillæ 3 to 7 pairs, on xix and following segments | *P. elongata* (part.). |
| | Copulatory papillæ very small, in groups on xviii and neighbouring segments | *P. hawayana* (part.). |
| 4. | Spermathecal diverticulum as a stalked sac, within which is a convoluted tube | *P. birmanica.* |
| | Spermathecal diverticulum ending in a small simple dilatation | *P. hawayana* (part.). |
| 5. | Copulatory organs absent | 6. |
| | Copulatory organs present | 7. |
| 6. | Spermathecal appendages consist of a single diverticulum | *P. travancorensis.* |
| | Spermathecal appendages consist of a diverticulum and a stalked gland or glands arising in connection with its ectal end | *P. houlleti.* |
| | Spermathecal appendages consist of two diverticula, of different characters, one dilated at the ental end, one simply tubular. | *P. trivandrana.* |
| 7. | Copulatory organs median | *P. osmastoni.* |
| | Copulatory organs paired | 8. |
| 8. | Copulatory organs situated in the spermathecal region | *P. bournei.* |
| | Copulatory organs in the region of the male pores | 9. |
| 9. | Copulatory organs as a single pair of papillæ on xviii | *P. carinensis.* |
| | Copulatory organs as two pairs of papillæ, in grooves 17/18 and 18/19 | *P. peguana.* |
| 10. | Copulatory organs absent | 11. |
| | Copulatory organs present | 14. |
| 11. | Prostatic duct with many windings | *P. lignicola.* |
| | Prostatic duct in a simple loop | 12. |
| 12. | Prostatic duct forms a long, backwardly-extending loop | *P. fecæ.* |
| | Prostatic duct forms a loop which is confined to the neighbourhood of the male pore | 13. |

| | | |
|---|---|---|
| 13. | Spermathecal diverticulum ends in a simple knob-like seminal chamber | *P. heterochæta* (part.). |
| | Spermathecal diverticulum ends in an elongated moniliform or irregular seminal chamber | *P. alexandri.* |
| 14. | Copulatory organs in the neighbourhood of the spermathecal apertures | *P. heterochæta* (part.) |
| | Copulatory organs in the neighbourhood of or behind the male pores | 15. |
| 15. | Setal rings closed | 16. |
| | Setal rings widely broken ventrally | *P. burliarensis.* |
| 16. | Copulatory organs median | *P. andersoni.* |
| | Copulatory organs paired | 17. |
| 17. | Copulatory organs as large discs on xviii. | *P. suctoria.* |
| | Copulatory organs as small papillæ on xvii and xix | *P. posthuma.* |

*P. quadragenaria*, which formerly passed as an Indian species, is according to Michaelsen (131) not such. The locality given by Vaillant and Perrier, "Indes orientales," probably does not refer to India, but to the Malay Archipelago.

*Perichæta lawsoni* was described by Bourne from Ootacamund in the Nilgiris (P. Z. S. 1886, p. 664). Beddard does not mention it in his revision of the genus in 1900; Michaelsen in the Tierreich volume of the same year places it as a doubtful species, and he does not admit it in his two Indian lists (54, 58). Its characters are as follows:—Length 250 mm.; diameter $2\frac{1}{4}$ mm. (thus it must be extraordinarily narrow in proportion to its length). Segments 119. Setal rings with small dorsal and ventral breaks; $aa=2\ ab$, $zz=3\ yz$; 30–35 setæ per segment. Clitellum indistinct, xiv–xvii; setæ on clitellum. Male pores not on papillæ; female pores paired; spermathecal pores two pairs, in 7/8 and 8/9. Gizzard in x (?); intestinal cæca originate in xxvi and extend forwards to xxiii.

*Perichæta hulikalensis*, from Hulikal-drug in the Nilgiris, is also described by Bourne (P. Z. S. 1886, p. 668); but even its genus is uncertain, and it may be a *Megascolex*. Length 200 mm.; diameter ca. 3 mm.; segments 209. Setæ about 42 per segment; $aa=4\ ab$, $zz=7\ yz$; setæ present on clitellum, no special setæ observed. Clitellum well marked, xiv–xvii. Male pores rather near together, on slight papillæ; female pore single; spermathecæ in segments vii and viii, each with a single diverticulum. "I believe intestinal diverticula are present in the usual position."

*Perichæta mirabilis*, described by Bourne from Naduvatam in the Nilgiris (P. Z. S. 1886, p. 668), is not mentioned by Beddard in his Monograph, but is allowed as a species of *Pheretima* by Michaelsen in the Tierreich; it does not, however, appear in either of his Indian lists. Length 130 mm.; diameter $2\frac{1}{2}$ mm.; segments ca. 114. Setal rings closed; number of setæ 39; clitellum xiv–xvi. Male pores far apart, on low papillæ; spermathecal pores four pairs, in 5/6–8/9. Four pairs of small

papillæ on the hinder parts of v–viii, and two pairs situated internally to the above, and on the anterior half of the segment, in vii and viii (these papillæ are said by Bourne to be related to the openings of corresponding groups of nephridia; but Michaelsen takes the papillæ to be copulatory papillæ, and the supposed nephridia to be glands). Gizzard in x (?); intestinal cæca present. Spermathecæ with a single appendage.

1. **Pheretima alexandri** (*Bedd.*).

1900. *Amyntas alexandri*, Beddard, P. Z. S. 1900, p. 998, text-figs. 1–3.

Length 145 mm.; segments 133; the six segments in front of the clitellum are more or less triannulate. Setæ rather but not markedly larger on the anterior segments, and again rather larger at the hinder end of the body; setæ *a* not larger in the anterior part of the body; numbers not counted, except on ii, where there are 16. Clitellum xiv–xvi (= 3), without setæ. Male pores very inconspicuous, in setal zone; in front of and behind the pores are slightly curved grooves, and a tumid lip surrounding the whole; 13 setæ intervene between the pores. Female pore single, median. Spermathecal pores four pairs, in 5/6–8/9, in about the same position as the male pores (not seen externally), the openings laterally situated. No genital papillæ.

Septa 5/6–7/8 much strengthened; 8/9 absent; 9/10 and 10/11 moderately strong, the following ones decreasingly so. Intestinal cæca originate in xxvii, rather long, reaching xx, gradually tapering, without secondary bulgings. Seminal vesicles in xi and xii. Prostates large, occupying xvii–xx, much lobulated, somewhat ear-shaped; duct rather narrow, looped, of equal diameter throughout; no copulatory pouch. Spermathecal ampulla of an inverted pear shape, comparatively small; duct relatively very large, longer than ampulla and more than half as thick, thickening even more towards the ectal end; diverticulum longer than main pouch, entering ectal end of duct, itself consisting of a duct and a moniliform seminal chamber as long as or not so long as the duct portion.

*Remarks.* The species is described from a single specimen. Beddard considers its relations to *P. trinitatis* and *heterochæta*, and concludes that it is distinct. Michaelsen (58, p. 11) considers it to be possibly identical with *P. heterochæta*. According to the figures, however, the form of the spermathecæ and especially of the diverticulum should distinguish it from *P. heterochæta*, as well as perhaps the prostate, which is vestigial or absent in the latter.

*Distribution.* Imported to Kew Gardens from the neighbourhood of Calcutta.

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**2. Pheretima andamanensis** *Mich.*

1907. *Pheretima andamanensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 164.
1909. *Pheretima andamanensis*, Michaelsen, Mem. Ind. Mus. i, p. 194, pl. xiii, fig. 25.

Length 108–120 mm.; maximum diameter 6–6½ mm. Segments ca. 110. Colour dorsally dark brownish to violet-grey, ventrally yellowish grey. Prostomium epilobous ca. $\frac{2}{5}$, small, tongue open behind. Dorsal pores from 12/13 (?), distinct only behind clitellum. Setæ a little enlarged in front of clitellum; rings nearly continuous, slightly broken dorsally; setæ closer set ventrally than dorsally; numbers 32/v, 45/x, 52/xii, 58/xix, 54/xxvi. Clitellum ring-shaped, xiv–xvi(=3), setæ present. Male pores about one-quarter of circumference apart, on almost circular smooth papillæ, which are themselves seated on large transversely oval rough protuberances occupying the whole length of xviii; about 15 setæ intervene between the pores. Spermathecal pores two pairs, in 7/8 and 8/9, about $\frac{2}{7}$ of circumference apart. No copulatory papillæ.

Septum 7/8 fairly stout, 8/9 and 9/10 wanting, 10/11 and 11/12 fairly stout, 12/13 and 13/14 still stouter. Gizzard large; cæca

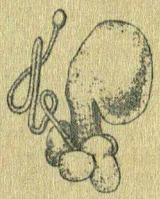

Fig. 119.—*Pheretima andamanensis* Mich.; spermatheca; × 5.

long and simple, extending forwards for about four segments, tapering. Typhlosole simple. Testis sacs unpaired, semicircular with the convexity anterior, in x and xi, separate from each other. Seminal vesicles two pairs, in xi and xii, somewhat granular, each with a dorsal rather large stalked appendage. Prostates loose and tuft-like, extending over segments xix–xxiii; duct thickened and muscular in its ectal two-thirds, thinner in the proximal third, forming an S-shaped curve; no distinct copulatory pouches. A large accessory gland in front of each prostate, in appearance resembling a *Pheretima*-prostate, more compact than the real prostate of this species, occupying xvi–xviii, and differing from the similar gland of *P. osmastoni* in the fact that the small divisions of the gland have no distinct ducts; its duct is thin, straight, ectally somewhat broader, opening just in front of and medial to the true prostate. Spermathecal ampulla sac-shaped; duct somewhat shorter, moderately set off, entally half as thick as ampulla, ectally much inflated; into this ectal part open a number

of irregularly sac-like sessile accessory ampullæ, and also a thin tubular diverticulum almost double as long as the main pouch and dilated entally to form a simple pear-shaped seminal chamber (text-fig. 119).

*Remarks.* Allied to *P. burchardi* and *osmastoni*.
*Distribution.* N. Cinque Island, S. Andaman Island.

### 3. Pheretima andersoni *Mich.*

1907. *Pheretima andersoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 166, text-fig. 13.
1909. *Pheretima andersoni*, Michaelsen, Mem. Ind. Mus. i, p. 198, pl. xiii, fig. 27, text-fig. 20.

Length ca. 250 mm.; maximum diameter 6 mm. Segments 120. Colour dorsally and anteriorly chestnut, on other parts of the body yellowish brown. Prostomium epilobous ca. $\frac{1}{3}$, tongue open behind. Dorsal pores visible only behind the clitellar region. Setæ everywhere very minute, the rings equally dense throughout, without gaps; numbers ca. 100/x. Clitellum ring-shaped, xiv–xvi (=3), apparently without setæ. Male pores in the setal zone, ca. one-third of circumference apart, in the centre of broad slightly-raised papillæ, oval in shape, limited by a furrow; about

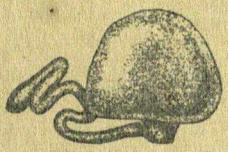

Fig. 120.—*Pheretima andersoni* Mich.; spermatheca; × 5.

26 setæ between the pores. Spermathecal pores four pairs, in 5/6–8/9, ventro-lateral, about two-fifths of circumference apart, on small papillæ. Copulatory organs as six large transversely oval cushions, mid-ventral, in 19/20–24/25, resembling a row of buttons, the interval between one cushion and the next small.

Septum 5/6 thin, 6/7 and 7/8 much thickened, 8/9 and 9/10 wanting, 10/11 and 11/12 much thickened. Gizzard large. Cæca large, slender, simple, without any dilatations, arising in xxvi. Last hearts in xii. Testis sacs two pairs, in x and xi, united in the middle line, the anterior smaller than the posterior; each sac communicates with a pair of seminal vesicles in the next following segment. The vesicles in xii larger than those in xi, all incised; the testis sacs in x also apparently communicate with a pair of seminal vesicles in x, which are flat and deeply incised. Prostates with flat heart-shaped glandular portion occupying several segments; duct fairly long, muscular, thinner at the ends, forming a loop which extends backwards; no copulatory sac

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Spermathecal ampulla sac-like; duct short, rather thick though much thinner than the ampulla; diverticulum a slender tube, with a wavy course, dilated at the free end to form a simple pear-shaped seminal chamber (text-fig. 120).

*Distribution.* Amherst, Lower Burma.

4. **Pheretima anomala** *Mich.*

1907. *Pheretima anomala*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 167, text-fig. 14.
1909. *Pheretima anomala*, Michaelsen, Mem. Ind. Mus. i, p. 189, text-fig. 17.

Length 80–90 mm.; diameter 5–5½ mm. Segments ca. 130. Colour? Prostomium epilobous ca. ½. Setæ very small, rings closed dorsally and ventrally, setæ equally closely set all round; numbers 70/v, 84/x, 74/xxv. Clitellum ring-shaped, xiv–xvi (=3); setæ present ventrally on xiv. Male pores on large conical papillæ on xx, about one-sixth of circumference apart, approximately in line with *k*, about 16 setæ intervening. No spermathecal pores. Copulatory papillæ, paired, conical, rather smaller than the porophores and a trifle more laterally situated, mostly four pairs in the setal zones of xviii, xix, xxi, and xxii; one sometimes wanting on one or other side, occasionally supernumerary papillæ on xvii or xxiii.

Septa 4/5–8/9 moderately thick, 9/10 thin, 10/11–13/14 very little thickened, none missing. A very large gizzard in viii. Intestinal cæca large, slender, simple. Testes seven pairs, in v–xi, with corresponding funnels; the five anterior pairs free, the two hinder—the homologues of the normal organs—enclosed in small testis sacs. No seminal vesicles seen. Prostates with large glandular part occupying several segments, much incised, moderately loose, almost grape-like; duct somewhat thickened ectally, describing a broad almost S shaped curve; no copulatory pouch. No spermathecæ.

*Distribution.* Sibpur, near Calcutta.

5. **Pheretima bicincta** (*E. Perr.*).

1909. *Pheretima violacea*, Michaelsen, Mem. Ind. Mus. i, p. 188.
1910. *Pheretima bicincta*, Michaelsen, Abh. Ver. Hamburg, p. 84.
1916. *Pheretima bicincta*, Stephenson, Rec. Ind. Mus. xii, p. 335.

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1895. *Perichæta violacea*, Beddard, Monog. p. 407.
1900. *Amyntas violaceus*, Beddard, P.Z.S. 1900, p. 641.
1900. *Pheretima violacea*, Michaelsen, Tier. x, p. 312.
1922. *Pheretima bicincta*, Michaelsen, Capita zool. i, 3, p. 23.

Length 50–80 mm.; diameter 2¾ mm. Segments 78. Colour during life a red-violet dorsally, clitellum yellow; these tints largely preserved in alcohol. Prostomium tanylobous, or epilobous ¼, with tongue widely open behind. Dorsal pores from 11/12

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or 12/13. Setal rings with quite small dorsal and ventral breaks; setæ of anterior segments enlarged, except on x where they are markedly smaller, small on the first two segments of the clitellum, large on the third; numbers 44/v, 50/x, 40/xvi. Clitellum xiv–xvi (=3), with complete rings of setæ; clitellum may be wanting on hinder half of xvi. Male pores in line with *f*, 4–8 setæ between the pores, about one-seventh of circumference apart, on considerable conical blunt porophores. Spermathecal pores five pairs, in 4/5–8/9, in line with *f* and with the male pores, except that the last may be rather further from the middle line. A pair of papillæ, not always present, just behind and to the outer side of the male pores, in 18/19, continuous with the raised area on which the pores are situated. A pair of small glandular depressions ventro-laterally in 9/10.

Septa 5/6–7/8 and 9/10–10/11 thickened, 8/9 absent. Gizzard elongated, firm, barrel-shaped. Intestine begins in xv or xvi; cæca very short, broad, apparently rudimentary, or may be altogether absent; originating in xxvi (?) or xxii. Last hearts in xii. Testis sacs in x and xi, large, smooth, united dorsally over the gut, and containing the hearts also. Seminal vesicles in xii, meeting dorsally, cut up into numerous small lobules; a second pair of vesicles, not apparent, found by sectioning within the testis sacs of xi. Prostates occupy xvi–xx; duct bent upon itself, the ectal half thick-walled and spindle-shaped; vas deferens joins the commencement of the thin-walled portion. Glandular cushions internally, corresponding to the papillæ outside. Ovisacs present in xiv. Spermathecal ampulla spindle-shaped, elongated; duct, not marked off, is merely the narrower ectal portion of the pouch; diverticulum from the ectal end of the whole, narrow, about half as long as the pouch, swollen at the extremity.

*Remarks.* The examination of the original specimens of Perrier's *Perichæta bicincta* (ranked in the Tierreich as a doubtful species) showed (Michaelsen, **58**) that they are identical with Beddard's *P. violacea*, originally described from Penang.

*Distribution.* Hyderabad in the Deccan, and Trivandrum, S. India. Outside India from Penang, the Philippines, Java, and the West Indies.

### 6. **Pheretima birmanica** (*Rosa*).

1888. *Perichæta birmanica*, Rosa, Ann. Mus. Genova, (*2*) vi, p. 164, pl. iii, figs. 7–9.
1895. *Perichæta birmanica*, Beddard, Monog. p. 405.
1900. *Amyntas birmanicus*, Beddard, P. Z. S. 1900, p. 637.
1900. *Pheretima birmanica*, Michaelsen, Tier. x, p. 255.

Length ca. 130 mm.; diameter 6 mm. Segments 112. Colour in alcohol a dirty flesh-colour. Prostomium ? Dorsal pores from 12/13. Setæ in continuous rings; number ca. 70. Clitellum

xiv–xvi (=3). Male pores on slightly swollen areas, lighter in colour, in line with the 15th setæ. Spermathecal pores three pairs, in 5/6–7/8, in line with the 15th setæ. No copulatory papillæ.

Septa 5/6 and 6/7 thickened. Gizzard barrel-shaped. Intestinal cæca present. Funnels in x and xi. Seminal vesicles in xi and xii, very small. Prostates well developed, lobed according to the three segments through which it extends; duct narrow, forming a U-shaped loop. Spermathecal ampulla oval; duct short, not distinctly marked off; diverticulum in the form of a stalked oval sac, half as long as the main pouch, in which lies a much convoluted tube.

*Remarks.* The glands described on the anterior faces of septa 5/6 and 6/7 are presumably nephridia. Testis sacs were not distinguished, perhaps on account of the bad condition of the specimens. The sac which forms the spermathecal diverticulum must be a connective-tissue investment, and the contained tube the proper diverticulum.

*Distribution.* Bhamo, Burma.

### 7. Pheretima bournei (*Rosa*).

1890. *Perichæta bournei*, Rosa, Ann. Mus. Genova, xxx, p. 110, pl. i, figs. 3–5.
1895. *Perichæta bournei*, Beddard, Monog. p. 403.
1900. *Amyntas bournei*, Beddard, P. Z. S. 1900, p. 635.
1900. *Pheretima bournei*, Michaelsen, Tier. x, p. 157.

Length 150 mm.; diameter 5 mm. Segments ca. 130. Colour dorsally brown, ventrally flesh-colour. Prostomium combined pro- and epilobous. Dorsal pores from 12/13, visible on clitellum also. Setal rings closed; setæ closer set ventrally than dorsally; number ca. 60. Clitellum xiv–xvi (=3). Male pores small, in line with 15th setæ, each accompanied by two small papillæ, in front of and behind the setal zone respectively, to the inner side of the pore, and so forming a triangle with it; external to the pore a semicircular ridge with its convexity outwards. Spermathecal pores three pairs, on vi, vii, and viii, near the posterior border (not in the furrows), in line with the 12th seta. Copulatory papillæ three pairs on each side, as small tubercles near the spermathecal pores, ventral to and behind each one.

Septa 8/9 and 9/10 wanting; 5/6–7/8 much and 10/11–12/13 slightly strengthened. Gizzard of the form of a truncated cone, slightly swollen in the middle and with the lower angle rounded off. Œsophagus swollen and transversely striated in x–xiv. Intestine begins in xv; cæca finger-shaped, originating in xxvii. Testis sacs two pairs, in x and xi, all separate from each other. Seminal vesicles compact, in xi and xii. Prostates of moderate size, much lobed; duct narrow, in the form of a loop. Spermathecal ampulla of an inverted pear shape; duct narrow, about as long as ampulla; diverticulum tubular, with a large ovoid seminal

chamber at ectal end, longer than whole of main pouch, joins ectal end of duct. Glandular swellings internally correspond to the tubercles seen externally near the spermathecal pores.

*Remarks.* Beddard (P. Z. S. 1900, p. 635) is "much disposed to think that this species is really *hawayanus*." Michaelsen allows it in the Tierreich, and in his list in **54**.

*Distribution.* Cobapo village, Cheba or Biapo Dist., Burma.

8. **Pheretima burliarensis** (*A. G. Bourne*).

1886. *Perichæta burliarensis*, Bourne, P. Z. S. 1886, p. 667.
1900. *Pheretima burliarensis*, Michaelsen, Tier. x, p. 258.

Length 100 mm.; diameter 3 mm. Segments 123. Setal rings widely broken ventrally, especially in the segments following on the male pores; in these segments also the setæ *a* are larger than the rest; two pairs of groups of enlarged setæ in vii and viii; numbers 38–40. Clitellum xiv–xvii (=4), setæ absent. Spermathecal pores four pairs, in 5/6–8/9. Copulatory papillæ in xix, xx, xxi, and xxii.

Gizzard in x (?). Intestinal cæca originate in xxvi, and extend forwards to xxiv. Spermathecæ with a single diverticulum.

*Remarks.* Beddard does not mention this species in his revision of the genus (P. Z. S. 1900); Michaelsen admits it in the Tierreich and in his Indian lists (**54**, **58**), but thinks that it may possibly be identical with *P. rodericensis*, a peregrine species which extends from Japan across the Indian Ocean and Africa to South America and the W. Indies.

Bourne's statement that the gizzard is in segment x in this and a few other forms may perhaps be due to his having numbered the segments from behind; the free space between septa 7/8 and 10/11 (if, as often, two septa were missing) would then appear to be segment x.

The papillæ on xix, xx, xxi, and xxii are said to be perhaps apertures, but no mention is made of any structure opening there; it is not stated whether they are single or paired.

*Distribution.* Burliar, Nilgiri Hills, S. India.

9. **Pheretima carinensis** (*Rosa*).

1890. *Perichæta carinensis*, Rosa, Ann. Mus. Genova, (2 *a*) x, p. 107, pl. 1, figs. 1, 2.
1895. *Perichæta carinensis*, Beddard, Monog. p. 404.
1900. *Amyntas carinensis*, Beddard, P. Z. S. 1900, p. 625.
1900. *Pheretima carinensis*, Michaelsen, Tier. x, p 260.

Length 120–200 mm.; diameter 6–7 mm. Segments 150. Colour brown dorsally, yellowish ventrally; clitellum darker than the ventral, lighter than the dorsal surface. Prostomium combined pro- and epilobous, tongue with parallel sides. Dorsal

pores from 11/12 or 12/13. Setal rings mostly completely closed; setæ more closely set ventrally than dorsally; number ca. 60/viii. Clitellum xiv–xvi (=3); dorsal pores absent. Male pores a little behind the setal zone, ventro-laterally situated, in line with the 15th seta, having the form of papillæ bordered by eye-like markings. Spermathecal pores three pairs, in 6/7–8/9, in line with the 10th setæ. Copulatory papillæ one pair, in xviii, of variable form, on the anterior part of the segments and internal to the male pores, approximately between setæ *c* and *g*; their length is greater than their width, and they reach groove 17/18 at their anterior end.

Septa 8/9 and 9/10 wanting. Gizzard of the form of a truncated cone, slightly swollen in the middle and with the hinder angle rounded off. Funnels in x and xi. Seminal vesicles two pairs, the anterior in xi, relatively small, tongue-shaped, slightly lobed, the posterior three times as long as wide, rectangular, occupying a variable number of segments, and touching the prostates behind. Prostates lobed, occupying three segments; duct long, muscular. Glandular elevations internally corresponding to the papillæ on the external surface. Spermathecal ampulla oval; duct half as long as ampulla, bent in the form of a retort; diverticulum narrow, tubular, bent, almost as long as main pouch, arising from ectal end of duct.

*Distribution.* Metelio, Cheba or Biapo Dist., Burma.

10. **Pheretima elongata** (*E. Perr.*).

1909. *Pheretima biserialis*, Michaelsen, Mem Ind. Mus. i, p. 187.
1910. *Pheretima elongata*, Michaelsen, Abh. Ver. Hamburg, xix, p. 84.
1920. *Pheretima elongata*, Stephenson, Mem. Ind. Mus. vii, p. 222.
1921. *Pheretima elongata*, Michaelsen, Mt. Mus. Hamburg, p. 68.
1922. *Pheretima elongata*, Stephenson, Rec. Ind. Mus. xxiv, p. 433.

1872. *Perichæta elongata*, E. Perrier, N. Arch. Mus. Paris, viii, p. 124, pl. iv, fig. 70.
1895. *Perichæta acystis* + *Perichæta biserialis* + *Perichæta elongata*, Beddard, Monog. pp. 423, 430, 431.
1900. *Amyntas biserialis*, Beddard, P. Z. S. 1900, p. 658.
1900. *Pheretima biserialis* + *Pheretima elongata*, Michaelsen, Tier. x, pp. 256, 265.

Length 95–230 mm.; diameter 4–5 mm. Segments 221. Colour greyish yellow. Prostomium without dorsal process. First dorsal pore in 12/13. Setal rings closed dorsally; ventral setæ enlarged in anterior part of body, but diminishing regularly from the middle line, *a* larger than *b*, *b* than *c*, etc.; intersetal intervals also diminish, *aa* larger than *ab*, *ab* than *bc*, *bc* than *cd*, thenceforward equal; in middle of body the diminution of the setæ cannot be followed beyond the first, *a* alone being enlarged, while *aa* is larger than *ab*, *ab* than *bc*, the rest equal; numbers 81/v, 90/x, 79/xiii, 70/xix, 70/xxvi. Clitellum usually without setæ,

xiv–xvi (=3). Male pores about one-quarter of circumference apart. Spermathecal pores mostly two pairs, in 5/6–6/7, about $\frac{1}{6}$ of circumference apart, some or all often wanting. Copulatory papillæ three to seven pairs, on xix and the following segments, one pair on the anterior part of each segment, each transversely oval, rather nearer the middle line than the male pores.

Septa 5/6 and 6/7 much, and 7/8 very much thickened. No intestinal cæca. Last heart in xii. Testis sacs in x and xi, those of each segment completely fused, projecting round the gut so as to resemble seminal vesicles, enclosing alimentary canal, hearts, and dorsal vessel, as well as the seminal vesicles of xi. Seminal vesicles in xi, xii, and xiii. Prostates with fairly large glandular portion, much cut up into lobes; duct U-shaped; no copulatory pouch. Spermathecæ may be absent; ampulla spherical; duct fairly short, narrow; diverticulum tubular, half to two-thirds as long as main pouch.

*Remarks.* The identification of *P. elongata* and *biserialis* rests on an examination of the original specimens of *P. elongata* (Michaelsen, 58). The species is widely peregrine.

*Distribution.* Bombay, Karachi, and Manmad, in the Bombay Presidency; Calcutta and Namkana, Sundarbans, in Bengal; Hyderabad, Deccan; Palia, Indore, and Ujjain, in Central India; Kandy and Panadhure, Ceylon; Mockoli, Bhaganamola, and Manakoti, in Coorg, S. India; Shimoga, in Mysore. Outside India from the Philippines, Malay Archipelago, Comoro Islands, Madagascar, Dutch Guiana, Venezuela, W. Indies, Central America; indeed, is world-wide in the tropics and sub-tropics.

11. **Pheretima feæ** (*Rosa*).

1888. *Perichæta feæ*, Rosa, Ann. Mus. Genova, (2) vi, p. 161, pl. iii, figs. 1–6.
1895. *Perichæta feæ*, Beddard, Monog. p. 434.
1900. *Amyntas feæ*, Beddard, P. Z. S. 1900, p. 643.
1900. *Pheretima feæ*, Michaelsen, Tier. x, p. 266.
1916. *Pheretima feæ*, Stephenson, Rec. Ind. Mus. xii, p. 335.

Length 180–360 mm.; diameter 7–9 mm. Segments 90–160. Colour dorsally blackish, ventrally paler; clitellum brownish black. Prostomium epilobous $\frac{1}{2}$, tongue not cut off behind. First dorsal pore in 12/13. Setæ in rings which are closed ventrally and closed or almost closed dorsally; setæ equally distant throughout, present on clitellum; number about 100 in spermathecal region. Clitellum xiv–xvi, and in addition small parts of xiii and xvii (=more than 3); no dorsal pores or setæ present. Male pores in line with 15th setæ; on round flat papillæ $1\frac{1}{2}$ mm. in diameter, ventro-laterally situated and taking up the whole length of the segment. Spermathecal pores four pairs, in 5/6–8/9, in line with 11th or 12th setæ. No other genital markings.

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Septa 5/6–7/8 and 10/11–11/12 much strengthened, 8/9 and 9/10 wanting. Gizzard barrel-shaped, posterior border somewhat swollen, occupies viii, ix, and part of x; a glandular ring round alimentary canal in x. Intestinal cæca as narrow cones, without secondary diverticula. Testis sacs in x and xi, single in each segment, but those of the two segments quite separate. Seminal vesicles two pairs, the anterior, in xi, small, the posterior, in xii, much longer and trilobate, extending back to the level of xv by bulging the septa backward. Prostates long, much cut up into lobes; duct long, prolonged backwards as far as xxv as a U-shaped loop, with the limbs parallel and close together. Spermathecæ four pairs, the hinder the larger; ampulla ovoid; duct rather short and narrow; diverticulum enters ectal end of duct, is tubular, bent in a zigzag or coiled, and when extended is longer than the main pouch.

*Remarks.* The "gland" in segment x is a flange-like collar round the œsophagus, resting against the hinder end of the gizzard; microscopically it is composed of small follicles, like those of the œsophageal blood-glands behind the pharynx in *P. posthuma*, etc.

Rosa found the intestinal cæca originating in xxviii and extending forwards to xxv; they arose in xxvi in my specimens.

*Distribution.* Kawkareik (Kokareet), Amherst District, Lower Burma.

12. **Pheretima hawayana** (*Rosa*).

1898. *Perichæta cupulifera*, Fedarb, P. Z. S. 1898, p. 445, text-fig. 1.
1900. *Amyntas hawayanus*, Beddard, P. Z. S. 1900, p. 645.
1900. *Pheretima barbadensis* + *Pheretima hawayana*, Michaelsen, Tier. x, pp. 254, 271.
1909. *Pheretima hawayana* f. *typica* + *Pheretima hawayana* subsp. *barbadensis*, Michaelsen, Mem. Ind. Mus. i, p. 187.
1910. *Pheretima hawayana* f. *typica*, Michaelsen, Abh. Ver. Hamburg, xix, p. 83.
1913. *Pheretima hawayana*, Stephenson, Spol. Zeyl. viii, p. 271.
1914. *Pheretima hawayana*, Stephenson, Rec. Ind. Mus. x, p. 343.
1916. *Pheretima hawayana* subsp. *typica* + subsp. *barbadensis*, Prashad, J. Bombay Soc. xxiv, pp. 499, 501, pl. i, figs. 3, 4; pl. ii, figs. 3–5.
1916. *Pheretima hawayana* f. *typica*, Stephenson, Rec. Ind. Mus. xii, p. 334.
1917. *Pheretima hawayana*, Stephenson, Quart. Journ. Mic. Sci. lxii, p. 267, pl. xix, fig. 5.
1917. *Pheretima hawayana*, Stephenson, Rec. Ind. Mus. xiii, p. 386.
1918. *Pheretima hawayana*, Thapar, Rec. Ind. Mus. xv, p. 71, pl. vi, fig. 1.
1919. *Pheretima hawayana* + *Pheretima barbadensis*, Bahl, Quart. Journ. Mic. Sci. lxiv, pp. 103, 104.
1919. *Pheretima hawayana*, Stephenson & Haru Ram, Tr. Roy. Soc. Edin. lii, p. 439, pl. figs. 1–6.

1919. *Pheretima hawayana*, Stephenson & Prashad, Tr. Roy. Soc. Edin. lii, p. 460, pl. figs. 1, 2.
1920. *Pheretima hawayana*, Stephenson, Mem. Ind. Mus. vii, p. 222.
1921. *Pheretima hawayana*, Stephenson, Rec. Ind. Mus. xxii, p. 760.
1922. *Pheretima hawayana*, Stephenson, Rec. Ind. Mus. xxiv, p. 433.

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1891. *Perichæta hawayana*, Rosa, Ann. Hofmus. Wien, vi, p. 396, pl. xiv, figs. 7, 9.
1895. *Perichæta barbadensis* + *P. pallida* + *P. hawayana* + *P. aspergillum*, Beddard, Monog. pp. 412, 415, 420, 430.
1900. *Amyntas hawayanus*, Beddard, P. Z. S. 1900, p. 645.

Length 50–125 mm.; diameter 3–5 mm. Segments 78–95. Colour greyish brown with violet shimmer. Prostomium combined pro- and epilobous, or epilobous $\frac{1}{2}$ with broad tongue. Dorsal pores from 10/11. Setæ on raised rings; rings closed, or sometimes distinctly broken; ventral setæ of iii–x or fewer segments may be enlarged; numbers 44/ix, 49/xi, 56/xii, 54/xix, 56/xxvii. Clitellum xiv-$\frac{1}{2}$ xvi or xvi (=$2\frac{1}{2}$–3); ventral setæ may be present on xvi and xiv. Male pores on small slightly raised papillæ in line with setæ *i*, $\frac{2}{7}$ of circumference apart. Spermathecal pores three pairs, in 5/6, 6/7, and 7/8, in line with *e*; or two pairs in 5/6 and 6/7. Copulatory papillæ as pigmented raised or sometimes depressed spots, in irregular groups of two or three to the inner side of the male pores; and often in transverse lines on the anterior parts of xviii and xix and posterior parts of xvii and xviii. Small papillæ may also occur on the posterior part of vii, slightly median to the line of the spermathecal pores, and in varying positions on the hinder part of viii.

Septa 5/6–7/8 thickened, 8/9–9/10 absent, 10/11–11/12 thickened. Gizzard bell-shaped. Intestine begins in xv; cæca originate in xxvi or xxvii, without secondary lobulations or with lobulations along the ventral border; typhlosole a small ridge. Testis sacs in x and xi. Seminal vesicles in xi and xii, irregularly lobulated. Prostates long, rectangular, extending over six or seven segments, xvii–xxii or xxiii, lobed according to the segments; duct almost straight, forming a single loop, or bent in the shape of an S. An ovisac may be present in xiv. Spermathecæ with circular or oval ampulla; duct narrow, three-quarters as long as ampulla; diverticulum narrow, tubular, somewhat coiled, equal or nearly equal in length to main pouch, with small terminal pear-shaped dilatation, discharges into ectal end of duct. Small glandular masses on inner side of body-wall corresponding to papillæ externally.

*Remarks.* Beddard (**37** *a*) united *P. barbadensis* and *hawayana*; subsequently Michaelsen placed *barbadensis* as a subspecies of *hawayana* (**54**), remarking that he had not met with any specimens which aroused any doubt as to where they should be placed—in the typical form or in the subspecies. Later I found

specimens with intermediate characters, or with some characters of the one form and some of the other, and therefore united the two (**69, 71, 75**). Prashad differs in opinion (**82**), and keeps the subspecies distinct.

Michaelsen finds the distinctions between the two to be the more robust habit of the type-form, the stronger setæ in the anterior part of the body, and the fact that in the type-form "the papillæ near the male pores are always united at each side, occupying an oval oblong area medial from the male pores and mostly somewhat oblique," while in the subspecies "the papillæ near the male pores are scattered, partly very near the male pores, partly near the median ventral line." Prashad thinks that *barbadensis* is to be distinguished by the unbroken rings of setæ, the clitellum extending over the whole of three segments, without setæ usually and constricted, the prostatic duct straight, not with an **S**-curve; what he says regarding the papillæ is partly contradicted by his own description of subsp. *barbadensis*, and the difference in the spermathecal ampullæ of the two forms seems from his figures to be one of degree of distension rather than one of shape.

The species being one of the commonest worms in India has been used for a number of morphological investigations; Stephenson and Haru Ram have investigated the prostate (**92**), Stephenson and Prashad the œsophagus (**91**), Bahl the nephridial system (**90**), Thapar the lymph-glands (**88**), and Stephenson the pharyngeal gland-cells (**87**).

*Distribution.* Lahore; Nepal Valley; Kurseong in Darjiling District; Manipur, Assam; Dehra Dun, Bindraban near Muttra, Ramnee in Garhwal; Rangamati in Bengal; Udaipur in Rajputana; Bombay; Pattipola in Ceylon; doubtless it occurs practically throughout the whole of India. Outside India it is also widely spread, *e.g.*, Borneo, China, Mauritius, Hawaii, Bermuda, Barbados, S. America, Teneriffe, and other places.

13. **Pheretima heterochæta** (*Mich.*).

1886. *Perichæta mirabilis*, Bourne, P. Z. S. 1886, p. 668.
1895. *Perichæta indica* (part.), Beddard, Monog. p. 427.
1897. *Perichæta indica* var. *ceylonica*, *P. i.* var. *ceylanensis*, Michaelsen, Mt. Mus. Hamburg, xiv, pp. 246, 163.
1900. *Amyntas heterochætus*, Beddard, P. Z. S. 1900, p. 622.
1900. *Pheretima indica* (part.) + *P. indica* var. *ceylonica*, Michaelsen, Tier. x, pp. 275, 276.
1909. *Pheretima heterochæta*, Michaelsen, Mem. Ind. Mus. i, p. 189.
1910. *Pheretima heterochæta*, Michaelsen, Abh. Ver. Hamburg, xix, p. 83.
1914. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. viii, p. 399.
1914. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. x, p. 343.
1915. *Pheretima heterochæta*, Stephenson, Mem. Ind. Mus. vi, p. 99.
1916. *Pheretima heterochæta*, Prashad, J. Bombay Soc. xxiv, p. 503, pl. i, figs. 1, 14; pl. ii, fig. 7.

1916. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. xii, p. 334.
1917. *Pheretima heterochæta*, Stephenson, Quart. Journ. Mic. Sci. lxii, p. 265, pl. xix, figs. 1, 3, 4.
1917. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. xiii, p. 385.
1918. *Pheretima heterochæta*, Thapar, Rec. Ind. Mus. xx, p. 71, pl. vi, fig. 2.
1919. *Pheretima heterochæta*, Bahl, Quart. Journ. Mic. Sci. lxiv, p. 104.
1920. *Pheretima heterochæta*, Stephenson, Mem. Ind. Mus. vii, p. 222.
1921. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. xxii, p. 760.
1922. *Pheretima heterochæta*, Stephenson, Rec. Ind. Mus. xxiv, p. 433.

Length 60–160 mm.; diameter 3–5 mm. Segments 91–110. Colour yellowish grey, brown dorsally in middle of body; setal zone whitish, and in anterior and posterior regions of the body raised as a ridge. Prostomium epilobous $\frac{2}{3}$. Dorsal pores from 10/11. Dorsal and ventral breaks in the setal rings small, less than $2\,ab$ and $2\,yz$; setæ decrease in size from *a* outwards, dorsal setæ smaller and closer set than the ventral, especially in the anterior part of the body, where the ventral setæ are much enlarged; setal intervals also decreasing outwards from the middle line; setæ of x smaller than of other segments; numbers up to 40 in front of clitellum, 40–54 behind. Clitellum ring-shaped, xiv-xvi (=3), setæ absent, dorsal pores present. Male pores on elevated papillæ, about $\frac{2}{5}$ of circumference apart, 12 setæ intervening. Spermathecal pores four pairs, in 5/6–8/9, eye-like, about $\frac{1}{3}$ of circumference apart. Small papillæ, sometimes altogether wanting, paired, anteriorly on vii and viii, less often on vi and ix, somewhat medial from the spermathecal pores.

Septa 5/6-7/8 much strengthened, 8/9 and 9/10 wanting, 10/11 and 11/12 also thickened. Gizzard large, somewhat conical, narrower in front. Intestinal cæca simple. Funnels in x and xi, in testis sacs, the sacs of x communicating with each other, those of xi entirely fused. Seminal vesicles two pairs, in xi and xii, irregularly lobed. Ovisacs may be present in xiv. Prostates often more or less vestigial, may be altogether absent; when present, much divided; duct large, muscular, in a horseshoe curve, convex towards the front and inner side; no copulatory pouch. Spermathecal ampulla of an inverted pear shape; duct almost equal in length to ampulla, narrow, muscular; diverticulum long, tubular, dilated at its ental end to a knob-like seminal chamber, often also with lateral seminal chambers.

*Remarks.* Michaelsen described a var. *ceylonica* (**33**), which also figures in the Tierreich, but not in his Indian lists (**54, 58**). The distinguishing character was the presence of a pair of papillæ close to and on the inner side of the male pores.

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Bahl has studied the nephridial system, which resembles that of *P. posthuma* (**90**), Stephenson the pharyngeal gland-cells (**87**), and Thapar the lymphatic glands on the intestine (**89**).

*Distribution.* Throughout India; Peshawar and Peshawar Dist.; Lahore; Simla and Naini Tal in the W. Himalayas; Kurseong and other places in Darjiling Dist., Gangtok in Sikkim, and the Abor country in the E. Himalayas; Manipur, Sadiya, and Cherrapunji, in Assam; Rangamati and Siliguri in Bengal; N. Shan Hills in Burma; Palni and Nilgiri Hills in S. India; Ceylon. Outside India the list includes Japan, Hawaiian Archipelago, Madagascar, the Azores, Sunda Islands, New Caledonia, Comoro Islands, Cape Verde Islands, North, Central, and South America—indeed, as Beddard says, "everywhere, including Europe."

14. **Pheretima houlleti** (*E. Perr.*).

1872. *Perichæta houlleti*, E. Perrier, N. Arch. Mus. Paris, viii, p. 99, pl. ii, figs. 31–44, pl. iii.
1889. *Perichæta houlleti*, Bourne, J. Asiatic Soc. Bengal, lviii, p. 111, pl. iii, figs. 4, 5.
1890. *Perichæta campanulata*, Rosa, Ann. Mus. Genova, (2) x, p. 115, pl. i, figs. 9, 10.
1895. *Perichæta houlleti*, Beddard, Monog. p. 424.
1898. *Perichæta houlleti*, Michaelsen, Zool. Jahrb. Syst. xii, p. 144.
1898. *Perichæta crescentica*, Fedarb, P. Z. S. 1898, p. 447, text-fig. 2.
1900. *Amyntas houlleti* (part.), Beddard, P. Z. S. 1900, p. 613.
1900. *Pheretima houlleti* + *P. crescentica*, Michaelsen, Tier. x, pp. 273, 262.
1903. *Pheretima houlleti*, Michaelsen, Sb. Böhm. Ges. Prag xl, p. 12.
1909. *Pheretima houlleti*, Michaelsen, Mem. Ind. Mus. i, p. 187.
1910. *Pheretima houlleti*, Michaelsen, Abh. Ver. Hamburg, xix, p. 83.
1916. *Pheretima houlleti*, Stephenson, Rec. Ind. Mus. xii, p. 334.
1917. *Pheretima houlleti*, Stephenson, Rec. Ind. Mus. xiii, p. 385.
1921. *Pheretima houlleti*, Michaelsen, Mt. Mus. Hamburg, xxxiii, p. 68.
1922. *Pheretima houlleti*, Stephenson. Rec. Ind. Mus. xxiv, p. 434.

Length 75–200 mm.; diameter 4–6 mm. Segments 98–108. Colour variable, purplish-brown on dorsum, with still darker median stripe; pale on ventral surface; clitellum pale. Prostomium epilobous $\frac{1}{2}$ or more. First dorsal pore from 9/10 to 12/13. Setal rings with small dorsal and ventral breaks; *ab* commonly the largest interval (except *aa*), but no regular decrease outwards; setæ *a* usually enlarged; ventral setæ of iv–ix enlarged, and set widely, so that the ventral break disappears here; numbers between 30 and 50 in front of clitellum, 50 or rather more behind (39/v, 42/viii, 52/xii, 56/xxiv). Clitellum xiv–xvi (=3), or $\frac{2}{3}$xiv–$\frac{2}{3}$xvi (=$2\frac{1}{3}$); dorsal pores present; a few setæ present, and these modified—tip trifid and the general form rather stumpy, or tip bifid with a web between the points and the ental end

truncated. Male pores on papillæ, about one-third of circumference apart, in line with *h*. Spermathecal pores three pairs, in 6/7–8/9, far out laterally, it may be almost in the lateral line of the body. No genital papillæ.

Septa 5/6–7/8 thickened, 8/9 and 9/10 wanting, 10/11–13/14 thickened. Cæca originating in xxvii, with constrictions. Testis sacs in x and xi, those in xi united ventrally, those in x apparently separate. Seminal vesicles in xi and xii, of considerable size, much cut up into lobes. Prostates large, occupying xvii–xx, much cut up into lobes; duct thinner entally, in the form of a loop, the ends of which are approximated; a considerable copulatory sac, which appears as a porophore when everted. Spermathecal ampulla irregularly shaped, or pear-shaped or heart-shaped; duct straight, as long as ampulla, thick, narrowing a little towards ectal end; diverticulum arising from near ectal end of duct, long, tubular, its ental portion much convoluted, the loops closely adpressed into a flattened semi-transparent mass, length of diverticulum in its natural condition about two-thirds that of main pouch; one or more stalked glands enter extreme ectal end of duct, each of a length less than that of duct, consisting of a narrow stalk surmounted by a nodular ovoid glandular part.

*Remarks.* Perrier described grape-like glands in vii, the duct going forwards to open into the œsophagus at the level of 6/7; these seem to be blood-glands, such as are found in some other species of *Pheretima*; but what the "pear-shaped glands" in vi are, which open backwards at the same level, I do not know,—perhaps part of the "pharyngeal glands."

Fedarb described *Perichæta crescentica* as a new species (**36**); it was distinguished from *P. houlleti* by the clitellar setæ not being in any way modified, while in *P. houlleti* the modification is very characteristic. Her specimens, however, may not have been fully sexual—the seminal vesicles were small, and the whole of the setæ were still present on the clitellum. Beddard (**37** *a*) and Michaelsen in the Tierreich accept *P. crescentica* as distinct from *houlleti*, but the species has disappeared from Michaelsen's later lists (**54**, **58**).

*P. houlleti* is closely related to *P. trivandrana* and *P. travancorensis*; see the remarks under these two species.

*Distribution.* Rawal Pindi; Dehra Dun, Bhim Tal, Allahabad, in the United Provinces; Calcutta and Raniganj, in Bengal; Cherrapunji in Assam; Pegu District in Burma; Bombay; Mangalore, Trivandrum, Trichur, Chevagun near Calicut, Merkara (Coorg), Shimoga (Mysore), in S. India; Ceylon. It is also widely distributed outside India, in the Philippines, China, Cochin China, Fiji, Sunda Islands, Java, Comoro Islands, Madagascar, Bahamas.

### 15. Pheretima lignicola *Steph.*

1914. *Pheretima lignicola*, Stephenson, Rec. Ind. Mus. viii, p. 399, pl. xxvii, fig. 17.
1915. *Pheretima lignicola*, Stephenson, Mem. Ind. Mus. vi, p. 99.

1916. *Pheretima lignicola*, Stephenson, Rec. Ind. Mus. xii, p. 335.
1920. *Pheretima lignicola*, Stephenson, Mem. Ind. Mus. vii, p. 223.

Length 105–165 mm.; diameter 4–6½ mm. Segments 90–130. Colour olive-green or bluish purple, ventrally pinkish. Prostomium epilobous, almost tanylobous. Dorsal pores from 12/13, the first slit-like. Setæ implanted on circular ridges, the rings unbroken ventrally, a very slight break dorsally; in front of the clitellum the setæ are larger than behind, especially those of ii–ix; numbers 22/vi, 44/ix, 47/xii, 65/xxiii. Clitellum xiv–xvi (=3); dorsal pores absent, a few setæ ventrally on xiv. Male pores in the setal zone, in large depressions, circular, surrounded by a prominent lip, except on their inner margins; the whole, including lips, extends nearly over the interval between the setal zone of xvii and that of xix; the pores two-sevenths of circumference apart, 12 setæ intervening. Spermathecal pores four pairs, inconspicuous, in 5/6–8/9, two-sevenths of circumference apart, approximately in line with *f*.

Septum 5/6 thickened, 6/7 and 7/8 much thickened, 8/9 and 9/10 absent. Gizzard cask-shaped, in viii. A collar-like structure round the œsophagus behind the gizzard, consisting of blood-glands, in x. Intestine begins in xiv–xvi; cæca originating in xxvi or xxvii, narrow, simple or crenulated on the dorsal margin. Testes and funnels in x and xi, in sacs, the sacs of x small and probably communicating with each other, those in xi larger and

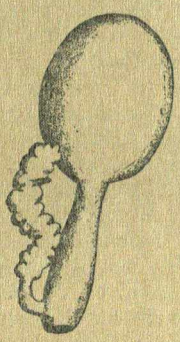

Fig. 121.—*Pheretima lignicola* Steph.; spermatheca.

separate. Seminal vesicles in xi and xii, those of xi within the testis sacs. Prostates of large size occupying xvi–xx, much cut up into lobes; duct with many windings, becomes thicker and more muscular as it proceeds; stout, smooth, and shining at its termination. Spermathecal ampulla ovoid or heart-shaped; duct of equal length or shorter, stout, muscular, and shining, sometimes fusiform in shape; diverticulum long, narrow, and twisted, its ental portion thin-walled, with numerous small irregularities, its ectal part shining and muscular (text-fig. 121).

*Distribution.* Dibrugarh, Assam; Lower Burma; Bombay.

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### 16. Pheretima osmastoni *Mich.*

1907. *Pheretima osmastoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 163, text-fig. 11.
1909. *Pheretima osmastoni*, Michaelsen, Mem. Ind. Mus. i, p. 191, pl. xiii, fig. 26, text-fig. 18.

Length 250–320 mm.; maximum diameter 10–11 mm. Segments 126–148. Colour dorsally violet-grey, iridescent; ventrally yellowish-grey. Prostomium epilobous ca. $\frac{1}{2}$, tongue open behind. Dorsal pores from 12/13 (?). Setæ somewhat enlarged in front of the clitellum and in the hinder half of the body, especially dorsally; dorsal setæ in general somewhat larger and further apart than the ventral; rings with a regular dorsal break, $zz = 1\frac{1}{2}$ or $1\frac{2}{3}$ $yz$; ventral break small and irregular; numbers 28/v, 50/ix, 58/xiii, 72/xix, 70/xxvi. Clitellum ring-shaped, xiv–xvi (= 3). Male pores about a quarter of circumference apart, with about 18 setæ intervening, on transversely oval papillæ in the setal zone, the surface of the papillæ bearing the small porophores. Female pores apparently paired, but near together. Spermathecal pores three pairs, in 6/7–8/9, about two-sevenths of circumference apart. Copulatory organs as broad, median, transversely oval or rectangular cushions with rounded angles, with numerous closely set fine pores upon them, the openings of small glands; the cushions take up the hinder $\frac{2}{3}$ or $\frac{3}{4}$ of their segments, and are about a quarter of the circumference in breadth; their distribution is variable, most often one, on x or rarely on viii, sometimes two, on xii and xiii.

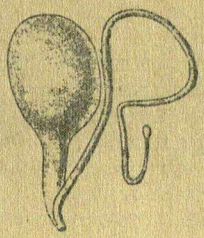

Fig. 122.—*Pheretima osmastoni* Mich.; spermatheca; × 4.

Septum 6/7 fairly strong, 7/8 very strong, 8/9 and 9/10 wanting, 10/11–12/13 very strong, 13/14 hardly strengthened. Gizzard thickly pear-shaped. Cæca fairly long, simple and slenderly cone-shaped, extending upwards not forwards. Typhlosole simple. Lymph glands present. Testis sacs two pairs, in x and xi; those of each segment communicating with each other, those of the same side separated. Seminal vesicles two pairs, in xi and xii, large, somewhat incised and granular. Prostates loosely and irregularly lobed, extending through ca. xviii–xxii; duct long, in a somewhat irregular loop the ectal limb of which is thick and muscular, the ental much thinner; no copulatory pouch. A bifid

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accessory gland opens by a simple terminal canal medial to each male pore; internally this canal bifurcates, the two halves of each gland being situated one in front of and one behind the prostate; each portion is grape-like, consisting of numerous fairly small groups of large gland-cells and their long narrow ducts, which open into a central canal, the main duct of the half gland; lastly the two main ducts unite. An enlarged seta, which must be regarded as a penial seta, between the opening of the male duct and that of the accessory gland. Spermathecal ampulla pear-shaped, duct not distinctly set off, narrow, shorter than ampulla; diverticulum long, tubular, narrow, irregularly undulating, with small pear-shaped seminal chamber at the ental end, the whole more than twice as long as main pouch, opens into ectal end of duct (text-fig. 122).

*Remarks.* The tips of the penial setæ were broken in all specimens. Penial setæ are not known elsewhere in the genus.

Accessory glands are found in *P. andamanensis* also, but their structure is rather different.

*Distribution.* Port Blair, S. Andaman.

### 17. Pheretima peguana (*Rosa*).

1890. *Perichæta peguana*, Rosa, Ann. Mus. Genova, (2) x, p. 113, pl. i, figs. 6–8.
1895. *Perichæta peguana*, Beddard, Monog. p. 403.
1900. *Amyntas peguanus*, Beddard, P. Z. S. 1900, p. 628.
1900. *Pheretima peguana*, Michaelsen, Tier. x, p. 292.

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1922. *Pheretima peguana*, Michaelsen, Capita zool. i, 3, p. 44.

Length 170 mm.; diameter 6 mm. Segments ca. 120. Colour grey-brown. Prostomium proepilobous. Dorsal pores from 12/13. Setal rings closed or almost so; setæ larger and set more widely ventrally than dorsally; numbers ca. 56 in spermathecal region, 66/xii. Clitellum xiv–xvi (= 3). Male pores as small fissures with anterior and posterior lips, $\frac{2}{7}$ of circumference apart, in line with 10th seta. Spermathecal pores, three pairs, in 6/7–8/9, a quarter of circumference apart, in line with 12th seta. Copulatory papillæ two pairs, in 17/18 and 18/19, circular, immediately internal to the line of the male pores, occupying the space between the setal rings of xvii and xix.

Septa 8/9 and 9/10 absent (or 8/9 may be vestigial); 11/12 is the only one which is a little thickened. Gizzard in viii. Œsophagus swollen in each segment from x to xiii, and marked by vascular striations. Intestine begins in xv, cæca simple, small, originating in xxvi. Two pairs testis sacs, those of each side fused together but not communicating with each other, and not with those of the other side. Seminal vesicles two pairs, in xi and xii, slightly lobed. Prostates occupying about three segments, much cut up into lobes; duct short, narrow, looped, discharges through

a muscular bulb, with copulatory sacs in front of and behind it. Spermathecal ampulla sac-like, duct short; diverticulum long, narrow and tubular, much coiled and enclosed in an oval sac. Accessory glands corresponding to the external papillæ, large, globular, of pearly appearance, consisting of a firm outer membrane enclosing a cavity.

*Remarks.* Rosa, having described the species from Rangoon, afterwards had other specimens from Siam (**135**), which enabled him to make a few corrections in his former account. Beddard appears also to have had specimens (? he may have examined the Siam specimens which Rosa had, since they belonged to the British Museum), since (**37** *a*) he says:—"I do not agree with Rosa as to the absence of the septum 8/9. I found it to be distinctly present in individuals examined by myself." Michaelsen has recently (**131**) examined specimens from Lombok and Java; he sectioned the region of the testis sacs; as regards the sac enclosing the coils of the spermathecal diverticulum, it was not very distinct, and the appearance was as if the coils of the diverticulum were united by a jelly-like mass, which in turn was surrounded by a fine membrane.

The spermathecal diverticulum recalls that of *P. birmanica*, and the accessory glands those of *Drawida japonica*.

*Distribution.* Rangoon. Outside India from Siam, Lombok, and Java.

18. **Pheretima posthuma** (*L. Vaill.*).

1883. *Megascolex affinis*, Beddard, Ann. Mag. N. H. (5) xii, p. 214.
1895. *Perichæta posthuma*, Beddard, Monog. p. 424.
1900. *Amyntas posthumus*, Beddard, P. Z. S. 1900, p. 641.
1900. *Pheretima posthuma*, Michaelsen, Tier. x, p. 295.
1902. *Pheretima posthuma*, Beddard & Fedarb, P. Z. S. 1902, ii, p. 164, text-figs. 36–39.
1909. *Pheretima posthuma*, Michaelsen, Mem. Ind. Mus. i, p. 189.
1911. *Pheretima posthuma*, Lloyd, Introd. to Biol. for Students in India, p. 68, pl. v.
1911. *Pheretima posthuma*, Lloyd & Powell, J. Bombay Soc. xxi, p. 289, text-figs. 1–3, p. 291.
1912. *Pheretima posthuma*, Stephenson, Rec. Ind. Mus. vii, p. 278.
1913. *Pheretima posthuma*, Stephenson, Tr. Roy. Soc. Edin. xlix, p. 764.
1914. *Pheretima posthuma*, Stephenson, Rec. Ind. Mus. x, p. 342.
1915. *Pheretima posthuma*, Stephenson, Mem. Ind. Mus. vi, pp. 37, 99.
1916. *Pheretima posthuma*, Prashad, J. Bombay Soc. xxiv, p. 502, pl. i, figs. 2–7; pl. ii, fig. 6.
1916. *Pheretima posthuma*, Prashad, 'The Anatomy of an Indian Earthworm, *Pheretima posthuma*,' Lahore, p. 1.
1916. *Pheretima posthuma*, Stephenson, Rec. Ind. Mus. xii, p. 334.
1917. *Pheretima posthuma*, Stephenson, Quart. Journ. Mic. Sci. lxii, p. 261, pl. xix, fig. 2.
1917. *Pheretima posthuma*, Stephenson, Rec. Ind. Mus. xiii, p. 385.

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1918. *Pheretima posthuma*, Thapar, Rec. Ind. Mus. xv, pp. 71, 74, pl. vi, figs. 3, 4.
1919. *Pheretima posthuma*, Bahl, Quart. Journ. Mic. Sci. lxiv, p. 73, pls. vi–viii, text-figs. 1–3.
1920. *Pheretima posthuma*, Stephenson, Mem. Ind. Mus. vii, p. 222.
1921. *Pheretima posthuma*, Bahl, Quart. Journ. Mic. Sci. lxv, p. 349, text-figs. 1–11.
1922. *Pheretima posthuma*, Stephenson, Rec. Ind. Mus. xxiv, p. 434.

Length 115–130 mm.; diameter ca. 5 mm. Segments ca. 140. Colour a rich brown. Prostomium tanylobous. Dorsal pores from 12/13. Setæ in unbroken rings; all setæ of approximately the same size; numbers 144/vi, 108/x, 95/xx, 92/xxxi. Clitellum xiv–xvi (=3); sometimes no setæ, at other times indistinct rows of setæ present. Male pores in setal zone, about a quarter of circumference apart, on prominent papillæ; 19 or 20 setæ intervene. Spermathecal pores four pairs, in 5/6–8/9, about one-third of circumference apart. Copulatory papillæ two pairs, on xvii and xix, very slightly internal to the line of the male pores; occasionally papillæ on some of the following segments.

Septa 5/6–7/8 much thickened, either 8/9 or 9/10 absent as a rule, 12/13 also thickened. Cæca originate in xxvi, conical, without secondary projections. Typhlosole a slight ridge only. Lymph glands present behind xxvi. Testis sacs median, in x and xi. Seminal vesicles three pairs, in x, xi, and xii. Prostates of moderate size, occupying xvi–xxi, irregularly lobulated; duct thick, looped; no copulatory pouch. Spermathecal ampulla ovoid; duct not sharply set off, rather longer than ampulla; diverticulum of variable length, as long as or only half as long as ampulla, fairly thick. Small accessory glands correspond to the papillæ on xvii and xix.

*Remarks.* The worm is well known in India, since it is commonly used, in N. India at least, as the type for elementary study in the colleges; descriptions have been published by Lloyd and Prashad (**62**, **82** *a*).

A considerable amount of morphological work has been done on this species. Stephenson has described parts of the vascular system in detail (**72**), and Bahl has given a complete description of the whole system in *Pheretima* (**97**), one of the species investigated being the present one. Bahl has described the remarkable nephridial system, and has shown that the septal nephridia empty themselves by segmentally arranged canals into a pair of supra-intestinal excretory ducts, which in turn discharge by segmentally arranged openings into the intestine (**90**). Thapar has studied the lymphatic glands on the intestine, and the "cœlomic organ" of Beddard and Fedarb, which is shown not to be a constant structure (**89**).

Lloyd insists, against Powell, on the separateness of the two vasa deferentia of a side as they pass backwards (**63**, **64**). According to Beddard the intestinal cæca are sometimes absent (**37** *a*).

An accessory prostate may be present in xvii, with well-developed duct (Stephenson, 86).

*Distribution.* The worm is universally found in North India, throughout the Punjab, United Provinces, and Bengal (including Bihar), and localities need not be specified. It has also been found in Bombay and Baroda; Ajmer and Udaipur, in Rajputana; Gwalior in Central India; the N. Shan States, in Burma; but it has not so far been recorded from Southern India. It is also common outside India in the Pheretima area—the Philippines, Malay Archipelago, Malay Peninsula, Cochin China, as well as in the Bahamas.

### 19. Pheretima suctoria *Mich.*

1907. *Pheretima suctoria*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 165, text-fig. 12.
1909. *Pheretima suctoria*, Michaelsen, Mem. Ind. Mus. i, p. 196, pl. xiii, fig. 28, text-fig. 19.
1922. *Pheretima suctoria*, Stephenson, Rec. Ind. Mus. xxiv, p. 434, text-fig. 1.

Length 75–135 mm.; diameter 4–7 mm. Segments 103–123. Colour dorsally and anteriorly chestnut, yellowish brown elsewhere. Prostomium epilobous ca. ½, tongue short and broad, closed behind. Dorsal pores from 12/13. Setæ all nearly of equal size; rings unbroken, intersetal intervals about the same everywhere, except that on the anterior segments they are rather greater dorsally than ventrally; numbers vary greatly, 25–38/v, 35–58/x, 60–70/xiii, 75/xix, 80/xxvi. Clitellum ring-shaped, xiv–xvi (=3); setæ absent. Male pores on small papillæ in setal zone, about one-third of circumference apart. Female pores paired, close together. Spermathecal pores four pairs, 5/6–8/9, ventro-lateral, about a quarter of circumference apart. Copulatory organs as a pair of large circular or transversely oval areas on xviii, transgressing the limits of the segment both in front and behind (according to fig.), with smooth surface, either depressed or elevated, of a dark ground colour with numerous lighter spots; these areas are placed between the papillæ of the male pores, which cause a slight indentation of the outer border of the areas; the setal zone causes a similar indentation of the inner border; 4 to 8 setæ intervene between the discs.

Septa 8/9 and 9/10 wanting, 4/5–7/8 and 10/11 slightly thickened, 11/12–13/14 fairly strongly thickened. Gizzard large. Intestinal cæca simple, slender, originating in xxvi; no typhlosole. Lymph glands present. Testis sacs two pairs, in x and xi; those of a side, and those of a segment, communicating, the whole appearing as a ring with four regularly arranged globular swellings. Seminal vesicles large, compact, two pairs, in xi and xii. Prostates occupying xvii–xix, much cut up into lobes; duct fairly long and equally thick throughout, irregularly bent; no copulatory pouches. Cushions internally correspond to the discs externally. Ovisacs present in xiv. Spermathecal

ampulla bulbshaped, narrowed entally; duct sharply set off, half as long and entally one-third as thick as ampulla, narrower ectally; diverticulum irregularly bent or coiled, very long and



Fig. 123.—*Pheretima suctoria* Mich.; spermatheca; × 8.

very thin, tubular, the ental end slightly dilated; if uncoiled would be two or three times as long as the main pouch; enters ectal end of duct (text-fig. 123).

*Remarks.* The above is taken from the original description by Michaelsen. My own specimens from Bombay showed a number of differences. The length was 205 mm., the colour dark brown; prostomium epilobous $\frac{4}{5}$, the tongue not cut off, and the grooves at its sides hardly differed from the numerous other longitudinal grooves round the mouth; the setæ of ii–vi were enlarged. The male pores were closer together, scarcely $\frac{1}{4}$ of circumference apart, and at the centre of the discs; the female pore appeared to be single. Septa 5/6–7/8 were very stout. The testis sacs enclosed the hearts, and in xi covered in the seminal vesicles also. The prostatic ducts became stouter towards the ectal end. There were no ovisacs. The spermathecal ampullæ were ovoid, and the duct narrower entally.

*Distribution.* The Andamans; Bombay.

20. **Pheretima taprobanæ** (*Bedd.*).

1892. *Perichæta taprobanæ*, Beddard, P. Z. S. 1892, p. 163.
1895. *Perichæta taprobanæ*, Beddard, Monog. p. 411.
1897. *Perichæta pauli*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 243, pl. fig. 26.
1899. *Perichæta taprobanæ*?, Michaelsen, Zool. Jahrb. Syst. xii, p. 140.
1900. *Amyntas taprobanæ*, Beddard, P. Z. S. 1900, p. 648.
1900. *Pheretima taprobanæ*+*P. taprobanæ* var. *pauli*, Michaelsen, Tier. x, pp. 308, 309.
1903. *Pheretima taprobanæ*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 12.

Length 80–145 mm.; diameter 5–7 mm. Segments 95–122, triannular in consequence of elevation of setal ridges. Colour (preserved) pale brownish grey, clitellum a darker brown. Prostomium epilobous $\frac{1}{2}$; a middorsal longitudinal furrow over prostomium and i. First dorsal pore in 11/12 or 12/13. Setal

rings indistinctly broken dorsally, closed ventrally; $zz=1\frac{1}{3}$ to $2yz$; numbers 70/v, 77/x, 70/xix, 54/xxvi. Clitellum xiv–xvi (=3); setæ present. Male pores on small, slightly raised papillæ, $\frac{1}{3}$ of circumference apart. Spermathecal pores one pair, in 7/8, almost half the circumference apart. Copulatory papillæ circular, sunk in the middle, paired, on the anterior half of their segments, vii–x and xviii–xx, often also on vi, xi, and xxi, the posterior in two lines which converge posteriorly, those on xviii rather internal to the line of the male pores, on xix in the line of the pores, on the following segments successively a little nearer to the middle line; the anterior papillæ in regular longitudinal lines, about 5 intersetal intervals nearer the middle line than the spermathecal apertures.

Septa 8/9 and 9/10 wanting; 6/7–7/8 and 10/11–13/14 thickened. Gizzard almost globular. Intestine begins xv; no intestinal cæca. Two pairs seminal vesicles, in xi and xii. Prostates with small glandular portion confined to xviii, and U-shaped duct, the ental part of which is rather thinner; no copulatory pouch. Spermathecal ampulla ovoid; duct fairly long, as long as ampulla, and thick; diverticulum tubular, as long as main pouch and half as thick as ampulla, joining ectal end of duct, its ental half swollen to form a seminal chamber, its ectal half acting as duct.

*Remarks.* Beddard at first overlooked the papillæ, which led Michaelsen to describe his own specimens as a separate species.

*Distribution.* Ceylon. Outside India from Madagascar and Brazil.

### 21. Pheretima travancorensis (*Fedarb*).

1898. *Perichæta travancorensis*, Fedarb, J. Bombay Soc. xi, p. 435, pl. ii, figs. 2, 5.
1900. *Amyntas travancorensis* (part.), Beddard, P.Z.S. 1900, p. 614.
1900. *Pheretima travancorensis*, Michaelsen, Tier. x, p. 310.

Length 70 mm.; diameter 4 mm. Segments 94. Colour dorsally and anteriorly purple; behind clitellum only the mid-dorsal line is purple. First dorsal pore in 16/17. Clitellum xiv–xvi (=3). Male pores raised, but not on sharply defined papillæ; 10 setæ intervene. Spermathecal pores three pairs, in 6/7–8/9.

Septum 8/9 wanting. Intestine begins in xv; intestinal cæca simple. Last heart in xiii. Seminal vesicles three pairs, small, in xi, xii, and xiii. Prostates fairly large, loosely racemose, occupying xvii–xix; duct coiled in a circle. Spermathecal ampulla pear-shaped, narrowing gradually to form the duct; diverticulum given off from the duct at its junction with the body-wall, thin, often undulating, if stretched out is about as long as the main pouch, dilated at its ental end to form a thickly pear-shaped seminal chamber.

*Remarks.* Beddard (**37** *a*) unites *P. crescentica* (Fedarb, **36**) with this species, and is followed by Michaelsen (**54**). Michaelsen (**54, 58**) considers this species to be possibly identical with *P. dubia* (Horst).

The spermathecal diverticulum of this form seems to be different in shape from that of *P. crescentica*; there is here no glandular appendage of the spermatheca looking at first like a second diverticulum; and there are three pairs of seminal vesicles as against two in *P. crescentica*. On these grounds I believe the species to be distinct; but *crescentica* should, I think, be united with *houlleti*.

*Distribution.* Travancore.

22. **Pheretima trivandrana** *Steph.*

1916. *Pheretima trivandrana*, Stephenson, Rec. Ind. Mus. xii, p. 335, pl. xxxii, fig. 27, pl. xxxiii, figs. 28, 29.

Length 70 mm.; maximum diameter 3 mm. Segments 100. Colour an equable grey. Prostomium epilobous $\frac{1}{2}$, tongue broad, not closed behind. Dorsal pores from 8/9. Setal rings closed dorsally in the first ten segments, thereafter a slight break, $zz=2\,yz$; ventral break also small, ca. $1\frac{1}{2}$ *ab*, or absent in some of the anterior segments; setæ of ii–ix rather enlarged, those of x rather small; numbers 28/v, 46/ix, 52/xii, 52/xix, and 54 in middle of body. Clitellum scarcely distinguishable, perhaps xiv–xvi (=3?). Male pores situated towards the inner side of, but well within, a pair of circular thickened areas which are somewhat raised in their centres; the pores in line with *g*, and rather more than $\frac{1}{4}$ of circumference apart, with about 9 setæ intervening. Female pores paired. Spermathecal pores three pairs, in 6/7–8/9, ventro-lateral, about $\frac{2}{5}$ of circumference apart.

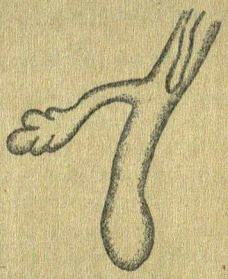

Fig. 124.—*Pheretima trivandrana* Steph.; spermatheca.

Septa 8/9 and 9/10 absent, about three in front of and three behind the gap somewhat thickened. Gizzards well developed, ovoid. Intestine begins in xv, cæca originate in xxvii. Testis sacs in x and xi. Seminal vesicles two pairs, in xi and xii, lobed. Prostates small, in xvii and xviii, cut up into numerous small lobules; duct describes almost a complete circle, and increases in

thickness towards the ectal end, firm and shining except at its ectal end, lying on a soft white cushion. Spermathecal ampulla relatively small, ovoid, or pear-shaped; duct very stout, almost straight, much longer than ampulla; diverticula two, one thin, finger-like, a simple tube, about half as long as duct, arising from ectal end of duct, its lumen wider at the ental end; the other arising from the middle of the duct, consisting of a pear-shaped chamber subdivided into about three or four loculi which give to the surface a lobulated appearance, and a stalk, the whole nearly as long as the main pouch above the entry of this diverticulum; of this second kind of diverticulum there may be two, one smaller than the other (text-fig. 124).

*Remarks.* This species is very similar to *P. houlleti*, and indeed may be identical with it. It is possible that the loculated seminal chamber of the second diverticulum may be in reality a convoluted tube, the windings closely pressed together, as in *P. houlleti*; a re-examination of the original material seems to show that this is not unlikely. I also looked for clitellar setæ, but no sacs were visible.

*Distribution.* Trivandrum (Travancore).

## 10. Genus **DIPOROCHÆTA** *Bedd.*

1890. *Diporochæta*, Beddard, P. Z. S. 1890, p. 56.
1895. *Diporochæta*, Beddard, Monog. p. 430.
1900. *Diporochæta*, Michaelsen, Tier. x, p. 199.
1907. *Diporochæta*, Michaelsen, Fauna S.W. Austral. p. 161.
1916. *Perionyx* (part.), Michaelsen, Mjöberg's Austral. Exp. pp. 46, 53

Setæ, at least in the middle and hinder parts of the body, numerous (more than eight) per segment. Spermathecal pores 2–5 pairs, the last in 8/9. One gizzard in the region of segments iv–vi, seldom vestigial. Purely meganephridial. Prostates tubular, with simple unbranched duct.

The genus was established by Beddard for worms with the essential three features of the group as we still know it,—perichætine arrangement of the setæ, tubular prostates, and meganephridia. In the Monograph he adds a character of the clitellum to the diagnosis,—"clitellum generally more than three segments." Michaelsen in the Tierreich volume included Bourne's *Perichæta pellucida* in the genus, which thus came to have an Indian representative (all previously admitted species having belonged to Australia or New Zealand). Michaelsen in his diagnosis admitted the possibility of a racemose prostate; but in 1907 he retracted this, in consequence of his views on the importance of the prostate in the classification of the Megascolecinæ, and defined the genus as above. Still more recently (1916) he has fused the genus with *Perionyx*, under the name of the latter, though allowing it a certain independence as a subgenus.

In this last change I do not follow him. The reason for the fusion is that there exists a series of intermediate forms. The feature in which *Diporochæta* differs from *Perionyx* is the prostate, tubular in the first, racemose in the second; and it happens that all stages in the evolution of the racemose (Pheretima-prostate) from the tubular (Plutellus-prostate) are to be found in the combined genus (*Diporochæta* + *Perionyx*), so that any separation between the two must be arbitrary; further, there is not either any geographical means of distinguishing them. *Diporochæta* as a subgenus, however, is to be distinguished, according to Michaelsen, as including all forms in which there is a distinct central canal through the middle of the glandular part of the organ, even though this central canal may receive branches.

But the fact that the dividing line is an arbitrary one is no reason for not drawing it, if convenience demands it. If the existence of intermediate forms is to be allowed to prevent us from making a division, we may look forward, as our knowledge increases, to seeing our groups diminish in number, until, the more perfect our knowledge becomes, the more our classification fades away into nothingness; so that when, owing to the number of forms known, our need for a detailed classification is greatest, we shall be left without any classification at all.

Michaelsen has already fused the genera *Notoscolex* and *Megascolex*; to be consistent, *Megascolides* also must be fused, since here too there are a number of intermediate forms between the Plutellus-prostate and the Pheretima-prostate. This would lead to the establishment of a huge genus, *Megascolides* + *Notoscolex* + *Megascolex*, which would be extremely unwieldy, and would contain forms with lumbricine setæ, tubular prostates, and a nephridial system consisting almost entirely of meganephridia, along with others with perichætine setæ, racemose prostates, and a nephridial system of micronephridia only—it would, in short, be a renunciation of classification.

In fine, one of the great features in the evolution of the Megascolecinæ has been the change in the prostate; and if this is not to be marked in our scheme of classification, the scheme will be comparatively useless: it will certainly fail to indicate what it ought.

The dividing line between *Diporochæta* and *Perionyx* considered as subgenera of *Perionyx* s.l., as proposed by Michaelsen, is not the same as that proposed in the case of *Megascolides* and *Notoscolex*. In the latter case *Megascolides* is to retain only those species in which there is no hint of branching of the duct; *Diporochæta*, however, is to include forms with branching ducts, so long as there is a definite central canal through the axis of the gland.

The genus *Diporochæta* has arisen from *Plutellus* by the substitution of the perichætine for the lumbricine setal arrangement; and, as has been said, has given rise to *Perionyx* by the substitution of the racemose for the tubular prostate.

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It should be noted, however, that the only Indian representative of the genus stands rather aside from the main line of this evolution by reason of the character of the anterior nephridia, in which it differs, apparently, from the Australian and New Zealand species or the majority of them. *Diporochæta* is defined as being purely meganephridial; but the term "meganephridium" is usually taken to mean the tubular form of the organ found, for example, in the Lumbricidæ. In the anterior part of *Diporochæta pellucida*, however, the nephridia are tufted—a form which is generally, I think, looked on as a variety of micronephridia (I have little doubt, for example, that when Michaelsen described a number of new species of the genus in 1910 (Abh. Ver. Hamburg, xix, 1), he intended, by calling them "meganephridial," to exclude this form of nephridium equally with the scattered micronephridia); and it would not have been strange if *Diporochæta pellucida* had found a place under the genus *Spenceriella* (micronephridial, with perichætine setæ and tubular prostates).

In the Megascolecidæ this modification of the anterior nephridia very commonly goes along with the breaking-up of the post-clitellar nephridia into scattered micronephridia. It seems possible, therefore, that *Spenceriella* may have arisen from such a *Diporochæta* as *D. pellucida* by the substitution of micronephridia for meganephridia (not from *Megascolides* by the development of the perichætine arrangement and further breaking-up of the nephridia). In any case, for geographical as well as anatomical reasons, it seems probable that the present species is not phyletically related to the Australian species.

(On the subject of the nephridia, see further under the species.)

*Distribution.* For the Indian species no locality is given; presumably it was in Southern India. The headquarters of the genus is in Victoria and Tasmania; species are also found in Queensland, New Zealand, and (one species) on the Chatham Islands.

1. **Diporochæta pellucida** (*A. G. Bourne*).

1894. *Perichæta pellucida*, Bourne, Quart. Journ. Mic. Sci. xxxvi, p. 13, pl. iv, figs. 17–32, pl. v, fig. 42.
1900. *Diporochæta pellucida*, Michaelsen, Tier. x, p. 207.

Length 450 mm.; diameter ca. 4 mm. Unpigmented; body-wall very transparent. Prostomium small, without dorsal process. Dorsal pores from 5/6. Dorsal setal gap = 10 *yz*, ventral gap =3 *ab*; numbers 24/ii, 44/v, 36/ix, 36/xx. Clitellum rather indefinite, including a little of the posterior end of xii and $\frac{1}{3}$ of xx (= ca. $7\frac{1}{2}$); not well developed ventrally. Male pores in a small dumbbell-shaped pit, at a distance apart equal to five intersetal intervals, but no setæ actually intervene. Female pores paired, in front of setæ *a*. Spermathecal pores in 7/8 and 8/9, between the lines of *a* and *b*.

Gizzard in v. Calciferous glands in xiv, xv, and xvi. Intestine begins in xviii; no cæca; no typhlosole. A pair of complex

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nephridia in each of segments vii–xi, consisting each of a nephridial tube with a bush-like group of tubules springing from one part; a pair of small simple nephridia in each of the following segments; no micronephridia. Testes and funnels free in x and xi. Prostates long, tubular, confined to xviii. Spermathecæ as elongated pyriform sacs with a small cæcum.

*Remarks.* In Bourne's own separate copy of his paper of 1886 in the P. Z. S. ("On Indian Earthworms. Part I.—Preliminary Notice of Earthworms from the Nilgiris and Shevaroys"), which has come into my hands, there is written opposite the heading of the description of *Perichæta* (*Pleurochæta*?) *gracilis* "=*P. pellucida.*" It would seem, therefore, that Bourne himself identified the *species inquirenda*: *Perichæta gracilis* with the present species; the differences in the descriptions, however, seem too great to justify the inclusion of the latter species in the synonymy. It will be best to leave *P. gracilis*, as Michaelsen does in the Tierreich, as a doubtful species of *Megascolex*.

Bourne used this species in his investigations on the development of the setæ, and has some observations on the development of the nephridia also.

The genus to which this species is to be referred depends on the interpretation of the anterior nephridia. These are bushy tufts on each side in segments vii–xi, and evidently are the same things as the tufts so commonly found in numerous genera of Megascolecidæ, in more than one subfamily. If they are considered as micronephridial, the species will go under *Spenceriella*; if each tuft is looked on as a meganephridium, under *Diporochæta*. In accordance with what was said under *Woodwardia*, I consider the tufts as a special form of meganephridium, and the present species as belonging to *Diporochæta*. It is, however, evident that such a form cannot belong to the direct line of ancestry of *Perionyx*; *Perionyx* must have originated from forms which retained the original structure of the meganephridia in the anterior part of the body.

*Distribution.* Probably Southern India.

## 11. Genus **PERIONYX** *E. Perr.*

1895. *Perionyx*, Beddard, Monog. p. 435.
1900. *Perionyx* + *Diporochæta* (part.), Michaelsen, Tier. x, pp. 207, 199.
1907. *Perionyx* + *Perionychella*, Michaelsen, Fauna S.W. Austral. p. 163.
1909. *Perionyx* + *Perionychella*, Michaelsen, Mem. Ind. Mus. i, p. 119.
1910. *Perionyx*, Michaelsen, Abh. Ver. Hamburg, xix, p. 58.
1916. *Perionyx* (part.), Michaelsen, Mjöberg's Austral. Exp. p. 7.

Setæ numerous (more than eight) per segment, in rings which are often almost closed. Male pores often approximated in greater or less degree, and may be very close to the middle line.

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Female pore unpaired (? always). Spermathecal pores, like the male pores, often very near the middle line, the last pair in 7/8 or 8/9. Gizzard very frequently more or less vestigial, in v or vi. Meganephridial. Two pairs testes and funnels. Prostates of the branched *Pheretima*-type.

The early history of the genus can be ascertained from the synonymy in Michaelsen's Tierreich volume, where the diagnosis does not differ very greatly from that adopted here. Since that date, however, the definition of the genus has been modified more than once.

In 1907 Michaelsen instituted a new genus *Perionychella*—meganephridial, with perichætine arrangement of the setæ and *Pheretima*-prostates; it differed in this last character from *Diporochæta*, in which its species had mostly been included, and from *Perionyx* in not having the vestigial gizzard and approximated male and spermathecal pores of the latter. The new genus was, however (in accordance with the view then held that the branched prostate had arisen once only in the history of the subfamily), not supposed to have arisen from *Diporochæta*, but from *Woodwardia*; *Perionyx* was its descendant. Its separation from *Perionyx* appeared to be justified, not only by the anatomical characters, but also by the facts of distribution, *Perionychella* being found only in the Australian region, *Perionyx* only in the Indian.

In 1909 Michaelsen described a number of species of *Perionychella* from India, though he recognized that the separation from *Perionyx* on anatomical characters was difficult, and that the geographical distinction too was breaking down. In 1910 he found that he could no longer maintain the two genera as distinct, since a *Perionyx* with vestigial gizzard and approximated genital pores had been found in the Australian region (Auckland Islands); he therefore united them under the name *Perionyx*.

The most recently proposed alteration of the content of the genus—the inclusion in it of *Diporochæta*—*Diporochæta* and *Perionyx* s. s. becoming subgenera of *Perionyx* s. l., has been discussed under the heading of *Diporochæta*, where also I give my reasons for continuing the two as separate genera.

On the phylogenetic derivation of *Perionyx*, see also under *Diporochæta*.

A typical *Perionyx* has a characteristic appearance, and can be referred to the genus at sight. The body is often depressed, the dorsal surface is of a deep purple colour, the ventral surface much paler; the setæ are numerous and close-set, especially ventrally, and the rings closed or nearly so; the male and spermathecal pores are very near the midventral line, and copulatory papillæ are much less frequent than in the genera *Megascolex* and *Pheretima*.

The most aberrant species are *polytheca*, with seven pairs of spermathecæ, and *annulatus*, with micronephridia; on the justification for retaining this latter species in the genus, see

Stephenson (**95**, p. 119); though by strict definition this worm should be a *Megascolex*, yet its general habitus is so markedly that of *Perionyx* that it can hardly be doubtful where its relations lie, while the matter is definitely settled by its occurrence in the *Perionyx* region and far away from that of *Megascolex*.

The structure of the prostate in a number of species is described by Michaelsen (**83** *a*).

*Distribution* (Chart III). The Eastern Himalayas, including the Abor Country and Assam, is the chief home of the genus; the Western Himalayas (neighbourhood of Simla, Kumaon Dist.) have a few endemic species; Bengal, Burma, South India (Nilgiris, Mysore), Bombay and neighbourhood (as far as Belgaum to the south), and Ceylon each have one or two species. *P. excavatus* and *P. sansibaricus* are peregrine species which have wandered widely; they are omitted from the above statement. Some immature specimens, probably of peregrine species, have been recorded from the Maldive Islands.

The genus is also endemic in the Australian region—in Victoria, Tasmania, and the Auckland Islands. In addition, *P. excavatus* extends over the islands and coasts of the Indian Ocean and Malay Archipelago; *P. sansibaricus* is found in Zanzibar as well as in S., W., and Central India; and a species *P. violaceus* is found in Sumatra and Java.

If the Indian localities are indicated on a map, the distribution is seen to be a double one: the main home of the genus is in the E. Himalayas, stretching W. to Simla and E. into Burma; but it has also established itself in a line along the S. W. of the peninsula from Bombay to Ceylon. These are the regions of the greatest rainfall. I have mentioned as peculiarities of the genus that it has not infrequently been found in wood or on trees or under the leaves of trees, or even in running water (**73**, **93**).

*Key to the Indian species of* Perionyx.

| | |
|---|---|
| 1. Seven pairs of spermathecæ, opening in 2/3–8/9 | *P. polytheca.* |
| Four pairs of spermathecæ, opening in 5/6–8/9 | *P. arboricola.* |
| Three pairs of spermathecæ, opening in 6/7–8/9 | 2. |
| Two pairs of spermathecæ, opening in 6/7 and 7/8 | 6. |
| Two pairs of spermathecæ, opening in 7/8 and 8/9 | 16. |
| 2. Spermathecæ without diverticulum, pigment in spots | *P. variegatus.* |
| Spermathecæ with a single diverticulum | 3. |
| Spermathecæ with two or more diverticula | 4. |
| 3. Nephridia (and presumably nephridiopores) in a regular line | *P. foveatus.* |
| Nephridiopores and end-bladders alternating in position in successive segments | *P. sansibaricus.* |

| | | |
|---|---|---|
| 4. | Penial setæ present | *P. ceylanensis.* |
| | No penial setæ | 5. |
| 5. | Nephridiopores alternating in position in successive segments | *P. saltans.* |
| | Nephridiopores not alternating; micronephridia coexist with meganephridia behind the genital region | *P. annulatus.* |
| 6. | Penial setæ absent | 7. |
| | Penial setæ present | 11. |
| 7. | Testis sacs present | 8. |
| | Testes and funnels free | 9. |
| 8. | Male pores ½ of circumference apart, on small papillæ | *P. himalayanus.* |
| | Male pores near togetner, in line with *b* or *c*, on papillæ delimited by a common groove in front and behind | *P. pokhrianus.* |
| | Male pores very close together, in a deep transverse fissure | *P. rimatus.* |
| 9. | Last heart in xiii | *P. kempi.* |
| | Last heart in xii | 10. |
| 10. | Setæ on dorsal surface in anterior third of body larger and set more widely than behind | *P. heterochætus.* |
| | No difference such as the above | *P. nanus.* |
| 11. | Ornamentation of penial setæ as definite spines or teeth | 12. |
| | Ornamentation of penial setæ as fine sculpturing | 14. |
| 12. | Male pores on large papillæ of characteristic outline | *P. alatus.* |
| | Male pores on small papillæ or in depressions | 13. |
| 13. | Male pores on papillæ or on a circular wall; spermathecal pores about ⅓ of circumference apart | *P. sikkimensis.* |
| | Male pores each in a depression; spermathecal pores ⅓ of circumference apart | *P. depressus.* |
| 14. | Last heart in xii | 15. |
| | Last heart in xiii | *P. pallidus.* |
| 15. | Male pores on the sides of a shallow depression; highest number of setæ ca. 80 | *P. inornatus.* |
| | Male pores in a depression which is surrounded by a thick lip; highest number of setæ ca. 60 | *P. pincerna.* |
| | Male pores on small papillæ which are conjoined in the middle line; highest number of setæ ca. 43 | *P. gravelyi.* |
| 16. | Penial setæ present | 17. |
| | No penial setæ | 25. |
| 17. | Penial setæ little modified | 18. |
| | Penial setæ with spines or teeth | 19. |
| 18. | Two sessile spermathecal diverticula | *P. fossus.* |
| | No spermathecal diverticula | *P. nainianus.* |
| 19. | Penial setæ with square-cut tip | 20. |
| | Penial setæ pointed, usually bluntly | 21. |

| | | |
|---|---|---|
| 20. | Spines projecting from the flat end of the penial setæ | *P. turaensis.* |
| | No spines on the flat end of the penial setæ. | *P. excavatus.* |
| 21. | No spermathecal diverticula | 22. |
| | Spermathecal diverticula present | 24. |
| 22. | Calciferous glands set off from the œsophagus in xiii | *P. fulvus.* |
| | No calciferous glands | 23. |
| 23. | Penial setæ with about 20 rings of spines | *P. koboensis.* |
| | Penial setæ with 10 or fewer rings of spines. | *P. bainii.* |
| | Penial setæ with a few scattered transverse rows of very minute teeth | *P. mysorensis.* |
| 24. | A spermathecal diverticulum; last heart in xiii | *P. millardi.* |
| | Two clusters of diverticula; last heart in xii. | *P. shillongensis.* |
| 25. | Clitellum extending over 13 segments | *P. annandalei.* |
| | Clitellum extending over fewer than 13 segments | 26. |
| 26. | Seminal vesicles present in ix | 27. |
| | No seminal vesicles in ix | 28. |
| 27. | One large mammillated spermathecal diverticulum | *P. simlaensis.* |
| | Two spermathecal diverticula | *P. minimus.* |
| 28. | One or more spermathecal diverticula | 29. |
| | No spermathecal diverticula | 30. |
| 29. | Last heart in xii; dorsal pores from 1/2 | *P. pullus.* |
| | Last heart in xiii; dorsal pores from 4/5 | *P. modestus* (part.). |
| 30. | Largest number of setæ over 100; length over 200 mm. | *P. m'intoshi.* |
| | Largest number of setæ under 100; length under 200 mm. | 31. |
| 31. | Male pores on longitudinally oval cushions in a midventral depression | *P. pulvinatus.* |
| | Male pores at end of a transverse groove | *P. modestus* (part.). |

A few natural groups may be distinguished. Of these the best marked is characterized by the possession of testis sacs; it includes *himalayanus*, *pokhrianus*, *rimatus*, and *alatus*, all with two pairs of spermathecæ opening in 6/7 and 7/8, and all from Darjiling District; *alatus* is the most distinct in possessing penial setæ, which the others lack.

Also from the same district are *pincerna* and *inornatus*, which may possibly be identical. *P. pallidus* and *gravelyi* may be coupled together, and have an obvious connection with the former pair. *P. heterochætus* and *nanus* from the same region, and *kempi* from the Abor Country, form another group which also has relations to *pallidus* and *gravelyi*. All hitherto mentioned belong to that large section of the genus which has two pairs of spermathecal pores opening in 6/7 and 7/8.

*P. saltans* and *sansibaricus* are linked together by the peculiar alternation in the position of the nephridiopores in successive segments; an approximation to this condition is seen in *ceylanensis* and *koboensis* also, though the home of the latter is remote from that of the other species just mentioned, which are found in the west and south.

*P. fulvus* (Calcutta, Burma) and *P. turaensis* (Assam) are perhaps connected with the widely wandering *excavatus*, and possibly *bainii* should come in the same group; while there are resemblances between *bainii* and *millardi* (*bainii* from Simla, *millardi* from Bombay Presidency). *P. parvulus* I have united with *excavatus*; the latter is known to vary very much in size, and it needs only to stretch the lower limit previously given for *excavatus* somewhat further to include *parvulus* without any considerable difficulty.

### 1. Perionyx alatus *Steph.*

1920. *Perionyx alatus*, Stephenson, Mem. Ind. Mus. vii, p. 212, pl. ix, figs. 14–16.

Length 84 mm.; diameter 3 mm. Segments 123. Colour dusky purple dorsally, pale ventrally. Prostomium epilobous $\frac{1}{3}$, tongue not closed behind. Dorsal pores from 4/5. Setal rings closed dorsally and ventrally; setæ rather closer set ventrally; numbers 50/v, 55/ix, ca. 54/xii, 50/xix, and ca. 52 in middle of body. Clitellum including xiii and first third of xvii (=$4\frac{1}{3}$). On xviii a pair of large transversely elongated papillæ, joined in the middle




Fig. 125.—*Perionyx alatus* Steph.; male genital field.

line by a narrow neck, with crenulated margins; the conjoined papillæ surrounded by a deep groove (text-fig. 125). The male pores as transverse grooves in the broader, inner part of the papillæ; distance between the middle points of the grooves one-fourth of the transverse extent of the ventral surface. Spermathecal pores two pairs, in 6/7 and 7/8, the same distance apart as the male pores, in line with the setal interval *de*.

No septa notably thickened, 6/7–8/9 slightly so. Gizzard in v, large, cylindrical, and rather soft. Intestine begins in xx behind the prostates. Last heart in xiii. Nephridia end all in the same line. Testis sacs in x and xi, delicate, both adherent to the seminal vesicle of xi, which spreads over the sac of x from behind. Seminal vesicles in xi and xii, fused dorsally over the alimentary canal in each segment. Prostates large, occupying xvii–xix, much indented; duct irregularly twisted, soft, moderately long, widest at its ectal end. The posterior pair of spermathecæ are the larger; the spermathecal ampulla is a considerable smooth sac; the duct is very stout, about two-thirds as long as the ampulla, separated from the ampulla by a constriction, below which it is slightly

swollen; the swollen upper part of the duct corresponds to the diverticulum, but there are no definite seminal chambers (text-fig. 126). Penial setæ (text-fig. 127) 1 mm. long, 20 $\mu$ thick;



Fig. 126.—*Perionyx alatus* Steph.; spermatheca; the markings on the upper part of the duct represent masses of spermatozoa shining through.



Fig. 127.—*Perionyx alatus* Steph.; tip of penial seta; × ca. 250.

shaft almost straight, but curved like a hockey-stick at the proximal end; the tip gently curved, bluntly pointed, the distal portion of the shaft ornamented by minute irregularly scattered spines.

*Remarks.* The species belongs to the *himalayanus* group, but is distinguished from its allies by possessing penial setæ; the configuration of the male field is also characteristic.

*Distribution.* Sitong Ridge, Darjiling Dist.

### 2. Perionyx annandalei (*Mich.*).

1907. *Perionychella annandalei*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 154, text-fig. 7.
1909. *Perionychella annandalei*, Michaelsen, Mem. Ind. Mus. i, p. 166, text-fig. 13.
1910. *Perionyx annandalei*, Michaelsen, Abh. Ver. Hamburg, xix, p. 61, pl. fig. 7.

Length 160–280 mm.; maximum diameter 6–10 mm. Segments 170–215. Colour dorsally a dark violet-blue, ventrally reddish grey. Prostomium proepilobous, shortly epilobous, or epilobous $\frac{1}{2}$. First dorsal pore in 6/7. Setæ very small in the anterior part of the body, somewhat larger behind; very close together ventrally, somewhat wider apart dorsally; rings complete, or shortly interrupted dorsally; numbers 85/x, 70/xix. Clitellum xii–xxiv (=13), ring-shaped, less well marked ventrally at the extremities. Male area depressed or elevated, occupying the whole length of

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xviii, pale in colour, as is also the surrounding region; in the setal zone the area elevated to form a ridge. Male pores in the lateral parts of the area in the setal zone; a few setæ on the ridge between the male pores. Spermathecal pores two pairs, 7/8 and 8/9, near the middle line.

Septa thickened in the region of the seminal vesicles. Gizzard moderately large, in vi. No calciferous glands. Funnels apparently free in x and xi. Seminal vesicles in xi and xii, or xi, xii and xiii, compact and grape-like, those of xiii, when present, smaller and apparently continuous with those of xii. Prostates occupying xviii and xix, thick, compact, with fissured surface, cleft by septum 18/19; duct short and thick. Spermathecal ampulla sac-like or irregular; duct half as long and half as thick as ampulla; two or three seminal chambers enclosed in its wall, projecting externally as a single papilla-like excrescence, or as so many small knobs, flat, and lustrous; no free diverticula. No penial setæ.

*Distribution.* Kurseong, Darjiling Dist.; Cherrapunji, Assam.

### 3. **Perionyx annulatus** *Steph.*

1914. *Perionyx annulatus*, Stephenson, Rec. Ind. Mus. viii, p. 386.

Length 100–150 mm.; diameter 4–6 mm. Segments 198–230. Dorsal surface in general a dusky purple; intersegmental grooves and setal ridges pale, a banded appearance resulting; ventral surface pale. Prostomium large, broad, epilobous $\frac{3}{4}$. First dorsal pore in 4/5. Setal rings unbroken or nearly so ventrally; dorsally a small interval ($1\frac{1}{2}$–2 *yz*); intersetal distances a little greater dorsally than ventrally; numbers 55/iv, 74/ix, 82/xiii, 70/xix, 70/xxvi. Clitellum rather paler, xiii-xvii (=5); xii slightly modified also. Male pores fairly close together, ca. $\frac{1}{8}$ of circumference apart, on the lateral boundaries of a rectangular midventral depression which takes up the whole length of the segment, and is $1\frac{1}{4}$ times as broad as long. Spermathecal pores three pairs, in 6/7–8/9, ca. $\frac{2}{11}$ of circumference apart, the posterior pair opposite the 9th seta.

Septa from the anterior end as far as 9/10, as well as 17/18 and 18/19, slightly thickened; 13/14–16/17 moderately so. Gizzard of some size, but soft and flattened dorso-ventrally, in vii. Œsophagus much bulged in xiii–xv, the anterior dilatation with wall strongly ridged internally. Intestine begins in xix. Last heart in xiii. Meganephridia in all segments; in addition, in the post-genital segments, a number of minute micronephridia in transverse lines on the body-wall, especially ventrally. Testes and funnels in x and xi. Seminal vesicles in xi and xii, those in xi fused together. Prostates confined to xviii, granular in appearance, hemispherical with the flat surfaces facing inwards; duct long and coiled, the coils closely applied to each other on the inner face of the gland, the last portion of the duct thicker than the rest.

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Spermathecæ large, sausage-shaped, almost meeting dorsally above the gut; duct short and moderately stout; diverticula two or more, very small, sessile on lower part of ampulla, divided or not divided into minute lobes. No penial setæ.

*Remarks.* A number of specimens showed variations in the position of the organs in the anterior part of the body; the male pores may be on xix or xx; there may be four pairs of spermathecæ; the last heart may be in xvi.

On the position of the worm see the introduction to the genus.

*Distribution.* Rotung, and S. of Yembung, Abor Country.

### 4. Perionyx arboricola *Rosa.*

1890. *Perionyx arboricola*, Rosa, Ann. Mus. Genova, (2) x, p. 119, pl. i, fig. 11.
1895. *Perionyx arboricola*, Beddard, Monog. p. 438.
1900. *Perionyx arboricola*, Michaelsen, Tier. x, p. 209.

Length 70 mm.; diameter at clitellum 5 mm. Segments 110. Body depressed, posterior end pointed. Colour dorsally greenish brown, ventrally yellowish. Prostomium epilobous $\frac{1}{2}$. Setal rings closed; setæ closely set ventrally, very widely apart dorsally, so that 8 or 9 are seen on the dorsal surface, and about 40 on the ventral; number per segment 56–60. Dorsal pores begin from 5/6. Clitellum ring-shaped, xiv–xvi (=3). Male pores on large papillæ, which are situated on the sides of a median depression, the anterior and posterior borders of which are at the middle of segments xvii and xix respectively. Spermathecal pores inconspicuous, four pairs, in 5/6–8/9.

Gizzard very small, in v. Seminal vesicles two pairs, in xi, and xii–xiv; the first pair small, the second divided into three lobes by the septa. Prostates very long, occupying nine segments, xvi–xxiv, cut into lobes by the septa; duct thin at first, rapidly widening. Spermathecæ with club-shaped diverticulum somewhat longer than the ampulla.

*Remarks.* Found on trees, especially in the axils of the leaves.

*Distribution.* Cobapo, Cheba or Biapo Dist., Burma.

### 5. Perionyx bainii *Steph.*

1915. *Perionyx bainii*, Stephenson, Mem. Ind. Mus. vi, p. 72, pl. vii, fig. 14, pl. viii, fig. 15.

Length 23–50 mm.; diameter 2–2½ mm. Segments 94. Colour dark bluish purple dorsally, grey ventrally. Prostomium epilobous $\frac{1}{2}$, tongue cut off behind. Dorsal pores from 4/5. Setal ring slightly interrupted dorsally; $zz = 2\,yz$ in front of clitellum, $1\frac{1}{2}\,yz$ behind; ring closed ventrally behind clitellum, but in front of clitellum there may be a slight break; numbers 52/vii, ca. 55/xiii, 56/xx. Clitellum xiii–xvii (=5). Male pores as transverse cracks with small tag-like papilla at the outer side of each, and a transverse groove in front and behind, ca. $\frac{1}{10}$ of

circumference apart; the region of the pores marked by a number of small fissures (text-fig. 128). Spermathecal pores in 7/8 and 8/9, considerably further apart than the male pores (about $\frac{1}{5}$ or $\frac{1}{6}$ of circumference).

No septa thickened. Gizzard unrecognizable as such; œsophagus dilated and soft in vi. No calciferous glands; œsophagus bulged in x–xiii with transverse vascular striation. Intestine begins in xvi. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, the anterior pair almost meeting, the posterior meeting and fusing. Prostates confined to xviii,

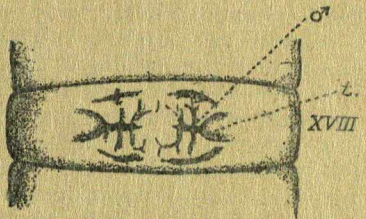


Fig. 128.—*Perionyx bainii* Steph.; male genital field; *t.*, overhanging papilla, or "tag."



Fig. 129.—*Perionyx bainii* Steph.; distal end of penial seta; × ca. 300.

each a compact mass; duct short, moderately stout, transverse in direction and almost straight. Spermathecæ large, with regularly ovoid ampulla; duct stout, marked off from the ampulla, about equal in length to the ampulla; no diverticulum. Penial setæ (text-fig. 129) 1 mm. long, 20 $\mu$ in thickness at middle of shaft, six or more on each side; shaft slightly curved towards distal end, tip bluntly pointed, with a slight bulbous swelling just proximal to the tip; about eight rings of fairly large spines near tip.

*Remarks.* On the similarity to *P. millardi* see under this latter species.

*Distribution.* Near Simla, W. Himalayas.

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### 6. Perionyx ceylanensis *Mich.*

1903. *Perionyx ceylanensis*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 6, text-fig. D.
1916. *Perionyx ceylanensis*, Michaelsen, Ark. f. Zool. x, no. 9, p. 8.

Length 42–75 mm.; maximum diameter ca. 2 mm. Segments 120–140. Colour dorsally violet with indistinct darker median stripe, ventrally yellowish. Prostomium epilobous $\frac{1}{2}$. Dorsal pores from 3/4 (rudimentary ?) or 4/5 (always distinct). Setæ closer set ventrally, the rings closed dorsally and ventrally or almost so; numbers 32/ii, 40/v, 40/x, 39/xii, 37/xix, 38/xxvi, 39/xlv. Nephridiopores at rather different levels, not regularly alternating. Clitellum ring-shaped, xiii–xvii (=5). Male pores near the middle line, in line with *c* or *cd*, on somewhat glandular, usually slightly raised but occasionally somewhat depressed areas which are separated by a median longitudinal fissure; penial setæ in a group on each side medial to the pore. Spermathecal pores three pairs, in 6/7–8/9, very close to the middle line.

No septa notably thickened. Gizzard very small, not thicker than the rest of the œsophagus, in v. Intestine begins in xii, only moderately wide at first. Meganephridia with ducts which vary somewhat in length, no end-bladders. Testes and funnels free in x and xi. Two pairs of rather small seminal vesicles in xi and xii. Prostates confined to xviii; duct thin and straight. Spermathecæ in vii, viii, and ix, with sac-like ampulla; duct one-third as long as ampulla, spindle-shaped, sharply marked off; diverticula two, club- or pear-shaped, joining junction of ampulla and duct. Penial setæ 0·3 mm. long and 10 $\mu$ thick, slightly and simply bowed, ending in a claw-shaped tip; the distal third with moderately large thin scattered spines, fairly closely apposed to the shaft.

*Remarks.* The spermathecæ vary in number; once (out of fifteen examples) a supernumerary pore was present in groove 5/6 on one side; once one of the pores in 6/7 was missing.

The position of the species is near *saltans* and *sansibaricus* (position of nephridiopores; and *cf.* the two small spermathecal diverticula in *saltans*).

*Distribution.* Peradeniya and Point de Galle, Ceylon.

### 7. Perionyx depressus *Steph.*

1914. *Perionyx depressus*, Stephenson, Rec. Ind. Mus. viii, p. 394, pl. xxvi, fig. 14.
1914. *Perionyx aborensis*, Stephenson, Rec. Ind. Mus. viii, p. 392, pl. xxvi, fig. 13.
1917. *Perionyx depressus*, Stephenson, Rec. Ind. Mus. xiii, p. 380, note.

Average length 75–100 mm., maximum 125 mm.; diameter 3–4 mm. Segments 125–156. Colour dusky purple dorsally, lighter ventrally; clitellum with a pink tinge. Body dorso-ventrally flattened, ventral surface hollowed; a mid-dorsal groove

from anterior end extending a variable distance backwards. Prostomium epilobous $\frac{1}{2}$–$\frac{2}{3}$. Dorsal pores from 4/5 or 5/6. Setal rings with a small dorsal break (=2 *yz* or a little more), but no ventral break; setæ set closer ventrally than dorsally; in number about 70 per segment (63/ix, 65/xx). Clitellum $\frac{1}{2}$ xii–$\frac{1}{3}$ xviii (=nearly 6). Male pores ca. $\frac{1}{5}$ of circumference apart, each in a depression which occupies the whole length of the segment, the interval between the depressions being equal to the breadth of a depression; within the depression a couple of narrow grooves, one in front of and one behind the male pore; the whole area pale in colour; no setæ between the male pores. Spermathecal pores conspicuous, in 6/7 and 7/8, near the lateral borders of the body and one-third of circumference apart.

No septa notably thickened. Gizzard very rudimentary, in front of the first septum, 6/7. No calciferous glands. Intestine begins in xvii. Last heart in xii. Nephridia pierce the body-wall in approximately the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, continuous dorsally over the gut; that in xi slightly lobed, that in xii large, lobed, bulging back the septa behind so as to reach the level of 13/14 or 14/15. Prostates massive rather rectangular blocks, not much cut up into lobes, confined to xviii; duct sinuous, thicker towards its termination. Spermathecæ prominent, with ovoid ampulla; duct short and very wide, $\frac{1}{2}$–$\frac{3}{4}$ as wide as ampulla; no diverticulum. Penial setæ in a considerable bunch, each 2 mm. long and 18 $\mu$ thick, slightly curved towards the tip, which is pointed; the distal part of the shaft with twenty or more rings of small spines, the rings being closer together towards the tip.

*Remarks.* A re-examination of the original specimens of *P. aborensis* shows that I had overlooked the penial setæ, and that the species is to be united with the present one. No clitellum was visible; the original statement on this point is erroneous.

The statement that there is a pair of seminal vesicles in x in *P. depressus* is probably a mistake; a mass of coagulum may have been taken for a vesicle.

The interval between the depressions in which the male pores are situated may also be depressed; thus there may be only one transversely elongated depression on the ventral surface of xviii.

*Distribution.* Rotung, Upper Rotung, Renging, all in the Abor Country, E. Himalayas.

### 8. Perionyx excavatus *E. Perr.*

1888. *Perionyx excavatus*, Rosa, Ann. Mus. Genova, (2) vi, p. 157.
1890. *Perionyx excavatus*, Rosa, Ann. Mus. Genova, (2) x, p. 121.
1892. *Perionyx intermedius*, Beddard, P. Z. S. 1892, p. 689.
1895. *Perionyx excavatus* + *P. intermedius* + *P. gruenewaldi*, Beddard, Monog. pp. 436, 437.
1900. *Perionyx excavatus* + *P. intermedius*, Michaelsen, Tier. x, pp. 208, 209.

1903. *Perionyx excavatus*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 12.
1909. *Perionyx excavatus*, Michaelsen, Mem. Ind. Mus. i, p. 175.
1910. *Perionyx excavatus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 61.
1914. *Perionyx excavatus*, Stephenson, Rec. Ind. Mus. viii, p. 386.
1916. *Perionyx excavatus*, Stephenson, Rec. Ind. Mus. xii, p. 317.
1916. *Perionyx parvulus*, Stephenson, Rec. Ind. Mus. xii, p. 321, pl. xxxi, fig. 15.
1917. *Perionyx excavatus*, Stephenson, Rec. Ind. Mus. xiii, p. 375.
1921. *Perionyx excavatus*, Stephenson, Rec. Ind. Mus. xxii, p. 760.
1922. *Perionyx excavatus*, Stephenson, Rec. Ind. Mus. xxiv, p. 435.

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1872. *Perionyx excavatus*, E. Perrier, N. Arch. Mus. Paris, viii, p. 126, pl. iv, figs. 73, 74.
1886. *Perionyx excavatus*, Beddard, P.Z.S. 1886, p. 308, text-figs. 3–6.

Length 23–120 mm.; diameter 2–5 mm. Segments 75–165. Colour from deep purple to reddish-brown dorsally, pale ventrally. Prostomium epilobous $\frac{2}{5}$–$\frac{2}{3}$. First dorsal pore in 4/5 or 5/6. Setal rings almost closed, ventrally more nearly than dorsally, or the midventral break may be absent; no setæ specially enlarged, and no great differences in the setal intervals; numbers 36–40, behind clitellum may rise to 54. Clitellum ring-shaped, xiii or part of xiii–xvii (=5 or less). Male pores approximated, in a common transversely oval small depressed area, each on a small transversely oval papilla, or sometimes represented by a small transverse slit; the anterior and posterior margins of the depressed area well marked, the lateral indistinct. Spermathecal pores in 7/8 and 8/9, approximated, about the same distance apart as the male pores.

No septa specially thickened. Gizzard vestigial, in vi, or may be unrecognizable. No calciferous glands; œsophagus swollen in xiii. Intestine begins in xv. Last heart in xii. Nephridia end in the same longitudinal line or nearly so. Testes and funnels free in x and xi. Seminal vesicles in xi and xii–xiv. Prostates small, usually confined to xviii, somewhat fissured, compact, sessile on body-wall; duct short and straight. Spermathecæ with large ovoid ampulla; duct short and narrow; diverticula one to four, very small, wart-like, on the duct, or diverticula may be quite unrecognizable. Penial setæ may be in a group of 4–6 on each side, medial from the male pores; 0·6 mm. long, with indistinctly quadrangular smooth tip and many rings of long thin teeth.

*Remarks.* This is one of the commonest worms in India. Besides the more usual situations it has been met with under logs, under bark, and in rotten wood; in the leaves of water-plants; under stones, or in mud by the side of a tank; and worms probably belonging to this species have been found in the hollows of trees in accumulations of dead leaves and rain-water; it is thus able to adapt itself to very various surroundings.

Michaelsen draws attention (54) to the variations met with, especially in the size. The spermathecal diverticula may be mentioned as another variable feature, and also the male field; the depression in which the male pores lie may be quite indistinct. Beddard has found very large variations in the numbers and position of the genital apertures (108).

*Distribution.* In the E. Himalayas—Dibrugarh and Sadiya in N.E. Assam, the Abor Country, and Darjiling Dist.; in the W. Himalayas—Kumaon Dist., Sahasar Dhara near Dehra Dun, Simla and the Simla Hills; Calcutta, Rajshahi, and Sibpur in Bengal; Pilibhit Dist. in the United Provinces; Teinzo, Bhamo Dist., and Thao, Ghecu Dist., in Burma; Talewadi, near Castle Rock, in Bombay Pres.; Kandy in Ceylon; Little Andaman I.

Outside India the species has been met with in the Philippines, Malay Archipelago, Siam, Cochin China, and Réunion I.

9. **Perionyx fossus** *Steph.*

1920. *Perionyx fossus*, Stephenson, Mem. Ind. Mus. vii, p. 214, pl. ix, figs. 18, 19.

Length 86 mm.; diameter 3·5 mm. Segments 136; body circular in transverse section. Colour a dusky purple dorsally, pale ventrally. Prostomium epilobous $\frac{3}{4}$, tongue cut off behind. Dorsal pores from 4/5. Setal rings regularly interrupted dorsally ($zz=1\frac{1}{2}$–$2\,yz$), setæ $z$ in straight lines; no ventral break; ventral setæ much closer set than the dorsal; numbers 52/v, 56/ix, 56/xii, 52/xix, and 54 in middle of body. Clitellum $\frac{1}{2}$ xiii–$\frac{1}{3}$ xvii ($=3\frac{5}{6}$). Male field as a deep squarish depression

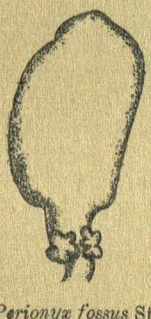

Fig. 130.—*Perionyx fossus* Steph.; spermatheca.

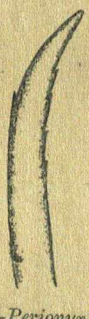

Fig. 131.—*Perionyx fossus* Steph.; tip of penial seta; × 400.

on xviii, across the floor and sides of which extends a transverse crack; male pores in the crack, at the junction of floor and sides of the depression, fairly close together, in line with *d* or *e*. Spermathecal pores two pairs, in 7/8 and 8/9, about three-quarters of circumference apart, in line with the ninth seta.

No septa notably thickened, perhaps 9/10 most so. Gizzard rather large but soft, in vi. No calciferous glands. Intestine

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begins in xvii. Last heart in xiii. Nephridia end in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, those in xi fused dorsally, those in xii fused in their hinder parts, which extend back to the hinder end of xiii. Prostates large compact masses which take up the space of three or four segments by bulging the septa of xviii forwards and backwards; duct narrow at first, becoming stouter and shining in its ectal portion. Spermathecal ampulla irregularly ovoid; duct half as long as ampulla and one-third as thick; two diverticula, small, flattish, sessile, lobulated, situated at about the middle of the length of the duct (text-fig. 130). Penial setæ (text-fig. 131) little modified; length 0·45 mm., thickness 18 $\mu$, shape that of an ordinary seta, the tip fairly sharply pointed, no nodulus; a few small indentations near the tip.

*Distribution.* Shillong, Assam.

10. **Perionyx foveatus** *Steph.*

1914. *Perionyx foveatus*, Stephenson, Rec. Ind. Mus. viii, p. 396, pl. xxvii, figs. 15, 16.

Maximum length 50 mm.; maximum diameter 3 mm. Segments 112. Colour dorsally dark brown to dark purple, paler ventrally. Prostomium epilobous $\frac{1}{2}$. No intersegmental furrow between i and ii. First dorsal pore in 4/5 or 5/6. Setal rings unbroken ventrally but with an irregular dorsal interval

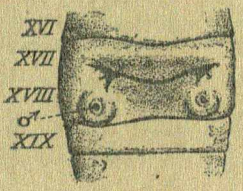


Fig. 132.—*Perionyx foveatus* Steph.; male genital area.

averaging 2–2$\frac{1}{2}$ *yz*; setæ much more closely set ventrally than dorsally; numbers 45–48 in anterior part of body. Clitellum xiii-xvii or $\frac{1}{2}$ xviii (=5–5$\frac{1}{2}$). Male pores as rounded apertures of some size, rather behind the setal zone, ca. $\frac{1}{5}$ of circumference apart; about eight setæ between the pores. In 17/18, in front of and rather internal to the male pores, a pair of puckered pits, connected with each other across the middle line by a furrow which is convex backwards; midventral region between pores and pits depressed; the pits vary somewhat in appearance; their posterior angles may be prolonged to join the male pores (text-fig. 132). Female pores apparently paired, separated by an interval of less than 2 *aa*, and just behind 13/14. Spermathecal pores three pairs, in 6/7–8/9, near the margins of the flattened ventral surface, round and prominent.

No septa specially thickened. Gizzard, in v, vestigial in the

extreme, a slightly wider part of the œsophagus only, walls not thickened. No calciferous glands. Last hearts in xii or xiii. Nephridia end in the same line; no end-sacs. Funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, the former smaller and flattened, or may be absent; both pairs when present composed of a number of bead-like lobules. Prostates vary in size, occupying one or more than one segment, compact and firm, slightly indented into lobes; duct stout and straight, of some length. Spermathecal ampullæ large, and rectangular from mutual pressure; duct very stout, as long as the ampulla and half as wide; diverticulum minute, attached to uppermost part of duct, occasionally absent. No penial setæ.

*Remarks.* A number of specimens were found in rotten wood. I re-examined the specimens recently; in one from Renging the last heart was found in xii (previously said to be in xiii); there was apparently a small gland on the right side, attached to the body-wall just to the outer side of and in front of the ending of the prostatic duct, possibly opening at the depression in 17/18; no such gland was seen on the left side.

*Distribution.* Renging, Rotung, and Upper Rotung, Abor Country, E. Himalayas.

### 11. Perionyx fulvus *Steph.*

1916. *Perionyx fulvus*, Stephenson, Rec. Ind. Mus. xii, p. 322, pl. xxxi, fig. 16.
1918. *Perionyx fulvus*, Stephenson, Rec. Ind. Mus. xvi, p. 16, text-figs. 4, 5.

Length up to 175 mm.; diameter 2·5–4·5 mm. Segments up to 178. Colour yellowish brown, almost unpigmented, the anterior segments with a slight bluish tinge dorsally, a median dorsal dark stripe along the whole length (some specimens in aquatic habitat deep brownish-purple dorsally). Prostomium epilobous $\frac{1}{2}$, tongue partly cut off behind by an inturning of the sides. Dorsal pores from 4/5. Setal ring with small dorsal break, less than $2\,yz$, and a small ventral break, less than $2\,ab$, in the anterior part of the body, but none behind; setæ closer set ventrally than dorsally; numbers 48/v, 55/ix, 52/xii, 53/xix, 55/xxv. Clitellum xiii–xvii (=5), rather constricted. Male pores very close together, on small porophores which are in a slight depression and turned somewhat inwards, separated in the middle line by a median groove, and limited in front and behind by transverse grooves (text-fig. 133). Spermathecal pores two pairs, close together in 7/8 and 8/9.

Septa 7/8 and 8/9 slightly thickened. Gizzard in vi, small, soft, squarish, vestigial. Calciferous glands of moderate size in xiii; lateral enlargements of the œsophagus, which are not set off from the tube, in xi and xii. Intestine begins in xvi. Last heart in xii. Nephridiopores in the same line. Testes and funnels free in x and xi. Seminal vesicles two pairs, those in xi large, meeting

dorsally but not fusing; those in xii united and prolonged backwards through xiii. Prostates rather small squarish masses, confined to xviii; duct soft and short, curled up in a hollow of the gland, broader towards its ectal end. Spermathecal ampulla

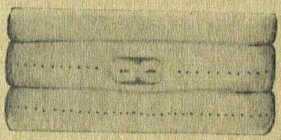

Fig. 133.—*Perionyx fulvus* Steph.; male genital area.



Fig. 134.—*Perionyx fulvus* Steph. distal end of penial seta.

irregularly ovoid; duct short and stout; no diverticula. Penial setæ (text-fig. 134) 0·83 mm. long, 20 $\mu$ thick at the middle, almost straight, tip slightly curved, pointed; distal end ornamented with about twelve rings of rather long fine spines.

*Remarks.* At Inle the worms were found in a few feet of water. I noted that in the pigmented specimens the colour develops as a series of longitudinal streaks in each segment, which expand and coalesce.

*Distribution.* Calcutta; Inle, S. Shan States, Burma.

### 12. Perionyx gravelyi *Steph.*

1917. *Perionyx gravelyi*, Stephenson, Rec. Ind. Mus. xiii, p. 378, pl. xvi, figs. 7, 8.

Length 48 mm.; maximum diameter 2 mm. Segments 89. Colour dorsally a light purple with darker mid-dorsal stripe, pale ventrally. Prostomium epilobous $\frac{2}{3}$, tongue broad, cut off behind. Dorsal pores from 6/7. Setal rings almost closed dorsally and ventrally; no noteworthy differences in the intersetal intervals; numbers 34/v, 40/x, 40/xii, 32/xix, and 32 in the middle of the body. Clitellum xiii or $\frac{1}{2}$ xiii–xvi (= $3\frac{1}{2}$)? Male pores as transverse slits

just behind the setal zone and between setæ *a* and *b*, which are modified as penial setæ; the pores and setæ are on papillæ which meet in the middle line, the conjoined papillæ being bounded by grooves in front and behind (text-fig. 135). Spermathecal pores in 6/7 and 7/8, between the lines of *a* and *b*, like the male pores very near the midventral line.

Septa 7/8–9/10 slightly strengthened. Gizzard small but moderately firm, in v. Œsophagus somewhat swollen in xiv and xv. Intestine begins gradually in xvii. Last heart in xii. Testes and funnels free in x and xi. Vesiculæ seminales of xi fused

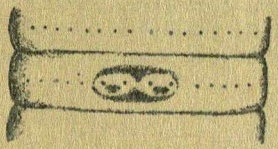

Fig. 135.—*Perionyx gravelyi* Steph.; male genital area.



Fig. 136.—*Perionyx gravelyi* Steph.; penial seta; × 150.

into a single large sac; those of xii fused behind septum 11/12, but separate posteriorly. Prostates occupying xvii–xix, in three lobes corresponding to the three segments; duct with an angle pointing backwards, rather thin, soft, broader ectally. Spermathecal ampulla sac-like, irregular; duct not sharply marked off, nearly as long as ampulla and half as thick; no diverticulum. Penial setæ (text-fig. 136) little modified, 0·4 mm. long and 21 $\mu$ thick; slightly curved proximally and distally, tip pointed; a few fine dot-like sculpturings near the tip, in more or less transverse rows.

*Distribution.* Pashok, Darjiling Dist., E. Himalayas.

### 13. Perionyx heterochætus (*Steph.*).

1917. *Perionyx aborensis*, var. *heterochætus*, Stephenson, Rec. Ind. Mus. xiii, p. 379, pl. xvi, fig. 9.

Length 60 mm.; diameter 2·5 mm. Segments 100. Colour dark purple anteriorly on dorsal surface, brownish behind with

darker median stripe; pale ventrally. Body depressed. Prostomium epilobous $\frac{1}{3}$, tongue not closed behind. Dorsal pores from 5/6. Setæ on dorsal surface in segments ii–xxxiv much larger and set further apart than behind, the change being sudden and coinciding with a change in pigmentation (darker and purpler in front, lighter and browner behind); setal ring closed ventrally, and almost so dorsally; numbers 30/v, 31/viii, 31/ix, 31/xii, 33/xix, and about 50 in middle of body. Clitellum apparently xiii-xvii (= 5), best marked over xiv–xvi. Male area a whitish patch taking up the whole length of xviii, the lateral margins rather swollen, the centre rather concave; the pores as transverse grooves in the setal zone, their centres about opposite the interval *de*, $\frac{2}{15}$ of circumference apart. Spermathecal pores in 6/7 and 7/8, in line with *e*, $\frac{1}{6}$ of circumference apart.

Septa 6/7–8/9 slightly thickened. Gizzard vestigial, in v. Œsophagus swollen in xi–xiii, with transverse vascular channels. Intestine begins behind the prostates. Last hearts in xii. Testes and funnels free, in x and xi. Seminal vesicles in xi and xii, of simple outline, meeting dorsally. Prostates squarish, confined to



Fig. 137.—*Perionyx heterochætus* (Steph.); spermatheca.

xviii; duct apparently only slightly muscular, curled and twisted in the hilus of the gland. Spermathecal ampulla irregular in shape, about as broad as long; duct two-thirds as broad and two-thirds as long as ampulla; diverticulum single, knob-like, sessile on the upper part of the duct, with a few indistinct seminal chambers (text-fig. 137). No penial setæ.

*Remarks.* I now separate this form as a distinct species, since (1) it does not come from near the same place as *P. aborensis*; (2) the setal distribution is distinctive; (3) I have since found penial setæ in *P. aborensis*, which I have united with *P. depressus*; (4) there is a spermathecal diverticulum here.

*Distribution.* Pashok, Darjiling Dist., E. Himalayas.

### 14. Perionyx himalayanus *Mich.*

1907. *Perionyx himalayanus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 158.
1909. *Perionyx himalayanus*, Michaelsen, Mem. Ind. Mus. i, p. 176, pl. xiii, figs. 16, 17.

Length 56–62 mm.; diameter $2\frac{2}{3}$–3 mm. Segments 86–95. Colour in general grey, with slight reddish tint dorsally in front.

Prostomium epilobous $\frac{3}{5}$, tongue not cut off behind. First dorsal pore in 8/9 (if not 7/8 or 6/7). Setæ moderately large; circles nearly complete, only indistinctly interrupted in the middorsal line; numbers 40/viii, 42/xxi. Clitellum xiii–xvii (=5), ring-shaped except on xiii, where it is interrupted ventrally. Male pores rather behind the setal zone, about one-fifth of circumference apart, on small transversely oval papillæ, each situated in the central depression of a large nearly circular glandular protuberance, which is sharply limited behind but only indistinctly in front. Spermathecal pores two pairs, in 6/7 and 7/8, about $\frac{1}{8}$ of circumference apart.

Septa of the region of the testes and some neighbouring ones slightly thickened. Gizzard vestigial, in vi (?). No calciferous glands. Nephridia end apparently in the same line. Funnels in x and xi, apparently enclosed in unpaired sacs, which are continued laterally into seminal vesicles. Seminal vesicles three pairs, the first, in x, being the lateral continuations of the testis sacs;

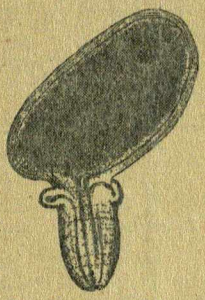

Fig. 138.—*Perionyx himalayanus* Mich.; spermatheca; × 20.

the others in xi and xii. Prostates with small, rather compact, irregular glandular part; duct moderately thick, irregularly bent or coiled, about as long as the glandular part. Spermathecal ampulla large, ovoid, obliquely placed; duct sharply set off, half as long and a quarter as thick as the ampulla, narrowed at its ectal end; diverticula two, very small, at ental end of duct, nearly opposite each other, without stalk (text-fig. 138). No penia setæ.

*Distribution.* Sandakphu, Darjiling Dist., E. Himalayas.

15. **Perionyx inornatus** *Steph.*

1916. *Perionyx inornatus*, Stephenson, Rec. Ind. Mus. xii, p. 320, pl. xxxi, fig. 14.

Length 96 mm.; diameter 5 mm. Segments 124. Colour yellowish brown. Prostomium apparently proepilobous. Dorsal pores from 6/7. Setal rings unbroken ventrally, a small and irregular dorsal break behind the genital region, none in front; setæ set closer ventrally than dorsally; numbers 56/v, 70/ix, 75/xii, 83/xix. Clitellum ? Male pores approximately in *de*, on the

sides of a shallow transversely oval depression with shelving sides, in transverse extent equal to $\frac{1}{9}$ of circumference. Spermathecal pores, two pairs, in 6/7 and 7/8, not far apart, the distance between them about equal to that between the male pores.

Septa 8/9 and 9/10 moderately thickened, those in front and behind (6/7–7/8 and 10/11–12/13) slightly so. Gizzard soft but of some size, squarish, in v. Intestine begins in xiv. Last hearts in xii. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, large and single in each segment, situated dorsally over the gut. Prostate small and confined to xviii; duct soft, white,



Fig. 139.—*Perionyx inornatus* Steph.; distal end of penial seta.

comparatively narrow and of the same diameter throughout, straight and passing transversely inwards. Spermathecal ampulla small and simple, ovoid; duct short, stout, not marked off; no diverticula. Penial setæ (text-fig. 139) 0·92 mm. long, 30 $\mu$ thick at the middle, with blunt point and straight shaft; the distal end ornamented with about 14 irregular and interrupted rings of very minute sculpturings.

*Remarks.* The species is closely related to *P. pincerna*; each is unfortunately only known from a single specimen, and it is possible that if the material had been more ample it might have been permissible to unite them. In the present state of knowledge, however, the differences in size, in the numbers of the setæ, and in the male field, seem to justify their separation.

*Distribution.* Sandakphu, Darjiling Dist., E. Himalayas.

### 16. Perionyx kempi *Steph.*

1914. *Perionyx kempi*, Stephenson, Rec. Ind. Mus. viii, p. 389, pl. xxvi, fig. 11.

Length 75 mm.; diameter nearly 3 mm. Segments 164. Colour light brown, paler ventrally and at the anterior end. Dorso-ventrally flattened, especially behind the clitellum. Segments in

general triannulate. Prostomium epilobous $\frac{1}{2}$, tongue cut off behind. A longitudinal middorsal groove from the anterior end to some distance behind the clitellum. First dorsal pore in 5/6. Setal rings unbroken ventrally, interrupted dorsally ($zz = 2\frac{1}{2}$–$3\,yz$); setæ very closely set ventrally, laterally and dorsally three times as wide apart or even more; dorsal setæ behind clitellum extremely small; number per segment about 50. Clitellum xii–$\frac{1}{3}$xix ($=7\frac{1}{3}$), swollen, friable. Male pores with puckered margins, on the lateral borders of a square depression which occupies the midventral portion of xviii; no setæ between the male pores. Spermathecal pores two pairs, in 6/7 and 7/8, ca. $\frac{1}{7}$ of circumference apart.

No septa notably thickened. No gizzard. Intestine begins in xix. Last hearts in xiii. Funnels free in x and xi. Seminal vesicles large, compact, only indistinctly lobed, in xi and xii, not fused dorsally. Prostates occupy xvii and xviii, bulging backwards septum 18/19, massive and compact, not distinctly lobulated

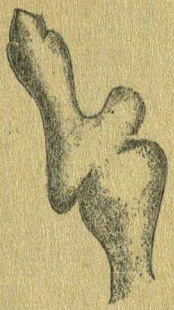

Fig. 140.—*Perionyx kempi* Steph.; spermatheca.

on the surface; duct short, curved in an S-shape. Spermathecal ampulla very irregular in shape, somewhat triangular; duct equal to ampulla in length or nearly so, sharply delimited from the ampulla by a constriction, dilated at its upper end, the dilated part containing spermatozoa and so functioning as a diverticulum; no other diverticulum (text-fig. 140). No penial setæ.

*Remarks.* Found in rotten wood.
*Distribution.* Kobo, Abor Country, E. Himalayas.

### 17. Perionyx koboensis *Steph.*

1912. *Perionyx koboensis*, Stephenson, Rec. Ind. Mus. viii, p. 391, pl. xxvi, fig. 12.

Length 100 mm.; diameter 4 mm. Segments 144. Colour dorsally dark purple anteriorly, pinkish posteriorly; ventrally pale. Prostomium epilobous $\frac{1}{2}$. First dorsal pore in 8/9. Setal rings almost complete; $aa$ and $zz = 2\,ab$ and $2\,yz$; setæ rather more closely set on the ventral than on the dorsal surface;

number ca. 51/vii, ca. 49/xvii, ca. 53/xxv, more posteriorly 54. Clitellum ½ xiii–xvi (= 3½). Male pores near together, as small transverse slits in the setal zone, in a transversely elongated whitish field continuous with the whitish setal ridge, of which it represents a broadening; no setæ between the pores, which are about four setal intervals apart. Spermathecal pores two pairs,

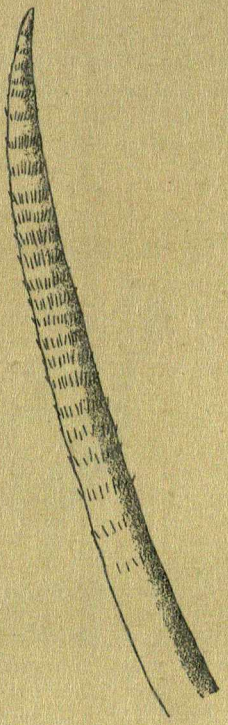

Fig. 141.—*Perionyx koboensis* Steph.; distal end of penial seta; × ca. 400.

in 7/8 and 8/9, near the middle line, about the same distance apart as the male pores. A slight thickening of the anterior border of segment xix in the midventral region.

Septa 6/7–8/9 slightly thickened. Gizzard in vi, somewhat vestigial. Œsophagus bulged in viii, and in xiv–xvii; longitudinal lamellæ internally in xiv and xv, less marked in xvi and xvii. Last heart in xii. Nephridia pierce the body-wall at varying positions, but not in two definite and alternating series; no end sacs. Testes and funnels free in x and xi. Seminal vesicles in x, attached to the anterior face of 10/11, and in xi and xii; each a single mass, continuous dorsally from side to side. Prostates in xviii, solid-looking, not cut up into lobes, somewhat

rectangular; duct stout and straight. Spermathecal ampulla ovoid; duct not marked off, as long as and nearly as broad as ampulla; no diverticula. Penial setæ (text-fig. 141) four or more in each group, up to 0·88 mm. long and 22 $\mu$ thick, with a slight sabre curve, pointed distally; the distal portion of the shaft ornamented with about twenty rings of extremely fine teeth.

*Remarks.* Found in rotten wood.
*Distribution.* Kobo, Abor Country, E. Himalayas.

### 18. Perionyx m'intoshi *Bedd.*

?1883. *Perionyx m'intoshii*, Beddard, Ann. Mag. N. H. (5) xii, p. 217, pl. viii, figs. 3, 8.
1892. *Perionyx macintoshii*, Beddard, P. Z. S. 1892, p. 687.
1895. *Perionyx macintoshii*, Beddard, Monog. p. 438.
1900. *Perionyx m'intoshi*, Michaelsen, Tier. x, p. 208.
1917. *Perionyx m'intoshi*, Stephenson, Rec. Ind. Mus. xiii, p. 383.

Length 230–375 mm.; diameter 9–12·5 mm. Segments ca. 200–261. Colour dorsally purple or violet, ventrally pale, clitellum buff. Prostomium epilobous $\frac{1}{2}$, tongue open behind. First dorsal pore in 5/6. Setæ relatively small; rings closed dorsally and ventrally; setæ more closely set ventrally, the intersetal intervals often irregular; numbers 78/v, 72/ix, 76/xii, ca. 90/xxiii, and 112 in the middle of the body. Clitellum xiii–xix (=7). Male pores closely approximated, on a common median field about 3 mm. broad, the pores as round pits behind the setal zone; the area rectangular with a well-marked border, taking up the whole length of the segment and encroaching on adjacent segments, often depressed. Spermathecal pores two pairs, in 7/8 and 8/9, fairly close together.

Septum 5/6 slightly, 6/7–11/12 moderately thickened, and some succeeding ones slightly. Gizzard in vi, of fair size, moderately firm. No calciferous glands. Intestine begins in xviii or xix. Last heart in xiii. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, large, lobed, and may be united together over the alimentary canal; there may be also a small rudimentary vesicle in xiii. Prostate lobed; duct short, stout but soft, running transversely inwards. Rudimentary ovisacs may be present in xiv. Spermathecal ampullæ almost spherical, prolonged into a short thin duct; no diverticulum. No penial setæ.

*Remarks.* My specimens showed a shifting back of the male pores and of the posterior border of the clitellum by one segment. The nephridia are stated to lie all in the same line, but there is no definite mention of the nephridiopores, which are the important things in this connection.
*Distribution.* Sibpur, Bengal; Nepal Valley; ? Akyab, Burma.

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19. **Perionyx millardi** *Steph.*

1915. *Perionyx millardi*, Stephenson, Mem. Ind. Mus. vi, p 74, text-fig. 2.
1920. *Perionyx millardi*, Stephenson, Mem. Ind. Mus. vii, p. 205, pl. ix, fig. 8.
1920. *Perionyx igatpuriensis*, Stephenson, Mem. Ind. Mus. vii, p. 220, pl. x, fig. 24.

Length 40–90 mm.; diameter 2–2·5 mm. Segments 126–170. Colour deep purple dorsally, brown ventrally, with a fairly sharp demarcation between the two. Prostomium epilobous $\frac{1}{2}$–$\frac{2}{3}$, sides of tongue converging behind, closed or not at hinder end. Dorsal pores from 4/5 or 5/6. Setal rings interrupted by small gaps dorsally and ventrally, or may be unbroken dorsally; breaks

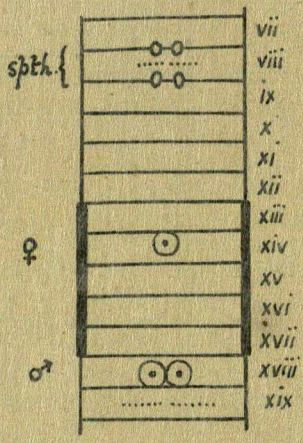


Fig. 142.—*Perionyx millardi* Steph.; genital area. *Spth.* indicates the spermathecal apertures, ♂ the male, and ♀ the female pores. The setæ in the neighbourhood of the male and spermathecal apertures are shown.

largest ventrally in front of clitellum, where $aa = 2\,ab$ or perhaps more; numbers 40/ix, 41/xii, 48/xix, 41 in the middle of the body. Clitellum xiii–xvii (=5). Male pores small, round, close to the middle line, on small papillæ. Spermathecal pores two pairs, in 7/8 and 8/9, close to the middle line, in line with *b* (text-fig. 142).

No septa thickened. Gizzard vestigial, in vi, of some size, but its walls thin and soft. No calciferous glands. Intestine begins in xviii or xix. Last heart in xiii. Nephridia end in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, the posterior pair the larger, and may bulge back septum 13/14. Prostates compact, may take up xviii and xix; duct short and narrow, soft, only slightly shining, straight, running transversely inwards. Spermathecal ampulla irregularly ovoid; duct short; a single diverticulum from junction of duct and ampulla,

small and scale-like, or cauliflower-like with a number of small seminal chambers, or three-lobed with the lobes almost independent of each other (almost separate diverticula) (text-fig. 143). Penial setæ 0·44–0·65 mm. long, 15–18 $\mu$ thick, slightly curved

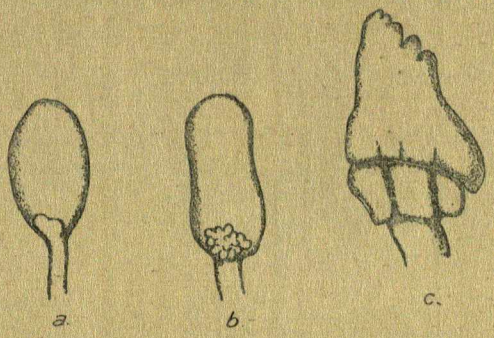


Fig. 143.—*Perionyx millardi* Steph.; different forms of spermathecæ.

towards the distal end, which is bluntly pointed; 9 or 10 circles of spines near the tip, of fair size; a slight bulbous swelling just proximal to the tip.

*Remarks.* The similarity of the penial setæ of this form to those of *P. bainii* (text-fig. 129) is striking. The spermathecal pores are much nearer together in the present species, the last heart is in xiii, the spermathecal duct is short, and the male pores are of simple form.

*Distribution.* Bombay, Talegaon, Kalyan, Vivar, Igatpuri (all near Bombay).

### 20. Perionyx minimus *Steph.*

1920. *Perionyx minimus*, Stephenson, Mem. Ind. Mus. vii, p. 219, pl. x, fig. 23.

Length up to 45 mm.; diameter 1 mm. or as a maximum 1¼. Segments 100. Ventral surface flattened. Colour a medium brown dorsally, a lighter brown ventrally. Prostomium epilobous ½, tongue cut off behind. Prostomium and segment i divided by a middorsal groove. Dorsal pores from 4/5. Setal rings almost closed ventrally; dorsal break well marked, $=2\,yz$; setæ much closer set ventrally; numbers 26/xx, ca. 36 in middle of body. Clitellum xiii or ½ xiii–xvii (=4½ or 5). Male pores on conspicuous round papillæ; the space between the papillæ depressed, the depression extending from the middle of xvii to the anterior third of xix, dumbbell-shaped in form, being encroached upon from the sides by the papillæ. Spermathecal pores in 7/8 and 8/9, about a quarter of the circumference apart.

No septa thickened. Apparently a vestigial gizzard in v. Œsophageal bulgings in xiii and xiv, slight, with longitudinal vascular striations. Intestine begins in xix. Pharyngeal glands

as definite lobes on each side, filling out the segments as far back as vii. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, brown in colour; the posterior pair large and lobulated, meeting each other dorsally. Prostates somewhat loosely lobulated, occupying more than one segment; duct

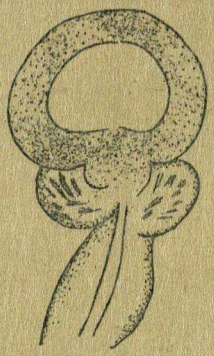

Fig. 144.—*Perionyx minimus* Steph.; spermatheca viewed under the microscope.

short, narrow, and rather soft. Conspicuous ovisacs in xiv. Spermathecal ampullæ rounded; duct of same length as ampulla; diverticula two, small, subspherical, shortly stalked, at ental end of duct; the duct becomes stouter below the diverticula (text-fig. 144). No penial setæ.

*Distribution.* Belgaum, Bombay Pres.

### 21. Perionyx modestus *Steph.*

1922. *Perionyx modestus*, Stephenson, Rec. Ind. Mus. xxiv, p. 435.

Length 85–167 mm.; maximum diameter 4 mm. Segments 174. Colour deep purple dorsally, violet ventrally. Body somewhat flattened dorso-ventrally. Prostomium epilobous ½, tongue open behind. Dorsal pores from 4/5. Setæ more closely set ventrally; dorsal break absent or very small, ventral break small in front of genital region, absent or small behind this; numbers ca. 38/v, 41/ix, 42/xii, 42/xix, and 42 in the middle of the body. Clitellum absent. Male pores at the ends of a transverse groove on xviii, not far from midventral line, about in line with *d*. Spermathecal pores near together, in 7/8 and 8/9, about in line with *c*.

Septa 6/7 and 7/8 slightly thickened, 8/9 and 9/10 moderately so. Gizzard vestigial, in v. No calciferous glands; œsophagus with transverse vascular striations in xii and xiii. Last heart in xiii. Nephridia all end in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, those of the same pair meeting in the middle line. Prostates small; duct relatively

stout, straight, shining. Spermathecæ as small elongated sacs; duct not distinguishable; a minute wart-like diverticulum near base (not always). No penial setæ.

*Distribution.* Cherrapunji, Assam.

22. **Perionyx mysorensis** *Steph.*

1921. *Perionyx mysorensis*, Stephenson, Rec. Ind. Mus. xxii, p. 762, pl. xxviii, fig. 10.

Length more than 38 mm.; diameter 2 mm. Segments more than 90. Colour light brownish purple dorsally, pale ventrally. Prostomium prolobous or slightly epilobous. Dorsal pores present. Setal rings closed dorsally and ventrally; numbers 54-62. Clitellum? Male pores close to the middle line, on a transverse ridge across the middle of the segment. Transverse trenches in

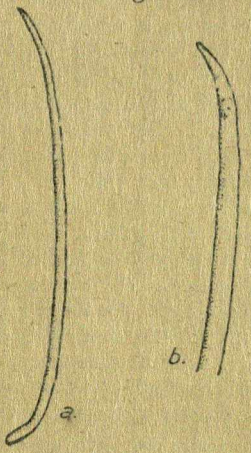


Fig. 145.—*Perionyx mysorensis* Steph.; penial seta; *a*, general form, × 130; *b*, distal end, × ca. 400.

front and behind the ridge; the whole contained within the limits of segment xviii. Spermathecal pores in 7/8 and 8/9, near the middle line.

Septa 6/7-9/10 somewhat thickened, and also 12/13-15/16. Gizzard quite vestigial, in vi. No calciferous glands; lateral swellings of the œsophagus in xiii. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in xi and xii. Prostates each a squarish mass, cut up into lobes; duct short, straight, passing transversely inwards. Spermathecæ spherical, sessile on body-wall; no diverticulum (? not fully developed). Penial setæ (text-fig. 145) 0·44 mm. long, slightly bowed, most so at the proximal end; tip tapering and fairly sharply pointed; a few scattered transverse markings composed of minute teeth.

*Distribution.* Forests of Shimoga or Kadur Dist., Mysore.

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23. **Perionyx nainianus** (*Mich.*).

1907. *Perionychella nainiana*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 155.
1909. *Perionychella nainiana*, Michaelsen, Mem. Ind. Mus. i, p. 169.

Length 85 mm.; diameter $2\frac{1}{2}$–$3\frac{1}{3}$ mm. Segments ca. 105. Colour dark bluish-violet dorsally, ventrally grey; anterior end violet grey both dorsally and ventrally. Prostomium epilobous $\frac{1}{2}$, tongue open behind. Dorsal pores from 3/4, apparently a rudimentary one in 2/3. Setæ fairly large, nearly equidistant; rings complete; numbers differ little in the various parts of the body, ca. 50. Clitellum only distinguishable by colour, xiii–xviii (=6). Male pores as small transverse slits just behind the setal zone, about $\frac{1}{5}$ of circumference apart; setæ interrupted in front of the pores, and 5 or 6 setæ median to the pores. Spermathecal pores in 7/8 and 8/9 about a quarter of the circumference apart.

Septa of the anterior male region a little thickened. Gizzard very small but not exactly vestigial, in v. No calciferous glands; œsophagus swollen in xiii and xiv, with lamellated and villous walls. Last hearts in xii. Nephridia of all segments similar. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, rather compact, roughly mammillated. Prostates confined to xviii, relatively small, lobed, deeply incised medially; duct about as long as gland, straight, rather thin, especially ectally. Spermathecæ very simple, with almost spherical ampulla; duct short and narrow; no diverticulum. The setæ medial from the male pore though not displaced are modified; about twice as long (0·7 mm.) as the ordinary setæ, and somewhat thickened (17$\mu$), almost straight, pointed, without distinct ornamentation but with the highest powers showing apparently some very fine hair-like structures near the tip, closely adpressed to the surface of the seta.

*Remarks.* The median setæ on xviii represent an early stage in the evolution of penial setæ.

*Distribution.* Naini Tal, W. Himalayas.

24. **Perionyx nanus** *Steph.*

1917. *Perionyx nanus*, Stephenson, Rec. Ind. Mus. xiii, p. 381, pl. xvi, fig. 10.

Length 53 mm.; diameter 1·5 mm. Segments 100. Colour brownish-purple dorsally, pale ventrally. Ventral surface flattened. Prostomium epilobous $\frac{1}{2}$, open behind. Dorsal pores from 5/6. Setal ring almost closed dorsally and ventrally (entirely closed ventrally in the anterior region); numbers ca. 36/ix and the same in xii, 35/xix, and 34 in the middle of the body. Clitellum xiv-xvii (=4), well marked. Male pores in line with *g* or *gb*, one-fourth of circumference apart, slightly behind the setal zone, prolonged somewhat towards the middle line as grooves; surrounding each pore a whitish thickened patch, the whole taking up the whole ventral surface of xviii (text-fig. 146). Spermathecal

pores in 6/7 and 7/8, widely apart (nearly $\frac{1}{3}$ of circumference), large and patent.

No septa notably thickened. Gizzard vestigial, in v. Œsophagus bulged in ix, with transverse vascular channels. Intestine begins in xix. Last heart in xii. Testes and funnels free in x and xi.

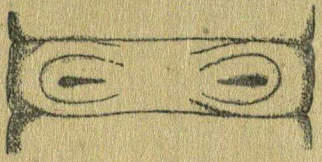

Fig. 146.—*Perionyx nanus* Steph.; male genital area.

Vesiculæ seminales large, in xi and xii, those in xi fusing together, but not those in xii. Prostates occupying xvii–xix; duct thin and soft, bent once on itself with the convexity forwards. Spermathecæ simple in form, ampulla pear-shaped; duct broad and short, not sharply marked off; diverticulum single, wart-like, sessile, not chambered, at the junction of ampulla and duct. No penial setæ.

*Distribution.* Pashok, Darjiling Dist., E. Himalayas.

### 25. Perionyx pallidus *Steph.*

1917. *Perionyx pallidus*, Stephenson, Rec. Ind. Mus. xiii, p. 376, pl. xvi, figs. 5, 6.

Length 80 mm.; diameter $3\frac{1}{4}$ mm. Segments 118. Colour pale, a purple tinge anteriorly on the dorsal side, and a median

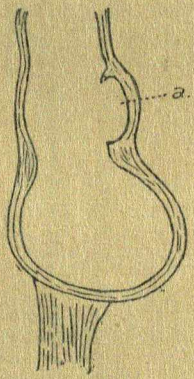


Fig. 147.—*Perionyx pallidus* Steph.; spermatheca under the microscope; *a*, bulging perhaps representing an incipient seminal chamber.



Fig 148.—*Perionyx pallidus* Steph.; penial seta; × 235.

purple stripe throughout. Prostomium epilobous $\frac{1}{2}$. Dorsal pores from 4/5. Setal rings quite closed ventrally, almost so

dorsally; setæ closer set ventrally; numbers 53/v, 72/ix, 52/xi, 64/xii, 52/xix, and 70 in the middle of the body. Clitellum xiii–xvi (=4), slightly swollen. A transverse groove on segment xviii, in which are the male pores, small cracks $\frac{1}{10}$ of circumference apart. Spermathecal pores small, slit-like, in 6/7 and 7/8, the same distance apart as the male pores.

Septa 5/6 and 6/7 thin, 7/8–9/10 slightly thickened. Gizzard vestigial, in vi. Within the œsophagus, in xiii and xiv, are longitudinal folds, scarcely to be called lamellæ. Intestine begins in xvii. Last heart in xiii. Nephridial ducts terminate in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, fused in each segment over the alimentary canal. Prostates very small; duct runs straight inwards. Spermathecæ (text-fig. 147) small, ampulla sac-like, rather constricted in the middle; duct short, scarcely separately distinguishable; diverticulum absent (? developing). Penial setæ (text-fig. 148) scarcely modified, of the ordinary form, 0·175 mm. long, 17$\mu$ thick; a few fine sculpturings on the distal half.

*Remarks.* Another form showing an early stage in the evolution of the penial setæ.

*Distribution.* Kalimpong, Darjiling Dist., E. Himalayas.

### 26. Perionyx pincerna *Steph.*

1916. *Perionyx pincerna*, Stephenson, Rec. Ind. Mus. xii, p. 319, pl. xxxi, figs. 12, 13.

Length 45 mm.; diameter 3 mm. Segments 88. Colour light brownish grey. Body cylindrical, not flattened. Prostomium

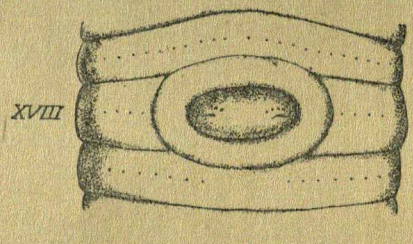


Fig. 149.—*Perionyx pincerna* Steph.; male genital area.



Fig. 150.—*Perionyx pincerna* Steph.; distal end of penial seta.

epilobous $\frac{1}{4}$, tongue cut off behind. Dorsal pores from 4/5. Setal ring with small and irregular dorsal break, on the average less than $2yz$; ventral break small and irregular, or may be wanting in front of clitellum; setæ set closer ventrally than dorsally; numbers 47/v, 57/ix, 60/xii, 50/xx. Clitellum indistinguishable. A transversely oval depression on xviii, deepest at

its margin, so that the middle of its floor is somewhat raised above its periphery; a thick whitish lip surrounds the whole and extends over the posterior half of xvii and anterior half of xix; male pores perhaps in *c* or *d*; a few penial setæ visible as black points (text-fig. 149). Spermathecal pores small slits near the middle line, in 6/7 and 7/8, ca. $\frac{1}{10}$ of circumference apart.

Septa 5/6-9/10 slightly thickened. Gizzard of moderate size, in v, with soft and thin walls, and hence in some degree vestigial. Intestine begins in xviii. Last heart in xii. Nephridia opening in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, single in each segment, arching over dorsal vessel and gut. Prostates confined to xviii, small, lobed; duct narrow, of the same diameter throughout, soft, not shining, with slightly wavy course. Spermathecæ simple oval sacs sessile on the body-wall, without distinguishable duct; no diverticulum. Penial setæ (text-fig. 150) 0·63 mm. long, 24 $\mu$ thick at the middle; simple in form, straight except for a bend at the proximal end, tip slightly curved and blunt; faint sculpturings near the tip appearing as fine points in about a dozen irregular and much broken circles.

*Remarks.* See note on *P. inornatus*.
*Distribution.* Near Ghoom, E. Himalayas.

27. **Perionyx pokhrianus** *Steph.*

1920. *Perionyx pokhrianus*, Stephenson, Mem. Ind. Mus. vii, p. 208, pl. ix, figs. 10, 11.

Length 65 mm.; diameter 3 mm. Segments 96. Colour pale violet dorsally, unpigmented ventrally. Prostomium epilobous $\frac{1}{2}$, tongue open behind. Dorsal pores from 4/5. Setal rings almost closed dorsally and ventrally, and may be quite closed in

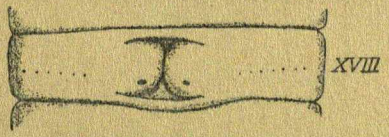


Fig. 151.—*Perionyx pokhrianus* Steph.; male genital area.



Fig. 152.—*Perionyx pokhrianus* Steph.; spermatheca.

hinder part of body; setæ slightly closer set ventrally; numbers 50/v, 58/ix, 54/xii, 48/xix, and 44 in the middle of the body. Clitellum xiii–xvi (=4). A pair of papillæ on xviii, midventral, touching each other, taking up the greater part of the length of the segment, not delimited from the rest of the surface on their

outer sides, but bounded in front and behind by a common transverse groove (text-fig. 151). Male pores on the papillæ, near the middle line, and nearer the posterior than the anterior limit of the papillæ. Spermathecal pores in 6/7 and 7/8, very close together, nearly in line with *b*.

No septa markedly thickened. Gizzard in v, large, barrel-shaped, rather soft but not otherwise vestigial. Intestine begins in xviii. Last heart in xiii. Nephridia apparently terminate in the same line. Testis sacs in x and xi, both continuous dorsally over the œsophagus and dorsal vessel; that in x very delicate, that in xi delicate and covered over by the seminal vesicles. Seminal vesicles in xi and xii, large, with granular surface, each meeting its fellow in the middle line dorsally. Prostates large, in xvii–xix, much indented; duct rather short, soft and thin, irregularly twisted, somewhat dilated at the ectal end. Spermathecal ampulla very irregularly lobed; duct short, constricted off from ampulla; diverticula as about three small swellings on the upper half of the duct (text-fig. 152). No penial setæ.

*Distribution.* Sitong, Darjiling Dist., E. Himalayas.

*a.* var. **affinis** *Steph.*

1920. *Perionyx pokhrianus* var. *affinis*, Stephenson, Mem. Ind. Mus. vii, p. 210, pl. ix, figs. 12, 13.

Length 55 mm.; diameter 2¼ mm. Segments 105. Colour a light slaty or purplish dorsally with darker median stripe, pale ventrally. Prostomium epilobous ⅔, tongue open behind. Dorsal

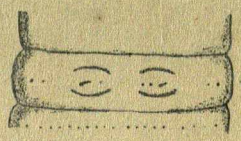


Fig. 153. — *Perionyx pokhrianus* Steph. var. *affinis*; male genital field.



Fig. 154.—*Perionyx pokhrianus* Steph. var. *affinis*; spermatheca.

pores from 4/5. Setal rings almost unbroken dorsally and ventrally; numbers 38/v, 44/ix, 45/xii, 37/xix, and 36 in middle of body. Clitellum xiii–xvi (=4). Male field (text-fig. 153) as a depression with sloping sides, on which are placed the papillæ of the male pores; papillæ delimited by grooves in front and behind, and separated by a slight interval in the middle line; pores as small transverse slits in line with *c*, *d*, or *e*. Spermathecal pores in 6/7 and 7/8, in line with the interval *cd*.

A number of the anterior septa slightly thickened. Gizzard in v, of moderate size and fairly firm. Intestine begins perhaps in xviii. Last heart in xii. The nephridial ducts appear to

end at different levels on the body-wall, but no regular alternation; no end bladders. Testis sacs in x and xi. Seminal vesicles with granular surface, in xi and xii; those in xi continuous with the testis sac; the pair in each segment fused together. Prostates large, taking up the whole of xvii-xix, deeply indented by the septa, and otherwise much incised; duct moderately long, bent with the angle backwards, soft and rather thin in its ental portion, thicker and shining ectally. Spermathecal ampulla large, irregularly lobed; duct stout, slightly shiny, well marked off, considerably longer than ampulla; diverticulum a rounded knob on the ental end of the duct containing two seminal chambers (text-fig. 154). No penial setæ.

*Remarks.* The differences from the type-form consist in the smaller numbers of the setæ, the configuration of the male field, the degrees of separation between the male and spermathecal apertures, the length of the spermathecal duct, and the position of the last heart.

*Distribution.* Sitong and Sitong Ridge, Darjiling Dist., E. Himalayas.

28. **Perionyx polytheca,** nom. nov.

1916. *Perionyx* sp., Stephenson, Rec. Ind. Mus. xii, p. 323, pl. xxxi, figs. 17, 18.

Length 8 mm.; maximum diameter 1 mm. Segments more than 30. In the living animal ground-colour whitish, each segment girdled with a broad dark band; preserved, the bands

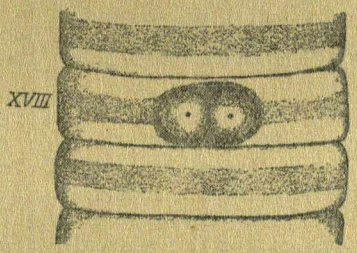


Fig. 155.—*Perionyx polytheca* Steph.; male genital area.



Fig. 156.—*Perionyx polytheca* Steph.; distal end of penial seta.

are dark purple, take up more than the middle third of each segment, and are less distinct ventrally, especially behind the genital region. Prostomium epilobous $\frac{1}{2}$, tongue cut off behind by a curved posterior border. Dorsal pores from 4/5. Setæ in unbroken rings, not countable; closer set ventrally. Clitellum not distinguishable. Male area (text-fig. 155) a clean-cut transverse oval occupying the whole length of the segment. Male

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pores as black points on two considerable rounded almost confluen papillæ on the floor of the depressed oval area. Spermatheca pores seven pairs, from 2/3 to 8/9, as minute white points (not visible in all the grooves externally) near the middle line.

No septa are specially thickened. Gizzard entirely absent. No calciferous glands. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in xii, nearly but not quite touching in the middorsal line. Prostates confined to xviii, compact; duct stout and very muscular, somewhat bent. Spermathecæ seven pairs; ampulla ovoid, 0·24 mm. long (except the first which is somewhat smaller); duct short and comparatively stout, half as long and half as thick as ampulla; diverticula one or two, globular, attached by short stalks to junction of ampulla and duct. Penial setæ (text-fig. 156) 0·27 mm. long or possibly 0·3 mm., 7$\mu$ thick near the base, straight and rod-like, tapering very gradually along the shaft, more rapidly near the tip, which is bluntly pointed; distal end ornamented with fine spines.

*Remarks.* When I described this species I did not name it, because the description of *P. ceylanensis*, which Michaelsen had described from the same place (Peradeniya, in Ceylon), was not at that time accessible to me, and I thought that the present worm might possibly be identical with that. It is, however, a very characteristically distinct species; the minute size and the very large number of spermathecæ, with the colouring, mark it out immediately.

The single specimen had been mutilated behind at some previous time. On account of its small size the internal anatomy was investigated by means of sections.

*Distribution.* Peradeniya, Ceylon.

29. **Perionyx pullus** *Steph.*

1920. *Perionyx pullus*, Stephenson, Mem. Ind. Mus. vii, p. 217, pl. x, fig. 22.

Length more than 62 mm.; maximum diameter 3·5 mm. Segments more than 165. Colour dark grey both dorsally and ventrally. Ventral surface concave, except at anterior end. Prostomium epilobous $\frac{2}{3}$, tongue triangular; a groove continued back from prostomium as far as clitellum. Dorsal pores from 1/2. Setal rings interrupted dorsally, $zz=3yz$ in front of clitellum, $2yz$ behind; ventral break absent, or small and irregular; setæ very small and closely set on ventral surface; numbers behind clitellum ca. 60, further back ca. 64. Clitellum xi–xx (=10). Male field on xix (in the single specimen), a rectangular area delimited at the sides by slight grooves, and in front and behind by deep trenches which coincide with the intersegmental furrows. Male pores apparently on two small whitish papillæ very close together. Spermathecal pores in 7/8 and 8/9, close to the middle line.

No septa specially thickened. Gizzard entirely absent. Pharyngeal glands bulky, extending back as large masses on the alimentary

canal as far as ix. Œsophagus bulged laterally, and its walls vascular, in x–xiii. Intestine begins in xvii. Last heart in xii. Nephridia end approximately in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi, xii, and xiii, relatively small, racemose in appearance. Prostates in xix, small, each consisting of a number of finger-like lobes in a bushy cluster;



Fig. 157.—*Perionyx pullus* Steph.; spermatheca.

duct small and soft. Ovarian funnels in xiii. Spermathecal ampulla very irregular in shape, narrowing below to become the duct, which is about as long as the ampulla, and itself narrows towards its ectal end; diverticula about three small rounded sessile chambers around the lower part of the ampulla (text-fig. 157). No penial setæ.

*Remarks.* The single specimen showed an abnormal position of the posterior male organs and male pores, but the abnormality was limited to these, the female organs and all in front having the usual situation. There appeared to be an additional pair of minute seminal vesicles in xiv.

*Distribution.* Belgaum, Bombay Pres.

### 30. Perionyx pulvinatus *Steph.*

1916. *Perionyx pulvinatus*, Stephenson, Rec. Ind. Mus. xii, p. 317, pl. xxxi, figs. 10, 11.

Length 57 mm.; maximum diameter 3·5 mm. Segments 126. Colour a deep brown dorsally with darker median stripe; lighter anteriorly; ventral surface pale. Body dorso-ventrally compressed, ventral surface flat. Prostomium epilobous $\frac{1}{2}$, tongue cut off behind. A median dorsal groove over prostomium and first two segments. Dorsal pores from 5/6. Setal ring with small and irregular dorsal break = 2–3 *yz*, the neighbouring setal intervals also irregular; ventral break absent; setæ set much closer ventrally than dorsally, all small; numbers 56/vi, 54/ix, 50/xii, 48/xix (approximate in each case). Clitellum xii–$\frac{1}{2}$ xix (= $6\frac{1}{2}$), rather indefinite. A conspicuous depression on xviii, extending slightly on to xvii and xix, rectangular with rounded corners, and rather broader than long, almost entirely occupied by two

longitudinally oval cushions which are in apposition in the middle line (text-fig. 158). Male pores anterior and internal to the middle point of each cushion, in front of the setal zone. Spermathecal pores large, in 7/8 and 8/9, opposite the tenth seta on each side.

No septa notably thickened, perhaps 6/7 slightly so. Gizzard vestigial, in vi. Œsophagus swollen in ix and x, the walls having here apparently a lamellate structure. Intestine begins in xv. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles two pairs, those in xi completely fused to form a single

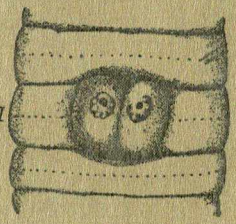


Fig. 158.—*Perionyx pulvinatus* Steph.; male genital area.



Fig. 159.—*Perionyx pulvinatus* Steph.; spermatheca.

large lobed mass; the posterior pair double in xii, but extending back and fusing incompletely in xiii, completely fused in xiv and xv. Prostates occupying xviii and xix, lobed; duct stout, beginning in the middle of the gland, forming a loop with its convexity forwards, bound down to the body-wall by a number of bands, and broadest towards its termination. Spermathecal ampulla irregularly shaped, roughly pyramidal, with nodular surface; duct as long and almost as wide as ampulla; no diverticulum (text-fig. 159). No penial setæ.

*Remarks.* The original must be wrong in stating that the spermathecal pores are half the circumference apart.

*Distribution.* Near Ghoom, E. Himalayas.

### 31. Perionyx rimatus *Steph.*

1920. *Perionyx rimatus*, Stephenson, Mem. Ind. Mus. vii, p. 206, pl. ix, fig. 9.

Length 80 mm.; diameter 4·5 mm. Segments 107. Body rather flattened. Colour light purple dorsally in the anterior part, pale except for a median stripe in the posterior half; pale ventrally. Prostomium epilobous ½. Dorsal pores from 4/5. Setal rings closed or almost so both dorsally and ventrally; setæ smaller and closer set ventrally; numbers 59/v, 63/ix, 64/xii, 56/xix, 56 in middle of body. Clitellum xiii–xvi (=4). Male pores in a deep transverse crack across the middle of xviii, apparently very near the middle line. Spermathecal pores small, rather close together, in 6/7 and 7/8, in line with *c* or the space *cd*.

Some slight thickening of the septa in the anterior part of the body, 7/8 and 8/9 most thickened. Gizzard vestigial, in v. Intestine begins behind the prostate. Last heart in xiii. Nephridia end in the same line. Testis sacs in x and xi; that in x lobed, appearing as a number of ovoid lobes lying side by side in a transverse series, enclosing œsophagus and hearts; that in xi smaller. Vesiculæ seminales in xi and xii, with granular



Fig. 160.—*Perionyx rimatus* Steph.; spermatheca.

surface, each pair fused dorsally above the alimentary canal, that in xi overlying the testis sac which is independent. Prostates occupying xviii and xix, much indented; duct much twisted, thin, not firm and shining, ectal end rather stouter. Spermathecal ampulla a large irregular sac; duct moderately stout, half as long as ampulla; diverticula as a few small warts on duct a short way below base of ampulla, in a cluster of about half a dozen (text-fig. 160). No penial setæ.

*Remarks.* Resembles *himalayanus* in possessing testis sacs, in being of lighter colour than is usual in the genus, and in coming from Darjiling Dist.

*Distribution.* Sitong, Darjiling Dist.

### 32. Perionyx saltans *A. G. Bourne.*

1886. *Perionyx saltans*, Bourne, P. Z. S. 1886, p. 669.
1895. *Perionyx saltans*, Beddard, Monog. p. 439.
1900. *Perionyx saltans*, Michaelsen, Tier. x, p. 210.
1921. *Perionyx saltans*, Stephenson, Rec. Ind. Mus. xxii, p. 760.

Length 60 mm.; diameter 2 mm. Segments 61. Setal rings almost closed; numbers 45–54. Nephridiopores alternating in position in successive segments in line with the 11th and 17th setæ; a segment which has the pore in the outer position on one side has it in the inner position on the other. Clitellum xiv–xvi (=3). Male pores on papillæ in a median pit. Spermathecal pores three pairs, in 6/7–8/9, near the middle line, in line with *d*.

Spermathecæ with two minute diverticula. No penial setæ.

*Remarks.* There is just a possibility that the worm I described in 1921 as belonging to this species may not do so in reality, as

it was not fully mature; I therefore give the following data separately, instead of incorporating them above.

Length 40 mm. Segments 108. Prostomium epilobous $\frac{2}{3}$. Dorsal pores from 3/4 or 4/5. Setæ 46–50, the rings closed ventrally, and almost so dorsally. The depression containing the male pores has sloping sides, and takes up the whole length of xviii. The nephridia end in considerable end-sacs, as in *P. sansibaricus*. In one of the spermathecæ there was, instead of two small diverticula, a single one, bilobed; in the others there were two.

Bourne remarks that "it is a very strong little worm, and the name refers to its power of leaping into the air when touched."

*Distribution.* Nilgiri Hills, S. India.

### 33. Perionyx sansibaricus *Mich.*

1909. *Perionyx sansibaricus*, Michaelsen, Mem. Ind. Mus. i, p. 174.
1920. *Perionyx sansibaricus*, Stephenson, Mem. Ind. Mus. vii, p. 204, pl. ix, fig. 7.
1921. *Perionyx sansibaricus*, Stephenson, Rec. Ind. Mus. xxii, p. 761.

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1891. *Perionyx sansibaricus*, Michaelsen, Mt. Mus. Hamburg, ix, pt. 1, p. 4, pl. i, fig. 1.
1895. *Perionyx sansibaricus*, Beddard, Monog. p. 438.
1900. *Perionyx sansibaricus*, Michaelsen, Tier. x, p. 209.
1903. *Perionyx sansibaricus*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 8, text-fig. E.

Length 32–63 mm.; diameter $2\frac{1}{2}$–$3\frac{1}{2}$ mm. Segments 84–108. Colour purple dorsally, pale ventrally; the purple darker anteriorly, and extending partly onto the ventral surface there. Prostomium epilobous $\frac{1}{2}$; first segment with median furrow. First dorsal pore may be found as far forwards as 2/3, but varies. Setal rings closed, ventrally somewhat more completely than dorsally; numbers 44/v, 54/ix, 58/xii, 47/xix, and 56 in the middle of the body. Nephridiopores in two series on each side, the series widely separated, one about $\frac{1}{6}$ of circumference from the midventral, the other, on alternate segments, not quite $\frac{1}{8}$ of circumference from the middorsal line. Clitellum ring-shaped, xiii–xvii (=5). Male area somewhat variable; depressed, broader than long, taking up the whole of the length of xviii; male pores close to middle line and usually in front of setal zone, the ring of setæ sometimes continuous across the segment immediately behind the pores; sometimes the whole area is not depressed, but only two crescentic depressions, one in front and one behind a transverse ridge bearing the pores. Spermathecal pores 6/7, 7/8, and 8/9, near the middle line.

No septa noticeably thickened. Gizzard entirely vestigial, in vi. Œsophagus may be wider, and the wall ridged and vascular.

in xiii; or there may be no such change. Last heart in xii. Nephridia with alternately dorsally and ventrally placed terminal vesicles. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, racemose. Prostates with large deeply indented glandular portion; duct thin, rather short, straight. Spermathecal ampulla pear-shaped, narrowing to a short duct; a small thickly pear-shaped diverticulum, one-fourth of the length of the ampulla, placed on the inner side of the duct, consisting of a few indistinct seminal chambers aggregated together on a short stalk. No penial setæ.

*Remarks.* One of the peregrine species of the genus.

Michaelsen on examining his first batch of specimens (from Zanzibar) thought that penial setæ were present, though he was unable actually to isolate any; examination of specimens from India, however, failed to reveal any. I have had a large number of specimens through my hands, and have never found any.

*Distribution.* Baroda, Igatpuri, Manmad, Wathur near Mahableshwar, Londa near Castle Rock, all in Western India; Khandwa, Central Provinces; Kala Khund (between Khandwa and Indore), Central India; Coonoor and Kotagiri in the Nilgiris; Kodaikanal in the Palni Hills. Outside India it has been found in Zanzibar, whence it was first recorded.

### 34. Perionyx shillongensis *Steph.*

1920. *Perionyx shillongensis*, Stephenson, Mem. Ind. Mus. vii, p. 213, pl. ix, fig. 17.

Length 66 mm.; diameter 3 mm. Segments 120. Circular in transverse section, not flattened. Colour a dusky purple dorsally, ventral surface unpigmented. Prostomium epilobous ½, tongue



Fig. 161.—*Perionyx shillongensis* Steph.; spermatheca.

open behind. Dorsal pores from 3/4. Dorsal and ventral breaks in the setal rings small, and in the hinder part of the body absent; setæ rather closer set ventrally; numbers 42/v, 46/ix, 49/xii,

48/xix, and 41 in the middle of the body. Clitellum xiii–xvii (=5), inconspicuous. Male area white, rather swollen; pores fairly conspicuous, rather close together, about in line with setal interval *cd*. Spermathecal pores in 7/8 and 8/9, in line with the interval *bc*.

Septa of anterior region slightly thickened, 6/7–9/10 perhaps most so. Gizzard in vii of fair size, walls somewhat soft. Intestine begins in xvi. Last heart in xii. Nephridial ducts end approximately in the same line. Testes and funnels free in x and xi. Seminal vesicles in xi and xii, large, smooth, meeting dorsally or actually fusing. Prostates confined to xviii, lobed; duct short, stout but without muscular shimmer, straight. Small ovisacs in xiv. Spermathecal ampulla an ovoid sac; duct half as long as ampulla, very stout; diverticula as two clusters of seminal chambers on the duct just below the base of the ampulla, each cluster cauliflower-like and sessile. Penial setæ 0·87 mm. long, 20 $\mu$ thick; shaft straight, tip slightly bowed and bluntly pointed; ornamentation of about eight rings of fine spines.

*Distribution.* Shillong, Assam.

### 35. Perionyx sikkimensis (*Mich.*).

1907. *Perionychella sikkimensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 156.
1909. *Perionychella sikkimensis*, Michaelsen, Mem. Ind. Mus. i, p. 170, pl. xiii, figs. 12, 13.
1910. *Perionyx sikkimensis* (part.), Michaelsen, Abh. Ver. Hamburg, xix, p. 60.

Length ca. 120 mm.; diameter 4–5 mm. Segments 109 (hinder end regenerated). Colour dorsally violet-grey, darker in front;



Fig. 162.—*Perionyx sikkimensis* (Mich.); spermatheca made transparent by acetic acid; × 20.



Fig. 163.—*Perionyx sikkimensis* (Mich.); distal end of penial seta; × 440.

ventrally grey. Prostomium epilobous ca. ½; segment i divided by a median furrow. First dorsal pore at 7/8 if not 6/7). Setæ

rather small; circles nearly complete, only slightly and irregularly broken dorsally; setæ more closely set ventrally than dorsally; numbers 60/vii, 64/x, 78/xiii, 72/xxv. Clitellum xiii–xvii (=5); in the middle part ring-shaped, interrupted ventrally in front and behind. Male pores on small papillæ, ca. $\frac{1}{3}$ of circumference apart; the surface between the pores somewhat depressed. Spermathecal pores in 6/7 and 7/8, ca. $\frac{1}{7}$ of circumference apart; inconspicuous, only seen from inside.

Septa 6/7–16/17 thickened, those in the middle of the series most, the others gradually thinner. Gizzard small, cylindrical, in vi(?), hardly thicker than the rest of the œsophagus, but not exactly vestigial, the muscular coat being fairly strong. No calciferous glands. Last heart in xii (?). Testes and funnels free in x and xi. Seminal vesicles large, in xi and xii, meeting dorsally and embracing the œsophagus. Prostates rather small and compact; duct leaves at a medial incisure, is fairly thick and nearly straight, about as long as the glandular part. Spermathecal ampulla fairly long, almost cylindrical; duct somewhat shorter and thinner, not set off from ampulla; no diverticulum (text-fig. 162). Penial setæ (text-fig. 163) apparently one per bundle, ca. 0·9 mm. long, 28 $\mu$ thick; almost straight, only slightly bent at the distal end; narrowing a little distally, with fairly sharp and simple point; distal part of seta ornamented with irregular, sometimes obliqne, transverse rows of small triangular teeth.

*Distribution.* Sandakphu, Kurseong, and doubtfully Subarkum, in Darjiling Dist., E. Himalayas.

*a.* var. **michaelseni**, nov. nom.

1910. *Perionyx sikkimensis* (part.), Michaelsen, Abh. Ver. Hamburg, xix, p. 60, pl. fig. 6.

Male pores on the border of a thick circular wall, in the middle of which is a deep triangular hollow. Penial setæ 0·6 mm. long, 20 $\mu$ thick, slightly bent proximally, almost straight distally; the tip, after showing a constriction, broadens and is cut off obliquely, the section being almost circular; ornamentation rather more sparing than in the type form.

*Remarks.* This form was described but not named by Michaelsen; the penial setæ seem to entitle it to separate recognition.

*Distribution.* Gangtok, Sikkim, E. Himalayas.

36. **Perionyx simlaensis** (*Mich.*).

1907. *Perionychella simlaensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 157.

1909. *Perionychella simlaensis*, Michaelsen, Mem. Ind. Mus. i, p. 172, pl. xiii, figs. 14, 15.

Length 85–100 mm.; maximum diameter 4–5 mm. Segments ca. 128. Colour in general violet-red; at the anterior end darker,

a deep blue-violet; ventrally grey. Prostomium epilobous $\frac{2}{5}$, tongue open behind. Dorsal pores from 4/5. Setal rings almost complete, indistinctly broken dorsally; setæ set much closer ventrally than dorsally; numbers 45/v, 46/viii, 52/xii, 45/xix, 45/xxvi. Clitellum ring-shaped, xiii–xvii (=5); interrupted ventrally in xiii. Male area (text-fig. 164) occupying whole of xviii, depressed, rectangular with rounded angles, rather broader than long, bounded laterally by raised glandular regions, and

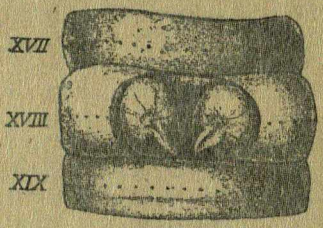



Fig. 164.—*Perionyx simlaensis* (Mich.); male genital area; × 7.

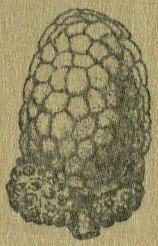


Fig. 165.—*Perionyx simlaensis* (Mich.); spermatheca; × 20.

containing a pair of nearly circular cushions, each of which bears a conical pointed penis-like projection directed obliquely backwards and towards the middle line. The male pores are in the middle of the cushions; and from them is prolonged on to the anterior surface of each penis a groove leading to its tip. No setæ between the male pores; setæ cease on the glandular thickenings lateral to the male area. Spermathecal pores in 7/8 and 8/9, ca. $\frac{1}{10}$ of circumference apart.

No septa specially thickened; those in the testis region and some adjacent ones a little thicker than the rest. Gizzard very small, in v; its walls, however, are of some thickness. No calciferous glands. Last heart in xiii. No perceptible difference between the nephridia of different segments. Testes and funnels free in x and xi. Seminal vesicles four pairs, in ix, x, xi, and xii–xiv, large, much incised. Prostates compact, thickly disc-shaped, much incised; duct fairly thick, irregularly bent, about as long as the glandular part. Spermathecal ampulla large, sac-like, the surface areolated, with numerous closely set bladder-like projections, some of which overhang somewhat; duct much shorter and thinner than the ampulla; diverticulum almost completely surrounding the duct, composed of numerous seminal chambers, and hence mammillated, opening into the ectal part of the ampulla (text-fig. 165).

*Distribution.* Dharmpur, Simla Hills.

37. **Perionyx turaensis** *Steph.*

1920. *Perionyx turaensis*, Stephenson, Mem. Ind. Mus. vii, p. 216, pl. x, figs. 20, 21.

Length 74 mm.; diameter 2 mm. Segments 132. Colour dark brownish-purple dorsally, with still darker median stripe, unpigmented ventrally. Prostomium epilobous $\frac{1}{2}$ or rather more, tongue squarish, either open or closed behind. Dorsal pores from 4/5 or 5/6. Setal rings almost closed ventrally, a small break dorsally; ventral setæ closer set and apparently smaller than the dorsal; numbers 48/v, 56/ix, 54/xii, 44/xix, and 55 in the middle of the body. Clitellum includes $\frac{2}{3}$ xiii and whole of xvii ($= 4\frac{2}{3}$). Male pores close together near the middle line, on small round papillæ which are situated in a slight common depression. Spermathecal pores in 7/8 and 8/9, close together near the middle line.

No septa specially thickened, 8/9 slightly so. Gizzard vestigial, in vi. Calciferous glands in xiii as well-defined ovoid swellings with longitudinal vascular channels. Intestine begins in xviii.



Fig. 166.—*Perionyx turaensis* Steph.; spermatheca; × 40.



Fig. 167.—*Perionyx turaensis* Steph.; distal end of penial seta; ×700.

Last heart in xii. Testes and funnels in x and xi, those in x perhaps contained within a testis sac. Seminal vesicles in xi and xii, large, contiguous in the middle line. Prostates confined to xviii; duct short and moderately stout, transverse in direction. Spermathecal ampulla with lobulated anterior border; duct thick, short, not definitely marked off; diverticula as a few small rounded knobs at the ental end of the duct, perhaps not always present (text-fig. 166). Penial setæ (text-fig. 167) 0·5 mm. long, 11 $\mu$ thick; shaft straight with a slight curvature at distal end, tapering rather rapidly; tip cut off squarely and carries five or six fine spines; six circles of fine spines also just proximal to tip.

*Distribution.* Garo Hills, Assam.

38. **Perionyx variegatus** (*Mich.*).

1907. *Perionychella variegata*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 158.
1909. *Perionychella variegata*, Michaelsen, Mem. Ind. Mus. i, p. 167, pl. xiii, fig. 11.

Length 21–24 mm.; diameter 2–2⅔ mm. Segments 49–63. Shape that of a land Planarian or leech; body very short and depressed, narrowing towards both ends, the hinder rather slenderer than the anterior. Colour primarily yellowish grey; dorsum speckled with dark violet-grey spots; a dark longitudinal dorsal stripe. Prostomium epilobous ⅔, tongue open behind; a median furrow over tongue and back to hinder end of segment i. First dorsal pore in 5/6. Setæ moderately large; rings only slightly interrupted dorsally, $zz = 1\frac{1}{2}\ yz$; ventral interruption indistinct; setæ rather closer set ventrally than dorsally; numbers in middle of body ca. 45–60. Clitellum xiii–xvii (=5); only distinguishable dorsally, by difference in pigmentation. Male pores on prominent circular papillæ, ca. ⅓ of circumference apart, about in line with *e*; the papillæ take up nearly the whole length of the segment; eight or nine setæ intervene between the pores, some of them on the papillæ. Spermathecal pores three pairs, in 6/7–8/9, about in line with *h*, and further apart than the male pores.

Septa throughout the body stronger than is usual in earthworms; 7/8 and 8/9 specially strong. Gizzard very small, in v; very little thicker than the rest of the œsophagus, but with well-developed muscular coat, which reduces the width of the lumen. No calciferous glands or gland-like widenings of the tube. Intestine begins in xiv. Last heart in xii. Nephridia with a long and moderately thick terminal vesicle. Funnels in x and xi, free. Seminal vesicles three pairs, large, in x, xi, and xii. Prostates intermediate in structure between the *Plutellus* and *Pheretima* types; glandular part kidney-shaped, consisting of a much-branched glandular tube, the branches compressed by a thin enveloping membrane; duct fairly long, slightly bent. Spermathecal ampulla globular; duct as long as ampulla, scarcely thinner, set off by a slight constriction; no diverticulum. No penial setæ.

*Distribution.* Phallut, Darjiling Dist., E. Himalayas.

## Subfamily OCTOCHÆTINÆ.

1899. Typhæinæ + Benhamiinæ (part.), Michaelsen, Zool. Jahrb. Syst. xii, p. 242.
1900. Octochætinæ + Trigastrinæ (part.), Michaelsen, Tier. x, pp. 318, 330.
1903. Octochætinæ + Trigastrinæ (part.), Michaelsen, Geog. Verbr. Olig. pp. 108, 109.
1909. Octochætinæ + Trigastrinæ (part.), Michaelsen, Mem. Ind. Mus. i, pp. 122, 203.

1910. Octochætinæ + Trigastrinæ (part.), Michaelsen, Abh. Ver. Hamburg, xix, p. 25.
1915. Octochætinæ, Stephenson, Mem. Ind. Mus. vi, p. 103.
1917. Octochætinæ, Stephenson, Rec. Ind. Mus. xiii, p. 359.
1921. Octochætinæ, Stephenson, P. Z. S. 1921, p. 103.
1921. Octochætinæ, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 36.

Arrangement of setæ from pure lumbricine to pure perichætine. One œsophageal gizzard in one simple segment, or two in two simple segments, or one enlarged gizzard in a space which represents two or more fused segments; in the last two cases calciferous glands in the region of segments x–xiii. Excretory system of meganephridia along with micronephridia, or micronephridia alone, the latter never having the form of sacs. Sexual apparatus from pure acanthodriline to pure microscolecine.

*Distribution.* In all parts of India, more sparsely in the North. Outside India in New Zealand (genera *Octochætus*, *Dinodrilus*, and *Hoplochætina*) and South Madagascar (genus *Howascolex*).

The subfamily was instituted, under the name Typhæinæ, for the genera *Octochætus*, *Eutyphœus*, *Dinodrilus*, and *Hoplochætella* (the last now ranked as a *genus inquirendum*; *cf. post.*, p. 467) by Michaelsen in 1899. There has since been a certain amount of discussion as to its limits; it may be said that it is intended to comprise a group of genera which spring, like other subfamilies, from the original Acanthodriline, the first modification in the present case being the splitting up of the nephridial system; other modifications are superadded in the younger genera—the change from lumbricine to perichætine arrangement of setæ, the microscolecine reduction of the male genital apparatus, and a doubling of the gizzard,—but the original and constant modification is the micronephridial development. The prostates retain the tubular form throughout.

Besides the genera originally included in the subfamily, a number of others are now recognized as belonging here—*Howascolex*, *Ramiella*, *Eudichogaster*, *Erythræodrilus*, and *Hoplochætina*. All the genera are found in India except *Dinodrilus* and *Hoplochætina*, which occur only in New Zealand.

*Howascolex*, the parent form of the subfamily, found in both Madagascar and India, is removed from the original Acanthodriline essentially by the fact that the nephridial system is partly broken up—micronephridia occur along with meganephridia. Certain members of the genus may show an increase in the number of setæ in the hinder segments (the perichætine arrangement), and in some the acanthodriline arrangement of the male organs begins to give place to the microscolecine; there is also an incipient development of calciferous glands in segment xvi.

(The acanthodriline arrangement of the male organs, the primitive one in the family, is that in which there are two pairs of tubular prostates, discharging to the exterior on segments xvii and xix; while the vasa deferentia discharge separately from the prostates on segment xviii. In the microscolecine condition the

openings of the vasa deferentia have been, as it were, attracted to the anterior prostatic openings, and discharge in common with the anterior pair of prostates on segment xvii, while the posterior pair of prostates have disappeared; the reduction of the prostates is often accompanied by a reduction of the spermathecæ to one pair also.)

*Octochætus* is derived from *Howascolex* by a more complete breaking-up of the nephridial system into micronephridia, and, it may be, the more pronounced development of calciferous glands in segments xv or xvi, or both.

*Dinodrilus* (not an Indian genus) is derived from those forms of *Octochætus* which still possess only incipient calciferous glands (subgen. *Octochætus*, *v. post.*, p. 371) by a multiplication of the setæ to six pairs; and *Hoplochætina* (confined, like *Dinodrilus*, to New Zealand) by a further multiplication giving the ordinary perichætine condition.

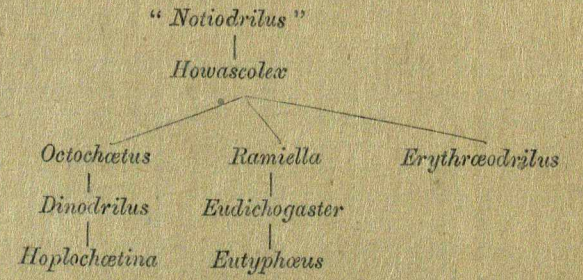
Another line of descent from, or from near, *Howascolex* gives *Ramiella*; the excretory system has broken up into micronephridia, but in a peculiar manner; the micronephridia are few in number—from seven pairs to as few as one pair per segment; no calciferous glands are in process of development.

From *Ramiella*, *Eudichogaster* has evolved by a doubling of the gizzard, and a development of calciferous glands in the region of segments x–xiii (and therefore in front of the place where they develop in the *Octochætus* line). In some cases there is a partial microscolecine reduction.

A further stage of evolution along this line is reached, as was first recognized by Michaelsen in 1921, in *Eutyphœus*, where the microscolecine reduction is complete, the calciferous glands have become localized in segment xii, and the two gizzards have fused again, with the disappearance of the septum between them.

*Erythræodrilus* perhaps represents an independent offshoot from *Howascolex*; the nephridial system has made no further advance, but the setal arrangement has become perichætine, calciferous glands have developed, as in *Eudichogaster*, in x–xiii, and the genital organs are undergoing the microscolecine reduction. Its relations, as shown by the calciferous glands, incline rather towards the *Eudichogaster* branch.

The following tree expresses shortly the above relations:



GSL



*Key to the Indian genera of* Octochætinæ.

| | |
|---|---|
| 1. The perichætine arrangement of setæ exists throughout the body | ERYTHRÆODRILUS. |
| At least in the anterior and middle regions of the body the setæ are arranged in the lumbricine manner | 2. |
| 2. Two gizzards | EUDICHOGASTER. |
| One gizzard | 3. |
| 3. Gizzard large, some septa missing in the gizzard region; purely microscolecine | EUTYPHŒUS. |
| Gizzard simple, in one simple segment; not purely microscolecine | 4. |
| 4. Purely micronephridial | 5. |
| Meganephridia along with micronephridia | HOWASCOLEX. |
| 5. Calciferous glands absent | RAMIELLA. |
| Calciferous glands present | OCTOCHÆTUS. |

## 1. Genus **HOWASCOLEX** *Mich.*

1901. *Howascolex*, Michaelsen, Bull. Ac. Sci. St. Pétersb. xv, p. 202.

1921. *Howascolex*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 36.

Setal arrangement lumbricine either throughout the body, or at least in the anterior and middle regions; often perichætine at the hinder end. One œsophageal gizzard in one simple segment; calciferous glands as mere swellings of the œsophagus in segment xvi, with or without a slighter development of the same kind in one of the neighbouring segments. True meganephridia accompanied by micronephridia. Sexual apparatus from purely acanthodriline to incompletely microscolecine.

*Distribution.* Coorg and Mysore. Outside India in S. Madagascar.

The faunistic relation of India to Madagascar which is indicated by the distribution of this genus is of great interest (*cf.* Introduction, p. 31, and Michaelsen, 99).

The type of the genus is *H. madagascariensis* Mich. (*v. sup.* Michaelsen, 1901). The Indian worms of this genus, all recently discovered and described by Michaelsen (99), differ from the type in the beginning perichætine arrangement of the setæ (in two out of three species), in having a typhlosole, and in certain small differences in the arrangement of the mega- and micronephridia. The micronephridia have apparently originated by the breaking-up of the meganephridia.

*Key to the Indian species of* Howascolex.

| | |
|---|---|
| 1. Setæ eight per segment throughout the body | *H. bidens.* |
| Setæ in the hinder segments more than eight | 2. [f. *ditheca.* |
| 2. Spermathecal pores one pair in 8/9 | *H. corethrurus.* |
| Spermathecal pores three, median, in 7/8–9/10 | *H. corethrurus* f. *typica.* |
| Spermathecal pores four pairs, in 5/6–8/9 | *H. merkaraensis.* |

### 1. Howascolex bidens *Mich.*

1921. *Howascolex bidens*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 38, text-fig. 1.

Length 70–90 mm.; diameter $1\frac{1}{2}$–$1\frac{3}{4}$ mm. Segments ca. 110–180. Colour an even grey, unpigmented. Prostomium epilobous ca. $\frac{1}{3}$. Dorsal pores present. Setæ lumbricine, larger at the ends of the body; $aa = 1\frac{1}{4}\ bc$, $bc = 2\ ab = 1\frac{1}{3}\ cd$, $dd$ = half the circumference in front, but only $\frac{2}{3}$ of circumference behind; arrangement of setæ irregular behind, certain setæ being displaced. Clitellum xiii–xvi (=4). Male porophores large, on xvii, joined by a bridge, and so forming a dumbbell-shaped elevation; pits on the porophores in *ab*, but extending inwards and outwards beyond these lines; penial setæ projecting, two, in the positions of *a* and *b*. Anterior prostatic pores within these pits, close to outer penial seta; posterior prostatic pores inconspicuous, in front of *b* of xix; male pores invisible, perhaps on xviii, at hinder ends of a pair of seminal grooves which extend a short way back from hinder margin of porophores. Setæ *a* and *b* of xviii absent; on xviii and xix narrow transverse ridges, extending about between the lines of *a* on each side. Female pore unpaired, anteriorly on xiv, at the centre of an almost circular area. Spermathecal pores one pair, large deep transverse slits in *ab* in 8/9, each surrounded by a glandular area. A median transversely oval papilla over groove 11/12.

Septa 6/7–13/14 thickened, 7/8 to 9/10 fairly strongly. A large cylindrical gizzard in v. Œsophagus in xvi swollen, with lamellæ internally; in xvii the same structure, but much less marked. Intestine begins in xx, with a well-marked typhlosole. Meganephridia alone in posterior part of body; apparently only micronephridia in anterior part of body, few in number, irregularly arranged. Testes and funnels free in x and xi; seminal vesicles in ix and xii, lobed. Prostates in xvii and xix, those in xix slightly smaller, glandular portion coiled, longer and much stouter than duct. Spermathecæ large (1·3 mm.); ampulla sac-like, passing into a short broad duct; diverticulum thickly club-shaped, one-third the length of the ampulla, opening into a bulging of the duct just below the ampulla; a spermatophore (? several aggregated spermatophores) in duct. Penial setæ 0·55 mm. long, relatively stout, 22–25 $\mu$ thick, slightly bowed at proximal or at both ends, distal end somewhat flattened, extreme tip bifid; a number of short transverse zigzag markings over a short length near the tip.

*Remarks.* This species approaches the type of the genus (found in Madagascar) in preserving the lumbricine arrangement of the setæ; it agrees with the other Indian species in possessing a typhlosole. The microscolecine reduction has been carried out in the spermathecæ, but not in the prostates, though the posterior pair is somewhat reduced in size and has no porophores.

*Distribution.* Shiboga (Mysore).

GSL



## 2. Howascolex corethrurus *Mich.* f. typica.

1921. *Howascolex corethrurus*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 42, text-figs. 2 *a*, 3.

Length ca. 110 mm.; diameter $1\frac{1}{3}$–$2\frac{1}{3}$ mm. Segments ca. 180. Colour pale yellowish grey. Prostomium indistinctly epilobous, small, retracted. Dorsal pores from 11/12. Setæ larger at the ends of the body, with lumbricine arrangement in anterior and middle regions; posteriorly perichætine; in the lumbricine region $aa : ab : bc : cd : dd = 24 : 6 : 15 : 10 : 108$; $dd = \frac{9}{16}$ of circumference; even at hinder end setæ *a*, *b*, and *c* regular, except that *b* and *c* are somewhat approximated; accessory setæ introduced dorsal to *d* and between *c* and *d*, the total number of setæ per segment 18 at most; extent of *aa* remains unaltered, while the median dorsal distance becomes hardly greater than an intersetal distance. Clitellum xiii–xvi (=4), thinner and somewhat depressed ventrally. A median-ventral longitudinally oval wall extends over segments xvii–xix, the interior of the oval occupied by a papilla of corresponding shape; a narrow groove between wall and enclosed papilla; this groove corresponds to the seminal grooves, the anterior prostatic pores being close together at the anterior pole and the posterior similarly at the posterior pole of the elliptical groove, at levels corresponding about to 17/18 and 18/19 (pores recognizable only in sections); male pores in the grooves, on xviii (in sections). Female pores anteriorly on xiv, close together (? fused), in an oval whitish area. Spermathecal pores three, median, in 7/8, 8/9, and 9/10. Paired papillæ in *ab* in 11/12, and a smaller pair, often absent, in 10/11; median papillæ in 15/16 and 20/21, and sometimes in 14/15.

Septa 6/7–12/13 moderately thickened, subsequent ones becoming gradually thinner, 17/18 and 18/19 absent, 19/20 still stouter than the first of the series. Gizzard in v. Œsophagus swollen in xvi, with prominent lamellæ internally. Intestine beginning in xxi, with typhlosole. Posteriorly meganephridia only; in middle of body usually only micronephridia, few and irregularly placed in each segment (occasionally in a few segments meganephridia only). Testes and funnels free in x and xi. Seminal vesicles, much lobed, in ix and xii. Prostates two pairs, tubular, thick, undulations compressed together; duct much thinner and shorter, in a single loop. Spermathecæ three pairs, those of a pair conjoined at the ectal ends of the ducts, retort-shaped; ampulla thickly pear-shaped, passing with a kink into the narrowing duct; diverticulum cylindrical, narrower near its attachment to the ectal end of duct, half as long and half as thick as duct. Penial setæ thin and delicate, 9 $\mu$ thick proximally, gradually tapering to a point, bowed; distal three-fifths with undulating contour.

*Remarks.* Differs from the type of the genus in the commencing

perichætine arrangement of the setæ, and in the presence of a typhlosole.

*Distribution.* Somavarpatna, Coorg.

*a.* forma **ditheca** *Mich.*

1921. *Howascolex corethrurus* f. *ditheca*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 42.

As for the typical form, with the following differences:—

Length 80 mm.; diameter $\frac{2}{3}$–1 mm. Segments ca. 170. Spermathecal pores one pair, in 8/9 in *a*. Spermathecæ one pair.

*Distribution.* Shimoga, Mysore.

### 3. Howascolex merkaraensis *Mich.*

1921. *Howascolex merkaraënsis*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 47, text-figs. 2 *b*, 4.

Length ca. 60 mm.; diameter 1·75–2 mm. Segments ca. 200. Colour brownish-grey. Prostomium indistinctly epilobous ca. $\frac{1}{3}$ (? proepilobous). Dorsal pores present. Setæ somewhat enlarged at the anterior, much enlarged at the posterior end; lumbricine arrangement in the anterior and middle parts of the body, *aa* : *ab* : *bc* : *cd* : *dd* = 24 : 7 : 17 : 13 : 58; *dd* = ca. $\frac{5}{9}$ of the circumference; perichætine at the hinder end, from about segment cxxx, commonly 12 (6 pairs) per segment; the accessory setæ, 1, 2, or seldom 3, introduced dorsal to *d*; *b* is shifted, usually dorsalwards, but the line *a* is regular; the other setæ irregularly placed at the hinder end. Clitellum ? Male field rectangular, longer than broad, embracing xvii–xix, extending laterally from *b* to *b*, depressed; setæ *a* and *b* absent on xviii. Prostatic pores two pairs, on xvii and xix, in the angles of the male field, median from the line *a*, the anterior pair larger than the posterior; seminal grooves almost straight, somewhat bent inwards in the middle of their length and at both ends. Male pores on xviii in the grooves (in sections). Female pore a transverse slit anteriorly on xiv, surrounded by a glandular area. Spermathecal pores four pairs, in 5/6–8/9, median from *a*, near the middle line, increasing in size backwards. Setæ *a* of ix shifted forwards and inwards, situated behind the hindmost spermathecal pores; setæ and pores surrounded by a median glandular area. A pair of eye-like papillæ in 11/12, in *ab*.

Septum 8/9 slightly, 9/10 and 10/11 moderately thickened, the next two decreasingly strengthened, 13/14 thin. Gizzard large, in vi (? v). Œsophagus much swollen in xvi, with prominent longitudinal lamellæ internally. Intestine begins in xviii; a small typhlosole. Last heart in xiii. In at least most segments of hinder part of body only meganephridia are present; in at least many of middle region only micronephridia, in moderately large numbers, irregularly arranged; perhaps both kinds occur in some segments. Testes and funnels free in x and xi. Seminal vesicles

in ix and xii, each consisting of a few lobes. Prostates in xvii and xix, the anterior pair longer and thicker than the posterior; in both, the glandular part pressed together, irregularly disposed, almost coiled, the duct much shorter and thinner, disposed in a loop. Spermathecæ four pairs, of different sizes; the posterior pair, in ix, very large, with pear-shaped ampulla, the wall of which shows a spiral constriction; duct not marked off, short and thin; diverticulum sausage-shaped, two-thirds as long and half as thick as the ampulla, entering ental end of duct; the spermathecæ of viii much smaller, the diverticulum small; those of vii and vi vestigial, small pear-shaped sacs without diverticula. Penial setæ 1·2 mm. long, 13 $\mu$ thick in the middle, tapering gently to a point; the distal two-thirds with undulating contour (except just above the tip); a few scars on the distal half of shaft, with prominent tooth-like border.

*Remarks.* This species is to be placed near the last; it is distinguished by the penial setæ, and by the commencing disappearance of the posterior prostates and anterior spermathecæ (commencing microscolecine reduction).

*Distribution.* Merkara and Bhagamanola, Coorg.

## 2. Genus **OCTOCHÆTUS** *Bedd.*

1892. *Octochætus* Beddard, P. Z. S. 1892, p. 668.
1895. *Octochætus* Beddard, Monog. p. 550.
1900. *Octochætus* Michaelsen, Tier. x, p. 319.
1921. *Octochætus* Stephenson, P. Z. S. 1921, p. 103.
1921. *Octochætus* Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 36.

Setæ with lumbricine arrangement. One œsophageal gizzard in one simple segment; calciferous glands in the region of segments xv–xvii. Purely micronephridial. Sexual apparatus purely acanthodriline.

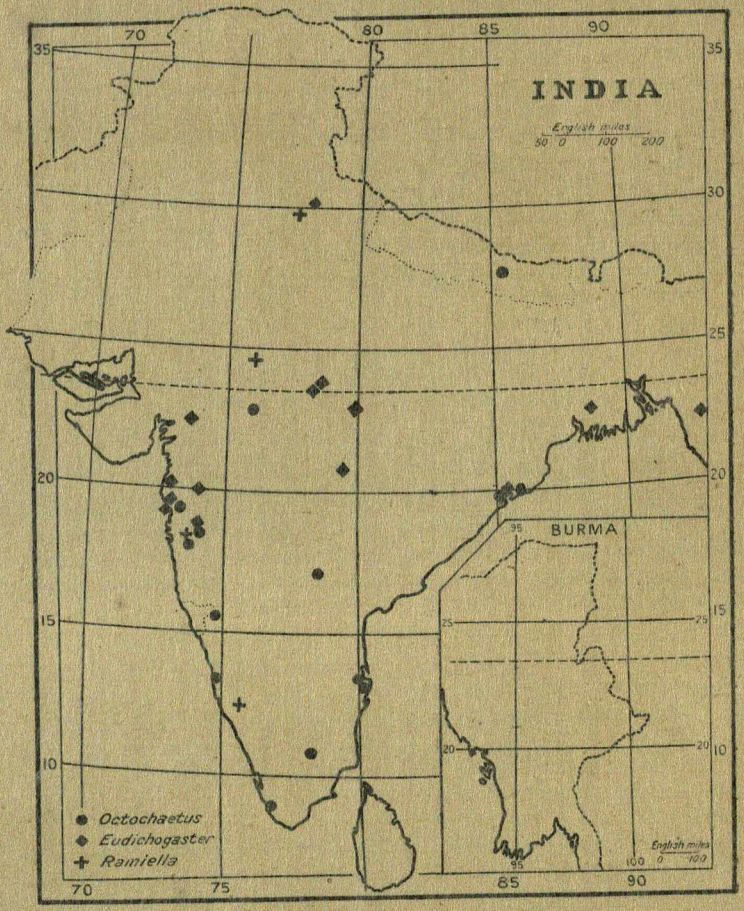
The genus has been recognized since its first establishment by Beddard in 1892. It consists of worms which are removed from the condition of the original Acanthodriline in having numerous micronephridia in each segment instead of a pair of meganephridia, and a pair of calciferous glands behind the ovarian segment.

We have, apparently, in *Howascolex* (a form which differs from the original Acanthodriline essentially only in having micronephridia along with the meganephridia) an intermediary; by the further breaking up of the nephridial system *Howascolex* would become *Octochætus*. This conclusion, arrived at before *Howascolex* was known from India (**80**), receives confirmation from Michaelsen's recent records of *Howascolex* from Mysore and Coorg (**99**). It must be added, however, that the species of *Howascolex* actually found in India are too advanced in some respects (perichætine arrangement of setæ at hinder end, incipient microscolecine reduction) to serve as the ancestors of *Octochætus*;

possibly the Indian stock of *Octochætus* was given off from a more primitive *Howascolex*, which has since undergone further evolution and differentiation.

*Distribution.* (Chart IV). Outside India the genus is found only in New Zealand (subgenus *Octochætus*). In India (subgenus *Octochætoides*) it is found throughout, with on the whole a certain

CHART IV.




preponderance, more marked if the peregrine species are excluded, in the West and South; the Central region, the East and North-East possess representatives, but in the Punjab the only species is

the widely-wandering *O. fermori*. Excluding this species and *O. beatrix*, also peregrine, the list of localities includes:—Mangalore, Travancore, S. Arcot Dist., Weyra Karur, and Madras, all in S. India; Baroda, Poona, and other places in the W. Ghats, Kalyan near Bombay, Castle Rock, all in the Western region; Barkul on the Sur Lake, and Barkuda in the Chilka Lake, in the East; Hyderabad (Deccan), Palia, Indore, Bina, and Gwalior, in the Central area; and near Katmandu in Nepal.

Michaelsen has pointed out that the Indian species of *Octochætus* show a difference from the type of the genus and the other New Zealand species in possessing better developed calciferous glands. For this reason, and on grounds of geography, he divides the genus into two subgenera, *Octochætus* for the New Zealand and *Octochætoides* for the Indian species (type *O. aitkeni*) (**99**).

If *Octochætoides* has developed in India, as seems not improbable (*v. sup.*), it may be independent of the New Zealand *Octochætus*, and the theory of the former wandering of *Octochætus* by land from New Zealand to the Indian region would be unnecessary (*cf. ant.*, Introduction, p. 31).

### Subgenus Octochætoides *Mich.*

1921. *Octochætus* (*Octochætoides*) Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 37.

Calciferous glands as sacs sharply delimited from the œsophagus, one pair in xv or xv and xvi, or two pairs in xv and xvi.

*Distribution.* Is equivalent to the Indian range of *Octochætus*, s. l. (*v. sup.*).

In this subgenus a character of systematic importance is frequently found, which is not met with in the preceding families and genera—the modification of the ventral setæ of segments viii and ix to form what are known as copulatory setæ.

The intimate structure of the calciferous glands in a member of the subfamily (*O. barkudensis*) has been investigated by Stephenson and Prashad (**91**).

It does not seem possible to speak of any part of India as specially the home of the subgenus. Taking *O. aitkeni* and *montanus* as perhaps the most archaic species (seminal vesicles in ix and xii, smooth penial setæ), we find them not far from the W. coast, one near Poona, one near the south end of the peninsula; the other species with seminal vesicles in ix and xii, however, take up broadly the centre of the country from coast to coast.

*Key to species of the subgenus* Octochætoides.

1. Seminal vesicles in segments ix and xii ..... 7.
   Seminal vesicles in segments xi and xii ..... 5.
   Seminal vesicles in xii only ..... 2.

| | | |
|---|---|---|
| 2. | Penial setæ absent | 3. |
| | Penial setæ present | 4. |
| 3. | No spermathecal diverticulum | *O. beatrix.* |
| | A small thick spermathecal diverticulum | *O. hodgarti.* |
| 4. | Testes and funnels free; all septa present | *O. castellanus.* |
| | Testis sac in segment xi; septa 5/6–7/8 absent | *O. fermori.* |
| 5. | Copulatory cushions present | 6. |
| | No copulatory cushions | *O. pittnyi.* |
| 6. | Copulatory cushions on xxiv and preceding segments | *O. thurstoni.* |
| | Copulatory cushions on xiii or 13/14, with or without a papilla on xviii | *O. maindroni.* |
| 7. | Penial setæ smooth | 8. |
| | Penial setæ with spines or teeth | 9. |
| 8. | Clitellum extending over five segments: last heart in xiii | *O. aitkeni.* |
| | Clitellum extending over about eight segments; last heart in xii | *O. montanus.* |
| 9. | Testis sacs present | 10. |
| | Testes and funnels free | 11. |
| 10. | Copulatory papillæ present on xviii (viii, xvi); copulatory setæ with serrated margins | *O. barkudensis.* |
| | No copulatory papillæ; copulatory setæ with transverse rows of seta-like hairs | *O. surensis.* |
| 11. | Septa of anterior part of body all present (though some of the number 5/6–8/9 may be vestigial) | 12. |
| | Septa 5/6 and 6/7, or 6/7 only, absent | 13. |
| 12. | Paired cushions on 11/12 (14/15, 21/22, 22/23) | *O. pattoni.* |
| | No paired copulatory organs | *O. phillotti.* |
| 13. | Copulatory setæ marked by semicircular scar-like depressions | *O. prashadi.* |
| | Copulatory setæ marked by two rows of spines, or two serrated ridges | 14. |
| 14. | The two pairs of prostatic pores sunk in transverse trenches separated by a transverse ridge | *O. paliensis.* |
| | The prostatic pores sunk in the limbs of a dumb-bell-shaped depression | *O. paliensis* var. [*riparius.* |
| | The prostatic pores not situated in definitely shaped depressions | *O. ganeshæ.* |

The penial and copulatory setæ afford good means of identification, and the original figures should be referred to where possible; unfortunately, the descriptions are often somewhat lengthy, and thus not convenient for introduction in the form of a key. The latter part of the above key would have been better if it had been possible to use these characters to a greater extent.

A few groups of species can be distinguished. *O. hodgarti* is very closely related to *beatrix*, the only difference of importance being the presence of a spermathecal diverticulum in *hodgarti* and its absence in *beatrix* (penial setæ, small and difficult to find, and overlooked at first in *beatrix*, may also have been overlooked in *hodgarti*); it might be perhaps allowable to make *hodgarti* a variety. If *hodgarti* is really a variety the species would have a very wide distribution, and would come next to *fermori* in this respect.

*O. beatrix* and *hodgarti* are members of a well-marked group, which also includes *fermori* and *castellanus*; in the three first we have the commencing disappearance of the anterior pairs of testes and funnels, and as a concomitant the reduction of the seminal vesicles to a single pair in segment xii; in *castellanus*, also, the reduction of the seminal vesicles has taken place, though that of the testes and funnels was not noted.

*O. paliensis* and *ganeshæ* are closely related, the chief difference being in the configuration of the male field; it might be allowable here again to rank one as a variety of the other. *O. prashadi* is perhaps to be associated with them in a small group. All are found not far from each other in the Western Ghats, *paliensis* also at several places in the central parts of the peninsula, and *prashadi* near Bombay.

1. **Octochætus (Octochætoides) aitkeni** (*Fedarb*).

1898. *Benhamia aitkeni*, Fedarb, J. Bombay Soc. xi, p. 432, pl. i, figs. 1–5, 7.
1899. *Octochætus aitkeni*, Michaelsen, Zool. Jahrb. Syst. xii, p. 242.
1900. *Octochætus aitkeni*, Michaelsen, Tier. x, p. 320.

Length 119 mm.; diameter 3 mm. Segments 180. First dorsal pore in 19/20 (? 18/19). Setal interval $aa = 2ab$ and is slightly greater than *bc*, which $= cd$ (*i.e.*, the lateral setæ are not paired). Clitellum xiii–xvii (= 5). Male pores very small and near together on xviii. Female pore single. Spermathecal pores near together in 7/8 and 8/9.

Gizzard in vii. Calciferous glands one pair, in xv, cut up into lobes. Intestine begins in xvi. Last heart in xiii. Seminal vesicles two pairs, in ix and xii. Prostates irregularly twisted, sausage-like. Spermathecal ampulla pyriform, the narrow end elongated to form the duct, which is joined at the middle of its length by a club-shaped diverticulum about half as long as the ampulla. Penial setæ smooth, three times as long as the normal setæ, slightly bowed; a nodulus-like thickening one third of the way from the distal end.

*Distribution.* Travancore.

2. **Octochætus (Octochætoides) barkudensis** *Steph.*

1916. *Octochætus barkudensis*, Stephenson, Rec. Ind. Mus. xii, p. 340, pl. xxxiii, figs. 32, 33.
1917. *Octochætus barkudensis*, Stephenson, Rec. Ind. Mus. xiii, p. 405, pl. xviii, figs. 25–27.
1919. *Octochætus barkudensis*, Stephenson and Prashad, Tr. Roy. Soc. Edin. lii, p. 464, pl. figs. 5, 6.
1920. *Octochætus barkudensis*, Stephenson, Mem. Ind. Mus. vii, p. 228.
1921. *Octochætus barkudensis*, Stephenson, Rec. Ind. Mus. xxii, p. 763.

Length 43–91 mm.; diameter 1·5–3 mm. Segments ca. 140. Colour grey or brown. Segments triannulate from vii to clitellum.

Prostomium variable, epilobous $\frac{1}{2}$ or tanylobous. Dorsal pores from 12/13. In the anterior part of the body $aa=4ab$ or nearly, $=1\frac{1}{3}bc$ or nearly, and $cd=1\frac{1}{2}$-$2ab$; further back $aa$ and $bc$ become relatively narrower, $aa=3ab$ or less, and $bc=2ab$; $dd$ is rather more than half the circumference. Clitellum includes $\frac{2}{3}$ xiii–$\frac{2}{3}$ xvii ($=4\frac{1}{3}$). Male field (text-fig. 168) characterized by two cushions on xviii which almost meet in the middle line;

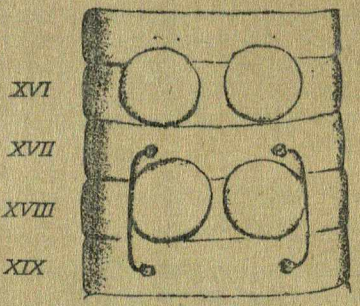



Fig. 168.—*Octochætus* (*Octochætoides*) *barkudensis* Steph.; male genital region, showing well marked copulatory papillæ.

prostatic pores on xvii and xix connected by grooves which are bent outwards to pass over the external margins of the cushions. Spermathecal pores on viii and ix, in front of and between setæ *a* and *b*. Additional genital markings, not always present:—On viii a pair of transversely oval papillæ which include the setæ *ab*

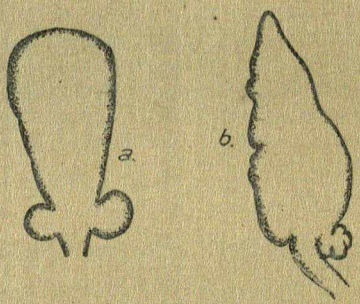



Fig. 169.—*Octochætus* (*Octochætoides*) *barkudensis* Steph.; *a* and *b*, two spermathecæ, showing variations in form.

and do not take up quite the whole length of the segment (these may be joined in the middle line); on xvi a pair of large flat papillæ taking up the whole length of the segment, and almost meeting in the middle line (text-fig. 168); occasionally a large median transversely oval papilla on xxii; rarely a median papilla on xxi.

The first septum, 4/5 or perhaps 5/6, somewhat thickened; the next is 8/9, which is slightly thickened; 9/10–11/12 considerably and a few following diminishingly thickened. Gizzard subspherical, the muscular thickening appearing as an oblique ring, in front of 8/9. Calciferous glands one pair only, in xv and xvi, sometimes asymmetrical; openings apparently in xv. Last heart in xii. Nephridia small and scattered in the anterior part of the body; towards hinder end in two transverse rows per segment, one behind the anterior and one in front of the posterior septum. Testis sacs in x and xi, single in each, enclosing alimentary canal and hearts. Seminal vesicles two pairs, in ix and xii; the anterior flattened and lobed, the hinder large. Prostates of moderate size, coiled, duct thin and twisted. Spermathecal ampulla of variable shape, prolonged to form a short and narrow stalk; diverticulum also variable,—none, one or two, sessile or stalked, with or



Fig. 170.—*Octochætus* (*Octochætoides*) *barkudensis* Steph.; distal end of penial seta.



Fig. 171.—*Octochætus* (*Octochætoides*) *barkudensis* Steph.; distal end of copulatory seta.

without indications of seminal chambers (text-fig. 169). Penial setæ (text-fig. 170) 0·58 mm. long, 10 $\mu$ thick in the middle; shaft slightly curved, distal end sinuous, tip pointed; ornamentation of relatively large spines which do not extend quite to the tip. Copulatory setæ (text-fig. 171) in viii, 0·52 mm. long and 17 $\mu$ thick, not much modified; shaft slightly curved, distal end rather bulbous, the margins cut up into a number of serrations, tip pointed.

*Distribution.* Barkuda Island, Chilka Lake, E. coast.

GSL



### 3. Octochætus (Octochætoides) beatrix *Bedd.*

1902. *Octochætus beatrix*, Beddard, Ann. Mag. N. H. (7) ix, p. 456.
1914. *Octochætus dasi*, Stephenson, Rec. Ind. Mus. x, p. 346, pl. xxxvi, fig. 7.
1922. *Octochætus beatrix*, Stephenson, Rec. Ind. Mus. xxiv, p. 436, text-fig. 2.

Length 70–80 mm.; diameter 4 mm. Segments 192. Colour pale grey, clitellum orange. Prostomium small, epilobous $\frac{1}{2}$, tongue pointed behind. Segments v–vi biannulate, vii–x triannulate. Dorsal pores from 12/13. Setæ all ventrally situated; $aa = 2\frac{1}{2}$ $ab = bc = 1\frac{1}{2}cd$; $dd = \frac{2}{3}$ of circumference; setæ *aa* approach each other more closely in front of and behind clitellum than elsewhere, and in front of clitellum the spaces *aa* and *bc* are relatively smaller than behind. Clitellum xiii–xvii ventrally, xiii–$\frac{1}{2}$xviii dorsally, very markedly limited by constrictions (= 5–5$\frac{1}{2}$). Male area presents a median rather small puckered depression which takes up the whole length of xviii and extends slightly onto the adjacent parts of neighbouring segments; all pores are within the line of setæ *a*; seminal grooves bowed outwards. Female pores paired, close together at the bottom of a transverse groove. Spermathecal pores on minute papillæ near the middle line, in the setal zone of viii and ix internal to *a*.

Septum 5/6 moderately thick; the next is 8/9, which with the four following is moderately stout; 8/9–11/12 all close together, especially 10/11 and 11/12. Gizzard short, resembling a stout ring in the middle of the space between 5/6 and 8/9. Calciferous glands one pair, in xv–xvi, large, lobed. Typhlosole prominent and double, beginning in xx. Last heart in xiii. Funnels free in x and xi, those of xi larger than those of x; testes of fairly large size in xi, absent (? always) in x. Seminal vesicles one pair, small and compact, in xii. Prostates one or two pairs, small; if only one pair, they are in xvii. Spermathecæ minute, ovoid, by the side of the nerve cord; duct short; no diverticulum. Penial setæ 0·6 mm. long, 13 $\mu$ thick in the middle, with slight double curve; tip pointed; ornamentation of a few irregular indentations of the margin near the free end.

*Distribution.* Calcutta; Bombay; Baroda.

### 4. Octochætus (Octochætoides) castellanus *Steph.*

1917. *Octochætus castellanus*, Stephenson, Rec. Ind. Mus. xiii, p. 407, pl. xvii, fig. 22, pl. xviii, figs. 23, 24.

Length 48 mm.; maximum diameter 2 mm. Segments ca. 125. Colour? Prostomium? Dorsal pores from 5/6. Setæ widely paired; $aa = 1\frac{2}{3}ab = bc = 1\frac{1}{2}cd$; $dd$ = ca. half of circumference. Prostatic pores as small pits on xvii and xix medial from *a*, on a common elevation in each segment; seminal grooves bowed outwards, running on broad curved ridges, so that there is a circular

depression in the middle of the male area. Female pore single, median. Spermathecal pores perhaps at the site of setæ *a* on viii



Fig. 172.—*Octochætus* (*Octochætoides*) *castellanus* Steph.; spermatheca.

and ix (or, as determined from inside, perhaps in front of the setal zone).

No septa wanting; 9/10 and 10/11 slightly thickened. Gizzard in vii. Calciferous glands one pair, in xiv, of moderate size and symmetrical. Funnels free in x and xi. Seminal vesicles in xii,

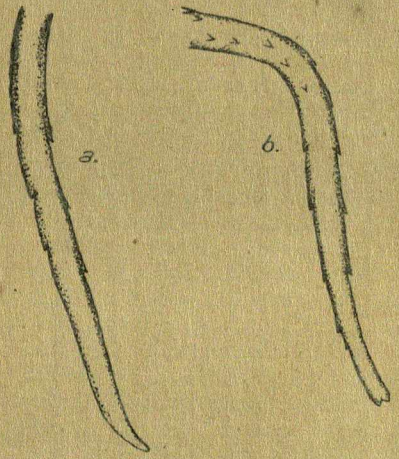



Fig. 173.—*Octochætus* (*Octochætoides*) *castellanus* Steph.; *a* and *b*, penial setæ, of two types; × ca. 360.



Fig. 174.—*Octochætus* (*Octochætoides*) *castellanus* Steph.; copulatory seta of segment viii; × ca. 300.

rather small, deeply lobed. Prostates rather small, in several loops; duct thin, half as wide as glandular part, semitransparent, running straight inwards. Spermathecæ near the midventral line,

rather small; ampulla spherical; duct slightly bent, about as long as ampulla and one-third as thick; diverticulum single, club-shaped, less than ampulla in length, attached near ental end of duct. Penial setæ 0·87–1 mm. long, 14 $\mu$ thick in the middle; main part of shaft only slightly curved; distal end of one of two forms:—(*a*) curve of distal end continues curve of shaft, tip tapering and bluntly pointed, a few teeth some distance above tip; (*b*) distal end considerably bent, it may be to nearly a right angle, tip rather expanded, spatula-like or slightly bifid, and the teeth more numerous; the first type is the shorter, corresponding to the shorter length given above. Copulatory setæ in viii and ix, 0·61 mm. long, 20 $\mu$ thick at the middle; shaft bowed, especially at the ends; distal portion of the shaft (almost half) cut up along its borders into a series of rough notches; tip rather claw-shaped and bluntly pointed.

*Remarks.* Described from a single specimen, in poor condition. The calciferous glands appear to be a segment further forwards than usual.

*Distribution.* Castle Rock, N. Kanara Dist., Bombay Pres.

### 5. Octochætus (Octochætoides) fermori *Mich.*

1907. *Octochætus fermori*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 171.
1909. *Octochætus fermori*, Michaelsen, Mem. Ind. Mus. i, p. 212, pl. xiv, figs. 42, 43.
1914. *Octochætus fermori*, Stephenson, Rec. Ind. Mus. x, p. 344, pl. xxxvi, figs. 5, 6.
1916. *Octochætus fermori*, Stephenson, Rec. Ind. Mus. xii, p. 338.
1917. *Octochætus fermori*, Stephenson, Rec. Ind. Mus. xiii, p. 405.
1920. *Octochætus fermori*, Stephenson, Mem. Ind. Mus. vii, p. 228.

Length 50–100 mm.; maximum diameter $2\frac{1}{3}$–3 mm. Segments 133–190. Colour light grey, clitellum yellower. Prostomium epilobous ca. $\frac{1}{2}$. Segments vi–vii biannular, viii–xii triannular (or some 4-annular), behind clitellum triannular. Dorsal pores from 17/18, or the first may be in front of clitellum, in 12/13. Setæ paired, the lateral widely; small, all ventral; behind clitellum $ab=\frac{2}{5}$ $aa=\frac{1}{2}$–$\frac{4}{5}bc$, $cd=\frac{3}{4}bc$ or more; in front of clitellum $ab=\frac{1}{2}aa=\frac{2}{5}$–$\frac{1}{2}bc$, $cd$ as before; $dd=\frac{3}{5}$–$\frac{2}{3}$ of circumference. Clitellum very distinctly delimited by constrictions at each end, xiii–xvii or $\frac{1}{2}$xviii ($=5$–$5\frac{1}{2}$); setæ present. Clitellum overhangs anterior part of male field; prostatic pores medial from *a*, seminal grooves bowed outwards. Spermathecal pores on viii and ix, in setal zone, very close together, on small papillæ which may be fused midventrally to form cushions. No copulatory organs.

Septum 4/5 thickened, 5/6–7/8 wanting, 9/10–11/12 thickened; 8/9–11/12 rather close together, especially 10/11 and 11/12. Gizzard large, between 4/5 and 8/9. Calciferous glands in xv or xv and xvi, large, much lobed, asymmetrical. Typhlosole a double lamella, begins in xviii. Last hearts in xiii. Testes and funnels

in testis sacs in xi; a smaller pair of funnels free in x, but no testes. Seminal vesicles one pair, large, incised, in xii. Prostates small, with irregular undulations; duct much thinner and shorter than glandular part. Ovisacs in xiv. Spermathecæ (text-fig. 175) small, by the side of nerve cord; ampulla pear-shaped; duct short, muscular, and not sharply set off; diverticulum opening



Fig. 175.—*Octochætus* (*Octochætoides*) *fermori* Mich.; spermatheca made transparent by acetic acid; × 35.



Fig. 176.—*Octochætus* (*Octochætoides*) *fermori* Mich.; distal end of penial seta; × 400.

into duct at junction of latter with body-wall, pear-shaped, half as long and thick as ampulla, with indistinct seminal chambers. Penial setæ (text-fig. 176) 0·55–0·66 mm. long, 15 $\mu$ thick, nearly straight, slightly bent at the distal or at both ends; tip simply pointed; a few teeth lie flat against the shaft in the region of the distal curvature.

*Remarks.* The species shows a stage in the passage to metandry, as does *O. beatrix*, to which this appears to be related. Copulatory setæ seem to be absent, as they are mentioned by neither of the authors who have described the species.

*Distribution.* Kasauli and Hoshiarpur in the Punjab; Saharanpur in the United Provinces; Raniganj in Bengal; Karakulam in Cochin; Gwalior in Central India; Dhanu, Surat, Ahmedabad, and Baroda in W. India.

### 6. Octochætus (Octochætoides) ganeshæ *Steph.*

1920. *Octochætus ganeshæ*, Stephenson, Mem. Ind. Mus. vii, p. 238, pl. xi, figs. 43–45.

Length 43 mm.; diameter 2·5 mm. Segments 150. Unpigmented. Prostomium epilobous $\frac{3}{4}$. Segments v and vi biannular, thence as far as the clitellar region triannular. Dorsal pores from 12/13. Behind genital region $ab=\frac{1}{4}\ aa=\frac{2}{5}bc=\frac{3}{4}cd$; in middle of body $ab=\frac{1}{3}aa=\frac{2}{5}bc=\frac{3}{4}cd$; setæ small and difficult to see in front of genital region; $dd$ equal to nearly $\frac{2}{3}$ of circumference in middle of body. Clitellum absent (or undeveloped?). Male field a rectangular slightly raised area, including xvii–xix,

extending outwards to between *b* and *c*. Prostatic pores between *a* and *b*; seminal grooves slightly bowed inwards. Female pores paired, minute indistinct papillæ anteriorly on xiv, internal to *a*. Spermathecal pores as minute slits on viii and ix, just in front of and between the two setæ of each ventral couple.

Septum 4/5 moderately strengthened, 5/6 and 6/7 absent, 7/8 and 8/9 slightly, 9/10–11/12 considerably, 12/13–14/15 slightly thickened. Gizzard of moderate size, rounded, in the space in



Fig. 177.—*Octochætus* (*Octochætoides*) *ganeshæ* Steph.; spermatheca.

front of 7/8. Calciferous glands in xv or xv and xvi, one pair. Intestine begins in xvii or xviii. Last heart in xii. Micronephridia in a single row in each segment. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, slightly lobed. Prostates consisting of a few coils only; duct half the thickness



Fig. 178.—*Octochætus* (*Octochætoides*) *ganeshæ* Steph.; distal end of penial seta; × 600.



Fig. 179.—*Octochætus* (*Octochætoides*) *ganeshæ* Steph.; distal end of copulatory seta; × 500.

of the glandular portion, soft and semitransparent, with undulating course, and of the same diameter throughout. Spermathecal ampulla an elongated sac, narrower towards its ental end, almost sessile on the body-wall; a single small diverticulum, simple or

with a few small lobulations, attached by a short stalk to the base of the ampulla where this joins the body-wall (text-fig. 177). Penial setæ (text-fig. 178) 0·42 mm. long, 10 $\mu$ thick; shaft almost straight, slightly bowed towards distal end, tip pointed and slightly hooked; ornamentation of a few circles of fine spines near the tip. Copulatory setæ (text-fig. 179) 0·27 mm. long, 10 $\mu$ thick, shaft straight except for a slight bowing towards the tip, which is bluntly pointed and somewhat claw-shaped; ornamentation a number of fine spines on the convex and concave borders of the terminal part of the shaft.

*Distribution.* Ganeshkhind, near Poona; Londa, near Castle Rock (both in Western India).

### 7. Octochætus (Octochætoides) hodgarti *Mich.*

1907. *Octochætus hodgarti*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 172.
1909. *Octochætus hodgarti*, Michaelsen, Mem. Ind. Mus. i, p. 213, pl. xiv, fig. 32.

Length 40 mm.; maximum diameter 2½ mm. Segments 138. Colour greyish. Prostomium epilobous ¾. Setæ ventrally closely paired, laterally less closely, especially in the anterior and middle parts of the body; $cd = 1\frac{1}{2}$–$2ab$, $aa = 1\frac{1}{4}bc$, $dd = \frac{2}{3}$ of circumference. Clitellum ring-shaped, xiii–xviii (=6). Male area almost circular, a little depressed. Prostatic pores somewhat medial from $a$; seminal furrows a little concave towards the middle line. Female pores paired. Spermathecal pores on viii and ix, in the setal zone and somewhat medial from $a$. No copulatory organs.

Septum 5/6 strong, 6/7 apparently missing, 8/9–13/14 strong, especially 9/10–11/12. A large gizzard behind 5/6. A pair of large, strongly bent and almost moniliform calciferous glands in xv, the moniliform appearance due to a number of transverse



Fig. 180.—*Octochætus* (*Octochætoides*) *hodgarti* Mich.; spermatheca made transparent by acetic acid; × 30.

constricting furrows. Typhlosole consisting of two longitudinal ridges. Last hearts in xiii. Testes and funnels two pairs, free in x and xi; anterior pair of funnels smaller than the posterior. Seminal vesicles in xii. Prostates small, irregularly undulating; duct small, thin. Spermathecæ (text-fig. 180) with short sac-like ampulla, which narrows ectally to pass into a conical duct about as long as ampulla; diverticulum small and thick, from upper end of duct or lower end of ampulla, half as long as ampulla.

*Remarks.* On its relations to *O. beatrix* see introduction to subgenus.

*Distribution.* Gowchar, Nepal Valley, Katmandu.

### 8. Octochætus (Octochætoides) maindroni *Mich.*

1907. *Octochætus maindroni* f. *typica*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 168, text-fig. 15.
1909. *Octochætus maindroni* f. *typica*, Michaelsen, Mem. Ind. Mus. i, p. 206, pl. xiv, fig. 29, text-fig. 21.

Length 180 mm.; diameter 4½–5 mm. Segments 198. Colour a uniform grey. Prostomium epilobous ca. ½. Segments ii–iv biannulate, v and some following segments triannulate. Dorsal pores from 12/13. Setæ very delicate, fairly widely paired; $aa=bc$, $aa : ab : bc : cd=5 : 2 : 5 : 3$; *dd* greater than half of circumference; at the anterior end the pairs further apart, *cd* equal to or greater than *bc* and equal to $1\frac{1}{2}ab$. Clitellum xiii–xvii (=5). The whole male area somewhat depressed; prostatic pores in *b*, on very small circular papillæ; seminal grooves convex towards the middle line. Spermathecal pores two pairs, anteriorly on viii and ix, between the lines of *a* and *b*, somewhat nearer the former. Copulatory organ as a single midventral cushion on 13/14, including ⅔ of xiii and ⅓ of xiv, broader than long, reaching nearly as far as *d* laterally, its anterior border convex, the posterior concave.

Septa 7/8–13/14 thickened, especially 9/10–11/12. Gizzard very large, in front of 7/8. One pair of very large calciferous glands opening into œsophagus in xv, but extending into xvi, divided up by deep incisions. Last hearts in xiii. Funnels free in x and xi. Seminal vesicles two pairs, in xi and xii, the anterior pair small and simple, the posterior larger and racemose.

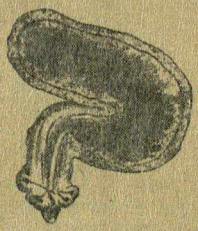


Fig. 181.— *Octochætus* (*Octochætoides*) *maindroni* Mich.; spermatheca made transparent by acetic acid; × 25.

Prostates restricted to xvii and xix; glandular part much bent, almost coiled; duct shorter, thin, irregularly bent. Spermathecal ampulla long, sac-like; duct shorter and narrower; diverticulum at ectal end of duct, very short, almost encircling the duct, with about 7 seminal chambers separated externally by more or less deep grooves (text-fig. 181). Penial setæ (*cf.* text-fig. 183) very

slender, 1·2 mm. long and 10 $\mu$ thick, somewhat bent at the distal end only; distal end somewhat flattened but not broadened, with two fairly sharp edges, point simple; proximal to the flattened portion an ornamentation of irregular transverse rows of large rather slender teeth.

*Remarks.* It is possible that the specimens were not quite mature; the diverticulum of the spermatheca may perhaps be like that of var. *chaperi* when mature.

*Distribution.* Gingi, S. Arcot Dist., S. India.

*a.* var. **chaperi** *Mich.*

1907. *Octochætus maindroni* var. *chaperi*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 169.
1909. *Octochætus maindroni* var. *chaperi*, Michaelsen, Mem. Ind. Mus. i, p. 208, pl. xiv, figs. 30, 31.

Length 50 mm.; diameter 2½–3 mm. Segments ca. 130. Clitellum ring-shaped, xiii–xvii (=5). Female pores paired. Copulatory organs as a large median transversely oval papilla on xviii between the seminal furrows; and a large transverse cushion on xiii, extending laterally beyond *b*.



Fig. 182.—*Octochætus* (*Octochætoides*) *maindroni* Mich. var. *chaperi*; spermatheca. × 45.



Fig. 183.—*Octochætus* (*Octochætoides*) *maindroni* Mich. var. *chaperi*; distal end of penial seta. × 500.

Spermathecal ampulla elongated sac-shaped; duct short, narrow, not sharply set off; diverticulum almost hemispherical, large, with very short and narrow stalk, and numerous seminal chambers which give the surface a mammillated appearance (text-fig. 182).

*Distribution.* Weyra Karur, Madras Pres.

### 9. Octochætus (Octochætoides) montanus *Steph.*

1920. *Octochætus montanus*, Stephenson, Mem. Ind. Mus. vii, p. 234, pl. x, figs. 39, 40.

Length 60 mm.; diameter 3·5 mm. Segments 158. Colour buff, unpigmented. Prostomium epilobous $\frac{1}{2}$, not marked off behind. Dorsal pores from 10/11. Setal relations on vii $ab = \frac{2}{5}aa = \frac{1}{2}bc = \frac{2}{5}cd$; behind clitellum $ab = \frac{1}{3}aa = \frac{2}{5}bc = \frac{1}{2}cd$; in middle of body $ab = \frac{1}{4}aa = \frac{2}{7}bc = \frac{1}{4}cd$; $dd$ is almost $\frac{2}{3}$ of circumference. Clitellum saddle-shaped, embracing nearly all of xii to xix (= nearly 8). Male field whitish, rectangular, including xvii–xix; seminal grooves longitudinal, in line with *a*. Female



Fig. 184.—*Octochætus* (*Octochætoides*) *montanus* Steph.; spermatheca.



Fig. 185.—*Octochætus* (*Octochætoides*) *montanus* Steph.; penial seta; × 40.

pores probably double, in a whitish pad midventrally on xiv. Spermathecal pores in 7/8 and 8/9, apparently in line with *a*. A genital papilla on 21/22, transversely oval, depressed in its centre.

Septum 4/5 moderately stout, 5/6–7/8 very thin, 8/9 somewhat thickened, 9/10–11/12 moderately so, 12/13 very slightly. Gizzard in vi. Calciferous glands two pairs, in xv and xvi, dorsally situated by side of the dorsal vessel. Intestine begins in xvii. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles much lobulated or racemose, large, in ix and xii. Prostates rather small; glandular part a rather thick opaque tube, with a few undulations; duct very small, short and thin. Spermathecal ampulla an irregular sac; duct large, stout at first, narrowing towards ectal end, as long as ampulla and half as thick in its first part; diverticulum single, joining duct at or above middle of its length, finger-shaped on the whole, slightly swollen at its free

end, where a few seminal chambers are indistinctly seen (text-fig. 184). Penial setæ (text-fig. 185) up to 1·5 mm. in length, very thin, only 6 $\mu$ thick in the middle; shaft rather bowed, slightly undulating towards the tip, tapering gradually, tip simply pointed; no ornamentation. No copulatory setæ.

*Distribution.* Panchgani, W. Ghats (near Mahableshwar).

### 10. Octochætus (Octochætoides) paliensis *Steph.*

1920. *Octochætus paliensis*, Stephenson, Mem. Ind. Mus. vii, p. 228, pl. x, figs. 30–33.

Length 45 mm.; diameter $2\frac{3}{4}$ mm. Segments 141. Colour yellowish grey, not darker on dorsal surface. Prostomium proepilobous or combined pro- and tanylobous. Dorsal pores from 12/13. Setæ paired; in front of clitellum $ab = \frac{1}{3}aa$, is less than $\frac{1}{2}bc$ and $= \frac{2}{3}cd$; behind clitellum $ab = \frac{2}{7}aa = \frac{1}{2}bc = \frac{2}{3}cd$; in middle of body $ab = \frac{2}{5}aa = \frac{2}{3}bc$ and is slightly less than $cd$; $dd$ is approximately $\frac{4}{7}$ of circumference. Clitellum xiii–xvii (= 5). Male field shows two trench-like depressions on xvii and xix; segment xviii appears between them as a transverse ridge. Prostatic pores in the deeper lateral parts of the trenches on small white papillæ in line with $b$; seminal grooves straight.



Fig. 186.—*Octochætus* (*Octochætoides*) *paliensis* Steph.; spermatheca.

Male area may join behind with a transversely elongated papilla on the posterior half of xx and anterior half of xxi. Ventral surfaces of viii and ix thickened, forming a couple of broad papillæ; spermathecal pores apparently just in front of site of setæ $a$ of these segments (setæ $a$ and $b$ not visible).

Septum 4/5 moderately thickened, 5/6 and 6/7 missing, 7/8–11/12 somewhat thickened, and diminishingly so as far as 14/15. Gizzard spherical, in front of 7/8. Calciferous glands large, kidney-shaped, in xv. Intestine begins in xvii. Last heart in xii. Testes and funnels free in x and xi. Seminal vesicles in ix and xii. Prostates as moderately thick convoluted tubes, bulging apart the septa bounding xvii and xix; duct thinner than the gland, wavy, shining, thinner in its first part than nearer the

surface. Small ovisacs may be present in xiv. Spermathecal ampulla (text-fig. 186) elongated, somewhat conical; duct not sharply marked off, not shining, one-third as long and half as wide as ampulla; diverticulum single, club-shaped, without distinct stalk, arising from ectal end of duct, one-third or one-fourth as long as main pouch, may be bound down to duct; in other cases the diverticulum has the form of a cauliflower, with a short stalk. Penial setæ (text-fig. 187) 0·65–0·76 mm. long, 16 $\mu$ thick, shaft straight, distal end slightly curved, tip bluntly pointed; ornamentation as eight circles of small spines near the tip; the end may

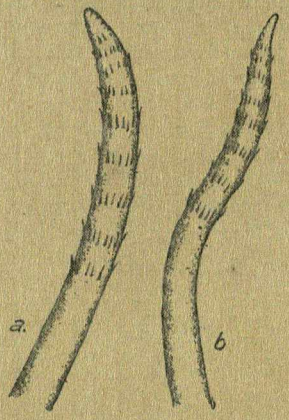



Fig. 187.—*Octochætus* (*Octochætoides*) *paliensis* Steph.; *a* and *b*, distal ends of two penial setæ; × ca. 340.



Fig. 188.—*Octochætus* (*Octochætoides*) *paliensis* Steph.; distal end of copulatory seta; × ca. 230.

be somewhat sinuous instead of simply curved. Copulatory setæ of viii and ix (text-fig. 188) 0·76–0·82 mm. long, 22 $\mu$ thick, distal part bowed, tip rather sharp, somewhat claw-shaped; a row of spines on both convex and concave border of the distal curved part.

*Remarks.* A very variable species; related to *O. ganeshæ*.

*Distribution.* Palia and Indore, Central India; Bina, Central Prov.; Poona.

*a.* var. **riparius** *Steph.*

1920. *Octochætus paliensis* var. *riparius*, Stephenson, Mem. Ind. Mus. vii, p. 231, pl. x, figs. 34, 35.

Length up to 90 mm.; diameter up to 3·5 mm. Segments 135. Prostomium tanylobous or almost so. Dorsal pores from hinder border of clitellum. Setal relations in front of clitellum $ab = \frac{1}{3}aa$

$= \frac{2}{5}bc = \frac{3}{4}cd$; behind clitellum $ab = \frac{2}{3}aa = \frac{2}{5}bc = \frac{3}{4}cd$; in middle of body $ab = \frac{1}{3}aa = \frac{2}{5}bc = cd$; $dd = \frac{5}{6}$ of circumference. Male area (text-fig. 189) rather square, including xvii–xix and the anterior half of xx; on it a dumbbell-shaped depression longitudinal in direction, the narrow part on xviii; the narrowing caused by two large flat papillæ continuous at their outer edges with the thickened edge of the general male area. Prostatic pores in *b*, in the broadened ends of the dumbbell; seminal grooves convex

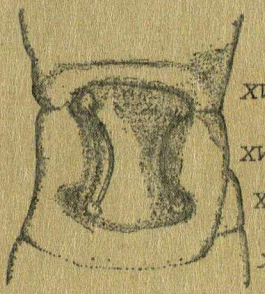



Fig. 189.—*Octochætus* (*Octochætoides*) *paliensis* Steph. var. *riparius*; male genital region.



Fig. 190.—*Octochætus* (*Octochætoides*) *paliensis* Steph. var. *riparius*; distal end of copulatory seta; × ca. 350.

inwards, skirting the inner borders of the papillæ. Spermathecal pores in same position as in type form; here in shallow depressions, each connected across the middle line by an irregular shallow trench.

The penial setæ have the sinuous distal end. Copulatory setæ (text-fig, 190) in form as before, the rows of spines replaced by thin serrated ridges; laterally on the seta, intermediate between the ridges, a series of semicircular markings, concave towards the tip.

*Remarks.* If the papillæ of the male area expanded inwards so as to join, the appearance would be like that of the type-form.

A number of muscular bands in the prostatic region, like those of *O. surensis*, are sufficiently marked in the dissection to attract attention.

*Distribution.* Gwalior.

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11. **Octochætus (Octochætoides) pattoni** *Mich.*

1907. *Octochætus pattoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 170, text-fig. 16.
1909. *Octochætus pattoni*, Michaelsen, Mem. Ind. Mus. i, p. 209, pl. xiv, figs. 33-35, text-fig. 22.

Length ca. 90 mm.; diameter ca. 3 mm. Segments ca. 180. Colour greyish, brown anteriorly on dorsum. Prostomium small, tanylobous (not always distinctly so). Setæ fairly large, all ventral; paired, but not very closely; $ab = cd = \frac{2}{3}aa = \frac{2}{3}bc$; $dd = \frac{7}{12}$ of circumference. Clitellum ring-shaped, or sometimes interrupted in the midventral line, dark brown, xiii or $\frac{1}{2}$xiii–xvi (= $3\frac{1}{2}$ or 4). Male field sunken, extending over xvii–xix and parts of xvi and xx, somewhat less extensive laterally on xviii, the whole surrounded by a wall. Prostatic pores in *ab*; seminal grooves slightly



Fig. 191.—*Octochætus* (*Octochætoides*) *pattoni* Mich.; spermatheca made transparent by acetic acid; × 20.

convex towards the middle line. Female pores paired. Spermathecal pores in 7/8 and 8/9 in *a*; or those of the hinder pair slightly closer together, just medial from *a*. Copulatory organs as paired oval glandular cushions, with a depression in the middle and a more or less distinct central papilla; lying mostly between *a* and *c*, but sometimes somewhat approximated or touching in the middle line; the most constant are in 11/12, less constantly in 14/15 or 21/22 or 22/23; seldom all present, and very seldom all absent.

Septum 5/6 strong, 6/7–8/9 very thin (apparently in part vestigial), 9/10 thin, 10/11–13/14 strong, 14/15 fairly strong. Gizzard large, oblique, in vi (?). A pair of asymmetrical large calciferous glands with short thick stalks opening near the mid-dorsal line at about the border-line between xv and xvi, one projecting forwards into xv and the other backwards into xvi. Intestine begins in xix; typhlosole a double ridge. Testes and funnels free in x and xi, these segments being narrow. Seminal vesicles racemose, in ix and xii. Vasa deferentia with large convolutions in xi, xii, and xiii; those of a side do not unite till they pierce the body-wall. Prostates long, convoluted; duct relatively long, describing some wide convolutions. Spermathecal

ampulla pear-shaped; duct cone-shaped, not set off; diverticulum thick, $\frac{2}{3}$ as long and $\frac{2}{3}$ as thick as the main pouch, the ental portion of the diverticulum with folded walls separating a number of indistinct seminal chambers (text-fig. 191). Penial setæ (text-fig. 192) 1·7–2 mm. long, 17 $\mu$ thick, slightly but regularly curved; the distal fourth seems to have sharp lateral edges, which become expanded at the tip, forming with the thicker axial part a sort of shovel, which is somewhat bent forwards; the distal ends of these



Fig. 192.—*Octochætus* (*Octochætoides*) *pattoni* Mich.; distal end of penial seta; × 325.



Fig. 193.—*Octochætus* (*Octochætoides*) *pattoni* Mich.; distal end of copulatory seta; × 240.

expansions are serrated; proximal to the expanded tip the shaft is ornamented with 8 or 9 rings of slender teeth, and at the edges with 8 or 9 larger teeth on each side. Copulatory setæ (text-fig. 193) on viii and ix, 0·8–1 mm. long and ca. 20 $\mu$ thick, tip somewhat laterally compressed and bluntly pointed, with fine ringed markings; proximal to this part the shaft bears a number of smooth transverse ridges, each concave distalwards, arranged in 3 or 4 longitudinal rows, about 11 ridges in each row; each bundle of setæ combined with a coiled glandular tube embedded in the body-wall.

*Distribution.* Madras.

12. **Octochætus (Octochætoides) phillotti** *Mich.*

1907. *Octochætus phillotti*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 169.
1909. *Octochætus phillotti*, Michaelsen, Mem. Ind. Mus. i, p. 205, pl. xiv, figs. 65-67.

Length 35–55 mm.; maximum diameter 2–2½ mm. Segments ca. 125. Colour greyish. Prostomium epilobous ca. ⅔, small, tongue open behind. Dorsal pores from 11/12. Setæ rather small, paired, but not very closely, the ventral somewhat closer than the lateral, especially in the clitellar region; *ab* greater than *cd*, $bc = 1\frac{1}{2}cd = \frac{3}{5}aa$; $dd = \frac{3}{5}$ of circumference. Clitellum ring-shaped, xiii–xvii (= 5). Male area sunk, bordered laterally by broad almost wall-like protuberances which overhang somewhat in segment xviii, so contracting the male area here. Prostatic pores in *a*; seminal grooves almost straight, slightly concave medially. Female pores paired. Spermathecal pores on viii and ix, just in front of *a*. The ventral part of xviii, and often of xx and of viii and ix, somewhat glandular. Often the spermathecal pores of a segment connected by a groove which is convex backwards, the posterior border of the groove sometimes wall-like.



Fig. 194.—*Octochætus* (*Octochætoides*) *phillotti* Mich.; spermatheca made transparent by acetic acid; × 20.

Septum 4/5 very strong, 5/6 and 6/7 very thin (? vestigial), 7/8–14/15 thickened, especially 10/11–12/13. A large somewhat oblique gizzard between 4/5 and 7/8. Calciferous glands one pair, large, surrounding œsophagus laterally and dorsally in xv, the stalk of each short and narrow. Intestine begins in xv, typhlosole as a double ridge. Last heart in xiii. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, the anterior smaller, the posterior cut up into lobes. Prostates of moderate size, the glandular part convoluted; duct much shorter and thinner, abruptly set off, describing one or two short broad loops. Spermathecal ampulla elongated, ovoid; duct short, not abruptly set off; diverticulum about one-fourth as long as ampulla, indistinctly stalked, opening into duct, divided by deep incisions into two or three lobes, sometimes almost to its base (text-fig. 194). Penial

setæ (text-fig. 195) 0·9 mm. long, 17 $\mu$ thick, almost straight; the distal end slightly bent, especially at the tip, which is hollowed out on the concave side like a spoon; proximal to this the shaft bears about 9 more or less regular oblique or broken



Fig. 195.—*Octochætus* (*Octochætoides*) *phillotti* Mich.; distal end of penial seta; × 300.



Fig. 196.—*Octochætus* (*Octochætoides*) *phillotti* Mich.; distal end of copulatory seta; × 300.

rings of fine triangular teeth. Copulatory setæ (text-fig. 196) in viii and ix, ca. 0·6 mm. long and 17 $\mu$ thick, somewhat bowed; distal end almost beak-like, with a slight ridge along each side; the distal half of the seta, except the tip, ornamented with a large number of closely placed rings of small triangular teeth.

*Distribution.* Hyderabad, Deccan.

### 13. Octochætus (Octochætoides) pittnyi *Mich.*

1910. *Octochætus pittnyi*, Michaelsen, Abh. Ver. Hamburg, xix, p. 86, pl. figs. 25, 26.

Length 60–62 mm.; diameter 2–3 mm. Segments ca. 165. Colour light grey, without pigment. Prostomium epilobous $\frac{1}{2}$, tongue closed behind. Segments iii–iv biannular, v–xii triannular or still further subdivided. First dorsal pore in 11/12. Setæ rather small, ventrally fairly widely paired, laterally rather more widely still; $aa : ab : bc : cd :: 6 : 2 : 5 : 3$, but $aa$ is smaller towards the front, near the male pores; $dd = \frac{2}{3}$ (in front) or $\frac{3}{5}$ of circumference (in middle of body). Clitellum xiii–xvii (= 5); mid-ventrally on xvii the hinder border is excavated to accommodate the male field, which the clitellum overhangs. Prostatic pores rather medial from $a$; seminal grooves convex medialwards, running on indistinct walls. Female pore single, median. Spermathecal pores on viii and ix, medial from $a$, between the first and second annuli of these segments.

Septa 7/8–12/13 fairly strongly thickened, especially the middle ones of the series. Gizzard large, in front of 7/8. Calciferous

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glands one pair, large, in xv and xvi, morphologically apparently belonging to xv; almost smooth externally, curved, meeting the dorsal vessel above. Typhlosole in anterior part of intestine a double ridge. Funnels free (?) in x and xi. Seminal vesicles in xi and xii. Prostates very small, confined to the ventral parts of their segments; glandular portion undulating, duct very narrow, much shorter than the glandular part, somewhat bent. Spermathecæ relatively small, ampulla ovoid; duct as long as and one-third as thick as ampulla; diverticulum thickly club-shaped, somewhat narrower and only half as long as duct, entering ectal part of duct. Penial setæ ca. $\frac{5}{6}$ mm. long, 17 $\mu$ thick, almost straight, bent only at the ends, rather bluntly pointed; ornamentation a few irregularly disposed relatively coarse "scars," the depressions of which are occupied by stout teeth. No copulatory setæ.

*Remarks.* Michaelsen considers this species to be related to *O. aitkeni*, but to be distinguishable by the setal arrangement, the smoothness of the calciferous glands, and the ornamentation of the penial setæ.

*Distribution.* Mangalore (W. Coast); Trivandrum (S. India).

### 14. Octochætus (Octochætoides) prashadi *Steph.*

1920. *Octochætus prashadi*, Stephenson, Mem. Ind. Mus. vii, p. 233, pl. x, figs. 36–38.

Length 51–61 mm.; diameter 2·5–3·5 mm. Segments ca. 150; v and vi biannular, some or all of the rest up to the clitellum triannular. Colour buff, no pigmentation; no difference between dorsal and ventral surfaces. Prostomium epilobous in varying degrees. Dorsal pores from 12/13, or a vestigial pore in 11/12.

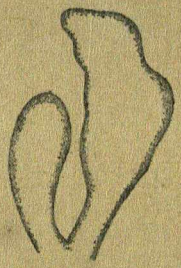

Fig. 197.—*Octochætus* (*Octochætoides*) *prashadi* Steph.; spermatheca.

In the anterior part of body $ab = \frac{2}{7}aa = \frac{2}{5}bc = \frac{3}{4}cd$; the same behind the clitellum; in middle of body $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{2}{3}cd$; $dd = \frac{4}{7}$ of circumference. Clitellum absent or indefinite. Male field a quadrangular thickening including part of xvi and the whole of xx; on xvii and xix transverse trench-like depressions, deeper laterally,

where the prostatic pores are situated on rounded papillæ in line with *b*. Female pores perhaps a pair of whitish dots near middle line on xiv, nearly at the middle of the length of the segment. Ventral surfaces of viii and ix thickened; spermathecal pores in 7/8 and 8/9, in *b* or between *a* and *b*.

Septum 4/5 somewhat thickened, 5/6 thin, 6/7 absent; thence some thickening as far as clitellar region. Gizzard in front of 7/8, large, globular but not very firm. Large calciferous glands in xv, projecting back into xvi, kidney-shaped on the whole, and each divided into an anterior and posterior lobe. Intestine begins in xvii or xviii. Last heart in xii or xiii. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, slightly lobulated. Prostates relatively large, bulging apart the septa of their segments;



Fig. 198.—*Octochætus* (*Octochætoides*) *prashadi* Steph.; tip of penial seta; × 175.



Fig. 199.—*Octochætus* (*Octochætoides*) *prashadi* Steph.; tip of copulatory seta; × 375.

glandular part loosely coiled, rather thick; duct much thinner, shiny, bent or wavy. Ovisacs may be present in xiv. Spermathecal ampulla variable in shape; duct very stout, not sharply marked off; diverticulum of considerable size, with a thick stalk, may be slightly lobed, and may show a few small seminal chambers on microscopical examination (text-fig. 197). Penial setæ (text-fig. 198) 1·5 mm. long, 40 $\mu$ thick; tip slightly hooked and rather hollowed on its concave side; a large number of closely set rings of fine spines extend nearly half-way along the shaft. Copulatory setæ (text-fig. 199) 0·8 mm. long, 26 $\mu$ thick; slightly bowed, tip pointed; distal portion of shaft marked by a number of scar-like depressions, semicircular in shape.

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*Remarks.* Related to *paliensis*, to which it is remarkably similar in many details; the penial and copulatory setæ are, however, very characteristic.

*Distribution.* Kalyan, near Bombay; Sakarwari, on the way to Mahableshwar.

### 15. Octochætus (Octochætoides) surensis *Mich.*

1910. *Octochætus surensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 88, pl. figs. 22–24.
1916. *Octochætus surensi* (mispr.), Stephenson, Rec. Ind. Mus. xii, p. 338, pl. xxxiii, fig. 31.

Length 75 mm.; diameter 2–2·5 mm. Segments 113. Colour grey, with dark brown tinge anteriorly and dorsally. Prostomium epilobous $\frac{2}{3}$, tongue cut off near the front. Setæ fairly large, rather widely paired, especially the lateral; in middle of body $aa : ab : bc : cd = 7 : 3 : 8 : 4$, and anteriorly $= 6 : 3 : 6 : 4$; $dd$ = about $\frac{1}{4}$ of circumference. Dorsal pores from 13/14 (or 12/13?). Clitellum xiii–xvii (= 5), ring-shaped, setæ visible. Male field of a square shape with rounded corners, surrounded by a fairly broad but not sharply defined wall, and extending from the setal zone of xvii to 20/21. Prostatic pores just internal to *b*; seminal grooves almost straight. Female pores paired. Spermathecal pores inconspicuous, on viii and ix, in the setal zone just internal to *b*. Copulatory cushions two pairs, ill defined, on the hinder parts of viii and ix, between *a* and *c*, curving round the spermathecal pores on their outer sides.

Septa 7/8–12/13 slightly thickened. Gizzard very large, in front of 7/8. Calciferous glands in xv, surrounding œsophagus, irregularly constricted. Typhlosole double in its anterior part. Testes and funnels in x and xi, apparently enclosed in testis sacs. Seminal vesicles large, in ix and xii. Prostates with long, fairly thick, irregularly coiled glandular part; duct thin, in a double loop. Strong muscular bands passing outwards from midventral portion of segments xvii and xix. Spermathecal ampulla ovoid or thickly sausage-shaped; duct half as thick and as long as ampulla or shorter; diverticulum sessile on duct above its middle, irregular in shape, about as long and thick as duct is thick. Penial setæ 1·75 mm. long, 24 $\mu$ thick, almost straight, but slightly curved at both ends; tip smooth, simply pointed; for a short distance proximal to the tip the shaft bears a number of triangular teeth, fairly large and fairly closely applied to the shaft. Copulatory setæ 1·4 mm. long and 35 $\mu$ thick, slightly bowed; tip claw-like and smooth; proximal to tip a large number of closely set transverse rows of hair-like projections, a series of these on each side of the seta, the rows closely placed one above the other; the concave border of the seta apparently deeply grooved, the groove and the opposite border of the seta free from spines.

*Remarks.* The above description is taken entirely from that of Michaelsen. My own specimens, from Barkul, differed in a number of points, and since they form possibly a separate variety the characters in which they differ are given below, instead of confusing the above description with particulars which may possibly not belong there.

Length 90 mm.; diameter 3·5 mm. Colour dark purplish brown middorsally, fading off laterally, so that the sides as well as the ventral surface are unpigmented; clitellum brown; anteriorly the pigmentation extends onto the lateral surfaces. Segments 171; vii–x more or less distinctly triannular, xi and xii 4-annular dorsally. Prostomium epilobous $\frac{3}{4}$, sides of tongue parallel, tongue not cut off behind. Dorsal pores from 12/13. Setal intervals in middle of body $ab = \frac{1}{2}aa$ = rather more than $\frac{1}{2}bc = \frac{8}{9}cd$;

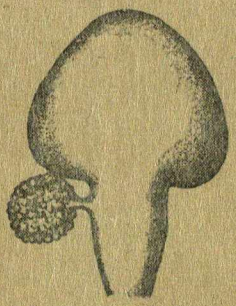

Fig. 200. – *Octochætus* (*Octochætoides*) *surensis* Mich.; spermatheca of specimen from Barkul.

behind clitellum $= \frac{2}{5}aa = \frac{1}{2}–\frac{2}{3}bc = \frac{2}{3}–\frac{8}{9}cd$. Clitellum xiii–$\frac{1}{2}$xvii above (= $4\frac{1}{2}$), but only extends to $\frac{1}{2}$xvi below (= $3\frac{1}{2}$). Male field covers xvi–xx; prostatic pores united across the middle line by broad grooves. No papillæ in spermathecal region, but the ventral surface of viii and ix is thickened and glandular.

Testes not seen in xi; the funnels of xi smaller than those of x. Testis sacs constituted by a delicate membrane which covers in the whole contents of the segments, dorsal vessel and alimentary canal included. The longitudinal groove in the copulatory setæ was not seen; and the transverse rows of hair-like spines appeared to be in four longitudinal series instead of two. The diverticulum of the spermathecæ was cauliflower-like and shortly stalked (text-fig. 200).

According to these specimens there would seem to be a commencing proandry (disappearance of posterior testes and funnels).

In my paper the ratios of the setal distances are wrongly worked out from my original notes.

*Distribution.* Sur Lake, and Barkul on the Sur Lake, in Orissa.

16. **Octochætus (Octochætoides) thurstoni** *Mich.*

1907. *Octochætus thurstoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 173, text-fig. 17.
1909. *Octochætus thurstoni*, Michaelsen, Mem. Ind. Mus. i, p. 215, pl. xiv, fig. 36, text-fig. 23.
1910. *Octochætus thurstoni*, Michaelsen, Abh. Ver. Hamburg, xix, p. 94.

Length 130–160 mm.; maximum diameter 5½–6 mm. Segments 198–204. Colour greyish. Prostomium tanylobous (?), small. Dorsal pores distinct only from 18/19. Setæ moderately large, not very closely paired ventrally, laterally almost separated; $cd$ = ca. $\frac{4}{5}bc$, $ab$ = ca. $\frac{2}{3}bc$, $aa$ = ca. $1\frac{1}{2}bc$; $dd$ = ca. $\frac{1}{4}$ of circumference. Clitellum complete ventrally, but not so swollen there; xiii–xvii (= 5). Male area a little depressed, with a cushion-like elevation between the seminal grooves. Prostatic pores between *a* and *b*; seminal grooves almost straight. Spermathecal pores on viii and ix, immediately in front of the setal zone, between *a* and *b*. Copulatory organs as two to four transverse cushions across the midventral line, on xxiv and preceding segments, extending laterally to *b* or not quite so far.



Fig. 201.—*Octochætus* (*Octochætoides*) *thurstoni* Mich.; spermatheca made transparent by acetic acid; × 12.

Septum 5/6 fairly strong, 6/7 and 7/8 (? and 8/9) missing, thence to 12/13 all very strong. Gizzard large, behind 5/6. Calciferous glands one pair, large, tightly rolled into a spiral, meeting each other dorsally, furrowed and incised, opening into œsophagus in xv (?), but taking up more than one segment. Typhlosole a double ridge. Funnels large, apparently free. Seminal vesicles in xi and xii, each composed of a few separated sacs. Prostates very long and much coiled; duct relatively short, muscular, describing a broad loop. Spermathecal ampulla spindle-shaped; duct short; diverticulum irregularly and thickly pear-shaped, narrowed at its attachment but without distinct stalk, almost as thick as ampulla, containing a large number of small

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seminal chambers, which project slightly on the surface, giving a mammillated appearance (text-fig. 201). No penial setæ discovered; strong transverse muscular bands in relation with ectal part of male apparatus.

*Distribution.* Madras.

### 3. Genus **RAMIELLA** *Steph.*

1914. *Octochætus* (part.), Stephenson, Rec. Ind. Mus. x, p. 347.
1920. *Octochætus* (part.), Stephenson, Mem. Ind. Mus. vii, pp. 236, 239.
1921. *Ramiella*, Stephenson, P. Z. S. 1921, p. 109.
1921. *Ramella*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 37.

Setal arrangement lumbricine. All septa present (after their commencement). One œsophageal gizzard in one simple segment. No calciferous glands. Excretory system purely micronephridial, the micronephridia relatively large and few in number, from seven to one pair per segment only. Sexual apparatus purely acanthodriline.

*Distribution.* Coorg; Mahableshwar in the W. Ghats; S. Rajputana; Saharanpur. Not known outside India.

The genus was instituted by me in 1921 in order to receive three species till then assigned to *Octochætus*. In the same year Michaelsen added another species, writing the generic name *Ramella*. I had formed the word from the Indian proper name Ram, as Michaelsen himself formed the generic name *Eiseniella* from the proper name Eisen; it would appear unnecessary to change the original spelling.

The distinguishing features are the absence of calciferous glands, and the fewness and large size of the micronephridia; to these may be added the fact that all the septa are present after their first beginning. While the absence of calciferous glands, and the presence of all the septa, are doubtless primitive characters, the small number of micronephridia may be secondary; in *R. bishambari* and *heterochæta* the number is reduced to one on each side in each segment.

The genus is to be derived from a form similar to *Howascolex*—perhaps from a point on the phyletic tree rather anterior to the evolution of *Howascolex*. The breaking-up of the nephridial system in *Howascolex* took place, perhaps, by the separating-off as it were of a number of micronephridia, leaving still a recognizable meganephridium on each side of each segment; in *Ramiella* the breaking-up appears to have been complete, resulting in a number of micronephridia only.

The distribution chart (Chart IV) shows the four species occupying stations on a slightly curved line which extends from north to south through the western part of the country.

*Key to the species of the genus* Ramiella.

1. A single nephridium on each side in each segment. 2.
   More than one micronephridium on each side of each segment ..... 3.
2. Penial setæ with expanded end ; distal portion (except tip) with teeth ..... *R. heterochæta.*
   Penial setæ with bluntly pointed tip ; no teeth. . *R. bishambari.*
3. Penial setæ with rings of small teeth ..... *R. pachpaharensis.*
   Penial setæ smooth ..... *R. pallidus.*

**1. Ramiella bishambari** (*Steph.*).

1914. *Octochætus bishambari*, Stephenson, Rec. Ind. Mus. x, p. 347.
1921. *Ramiella bishambari*, Stephenson, P. Z. S. 1921, p. 109.

Length 35 mm. ; diameter 1 mm. Segments 85. Thin narrow worms, of indefinite grey colour. Prostomium epilobous $\frac{1}{3}$–$\frac{1}{2}$. Setal intervals behind clitellum $ab = \frac{2}{7}aa = \frac{2}{5}bc = \frac{2}{3}cd$. Clitellum xiv–xvi (= 3) ; body narrower here. Prostatic pores apparently in the site of setæ *a* of xvii and xix ; seminal grooves longitudinal in direction ; setæ *b* apparently absent on xvii and xix, penial setæ in site of *a*.

No septa wanting ; 7/8–9/11 considerably thickened, 6/7 moderately, 5/6 and 10/11 slightly. Gizzard in vi, small and elongated. Œsophagus segmentally dilated behind vii, the epithelium folded, but no calciferous glands. One nephridium on each side in each segment, not connected with the septa. Testes and funnels free in x and xi. Seminal vesicles three pairs, in x, xi, and xii, meeting or almost meeting dorsally above the alimentary canal. Prostatic ducts bent into a gentle S-shaped curve. Spermathecæ in segments viii and ix, opening in 7/8 and 8/9 ; ampulla ovoid, duct longer than ampulla, bent, and stoutish ; diverticulum of some size, approximately spherical, given off from base of ampulla. Penial setæ at prostatic pores in bundles of two or more ; each curved to nearly a quarter of a circle ; extremely simple, tip bluntly pointed ; length 0·4 mm., thickness 10 $\mu$.

*Remarks.* The nephridia are of large size, but they are not attached to the septa, and therefore do not correspond to the meganephridia of more primitive forms ; if they did, the species would belong to the Acanthodrilinæ (genus *Acanthodrilus*). The organs must be secondarily enlarged micronephridia, other micronephridia in the segment having disappeared. This lends some weight to the supposition that the larger nephridia sometimes met with in other genera (e. g., *Megascolex*) are secondarily enlarged micronephridia, and not a remnant of a former meganephric condition.

*Distribution.* Saharanpur, U.P.

## 2. Ramiella heterochæta *Mich.*

1921. *Ramella heterochæta*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 51, text-figs. 2 *c*, 5.

Length ca. 80 mm.; diameter $\frac{3}{4}$–$1\frac{1}{2}$ mm. Segments ca. 160. Colour an even light grey, unpigmented. Prostomium prolobous to slightly proepilobous; a longitudinal middorsal furrow divides segment i. Dorsal pores not plainly recognizable. Setæ paired, the ventral fairly closely, the dorsal widely; in the middle of the body $aa : ab : bc : cd : dd = 4 : 1 : 6 : 2 : 6$; towards hinder end *dd* is less, may be equal to or even less than *cd*, and then $aa : ab : bc : cd : dd = 5 : 3 : 9 : 4–5 : 5–4$; dorsal setæ enlarged in hinder part of body. Clitellum saddle-shaped, $\frac{1}{2}$xiii–xvi ($= 3\frac{1}{2}$). Prostatic pores two pairs, on xvii and xix, on fairly large papillæ, in line with setæ *b*; the papillæ of the same side connected by a wall, along which runs the almost straight seminal groove. Male pores not visible (except in sections), on xviii, in the grooves. Female pores in front of and internal to setæ *a* of xiv, in a transversely oval whitish field. Spermathecal pores not usually apparent, two pairs, in 7/8 and 8/9, rather below the line *c*. A pair of large transversely oval eye-like papillæ in 11/12 outside the line *b*.

Septum 6/7 very slightly, the subsequent ones as far as 11/12 more strongly thickened, 8/9, 9/10, and 10/11 most so, but still only moderately. Gizzard in v. Typhlosole present. Last heart in xii. Nephridia one pair per segment, unconnected with septum, and apparently without funnel (= a large micronephridium). Testes and funnels free, in x and xi. Seminal vesicles in ix and xii, lobed. Prostates confined to xvii and xix, with irregularly twisted glandular portion, and short thin duct. Spermathecæ in viii and ix, ampulla elongated, sac-like, broader at the base; duct cylindrical, half as long and a quarter as thick as the ampulla, sharply set off; diverticulum single, small, pear-shaped, scarcely longer than duct, which it enters at ental end of latter. Penial setæ thin, 0·6 mm. long, 10 $\mu$ thick proximally, 5 $\mu$ thick distally, bowed; tip expanded in a plane at right angles to that of curvature of seta, forming a triangle with base terminal and slightly excavated, and angles rounded; distal portion of seta with the exception of flattened tip presents a number of small triangular teeth. Copulatory setæ in spermathecal region perhaps present.

*Remarks.* The species is distinguished from the others of the genus by the form of the penial setæ and of the spermathecal diverticulum, and probably by the enlargement of the dorsal setæ of the hind part of the body. It agrees with *R. bishambari* in having only one pair of large micronephridia per segment.

*Distribution.* Somavarpatna, Coorg.

### 3. Ramiella pachpaharensis (*Steph.*).

1920. *Octochætus pachpaharensis*, Stephenson, Mem. Ind. Mus. vii, p. 239, pl. xi, figs. 46, 47.
1921. *Ramiella pachpaharensis*, Stephenson, P. Z. S. 1921, p. 109.

Length 28 mm.; diameter 1 mm. Segments 95. Unpigmented. Prostomium broad, slightly epilobous, tongue not cut off behind. Dorsal pores from 7/8. Setal relations in general $ab = \frac{2}{3}aa = \frac{2}{3}bc = \frac{2}{3}cd$; *dd* slightly less than half circumference. Clitellum xiii–$\frac{2}{3}$xvii ($= 4\frac{2}{3}$); saddle-shaped except on xiii, or xiii and xiv, where it is complete. Prostatic pores between *a* and *b*; seminal grooves straight, longitudinally between the pores. Female pores apparently paired, on the anterior part of xiv. Spermathecal pores in 7/8 and 8/9 (?).

Septum 5/6 somewhat thickened, 6/7 considerably, 7/8–9/10 much thickened, 10/11–13/14 somewhat so. Gizzard in vi, barrel-shaped, of fair size, but soft and so in some degree vestigial.

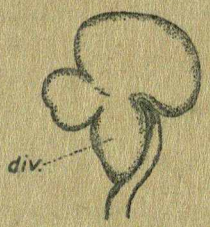


Fig. 202.—*Ramiella pachpaharensis* (Steph.); spermatheca; *div.*, diverticulum (?).



Fig. 203.—*Ramiella pachpaharensis* (Steph.); tip of penial seta; × ca. 300.

Intestine begins in xiv. Last heart in xii. Micronephridia as flattened coils; behind genital region three on each side per segment, in front even fewer, perhaps only one on each side in some segments? Testes and funnels free in x and xi. Seminal vesicles as rounded masses which may meet dorsally, in xii only. Prostates of fair length, extending beyond their own segments, bent several times; duct much thinner, almost straight, shining. Ovisacs present in xiv. Spermathecal ampulla very irregular and deeply lobed; duct as long as ampulla, narrow, firm, shining; diverticulum apparently as a saccule attached to ental end of duct, much resembling one of the lobes of the ampulla

(text-fig. 202). Penial setæ (text-fig. 203) bent into $\frac{2}{3}$ of a circle; length across the bend 0·7 mm., thickness at middle 12 $\mu$, at proximal end 20 $\mu$; shaft tapers gently, distal end slightly recurved, tip somewhat wavy, point fairly sharp; ornamentation a number of irregular rings of small teeth.

*Distribution.* Pachpahar, 40 m. S. of Kotah, Rajputana.

4. **Ramiella pallida** (*Steph.*).

1920. *Octochætus pallidus*, Stephenson, Mem. Ind. Mus. vii, p. 236, pl. xi, figs. 41, 42.
1921. *Ramiella pallida*, Stephenson, P. Z. S. 1921, p. 109.

Length 40–44 mm.; diameter 2·5 mm. Segments 166; vi–ix indistinctly triannulate. Unpigmented. Prostomium prolobous or slightly epilobous. Dorsal pores from 10/11. In front of spermathecæ $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{2}{3}cd$; behind genital segments $ab = \frac{1}{3}aa = \frac{1}{3}bc = \frac{1}{2}cd$; at middle of body $ab = \frac{2}{5}aa$ = nearly $\frac{1}{2}bc = \frac{3}{5}cd$;

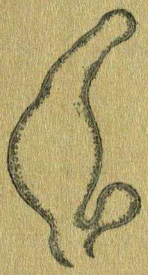

Fig. 204.—*Ramiella pallida* (Steph.); spermatheca.



Fig. 205.—*Ramiella pallida* (Steph.); tip of penial seta; × 600.

$dd$ = half of circumference or rather less at middle of body, but only $\frac{1}{3}$ at hinder end. Clitellum saddle-shaped, xiii–xvii (= 5). Male field a thickening on ventral surface of xvii–xix, which may extend onto xvi and xx, and which laterally reaches beyond the line of $b$, or in some cases to $c$. Prostatic pores in $b$; seminal grooves just outside this line, straight for the most part, curving inwards at their extremities. Female pores paired, on minute papillæ a little internal to and in front of the site of setæ $a$. Spermathecal pores at site of setæ $a$ on viii and ix.

Septum 4/5 thin, 5/6 and 6/7 very slightly strengthened, 7/8–11/12 all somewhat thickened, 12/13 very slightly so. Gizzard barrel-shaped, in vi; œsophagus strengthened in v also by shining longitudinal muscular strands. Intestine begins in xvi. Last heart in xii. Micronephridia in postclitellar segments of moderately large size, about seven on each side in a transverse

row, increasing in size from the ventralmost to the fifth, the two most dorsal smaller again; this difference in size disappears towards the hinder end; in xi and xii masses of nephridial tubules aggregated to form compact oval bodies, a pair in each segment. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, those in ix with almost smooth borders, those in xii racemose. Prostates with glandular part as a series of apposed loops; duct very narrow at its beginning, then wider, of some length, first forming a bend, then straight, stout and shining. Ovisacs in xiv. Spermathecal ampulla elongated, narrower towards its blind end and swollen near its base; duct short, dilated; diverticulum single, stalked, rounded, attached to side of duct, not chambered (text-fig. 204). Penial setæ (text-fig. 205) 0·79 mm. long, 7–8 $\mu$ thick; shaft slightly bowed, tapering gradually; point fairly sharp, distal end of seta has a wavy outline; no ornamentation.

*Remarks.* There appears to be the beginning of a double gizzard, such as is found in the genus *Eudichogaster*.

*Distribution.* Panchgani and Mahableshwar, in the W. Ghats.

## 4. Genus **EUDICHOGASTER** *Mich.*

1896. *Benhamia* (part.), Beddard, P. Z. S. 1896, p. 209.
1898. *Dichogaster* (part.), Fedarb, P. Z. S. 1898, p. 449.
1900. *Trigaster* (part.), Michaelsen, Tier. x, p. 330.
1902. *Eudichogaster*, Michaelsen, Mt. Mus. Hamburg, xix, p. 13.
1910. *Eudichogaster*, Michaelsen, Abh. Ver. Hamburg, xix, p. 92.
1921 *Eudichogaster*, Stephenson, P. Z. S. 1921, p. 103.
1921. *Eudichogaster*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 37.

Setal arrangement lumbricine. Two œsophageal gizzards in two simple segments. Calciferous glands in the region of segments x–xiii, occupying 4, 3, or 2 segments, either as simple dilatations of the œsophagus or as paired sacs. Excretory system purely micronephridial. Sexual apparatus from purely acanthodriline to incompletely microscolecine (prostatic pores two pairs on xvii and xix, or one pair on xvii or xviii; spermathecal pores two pairs on viii and ix, or one pair on viii or in 7/8).

*Distribution.* The genus is confined to India. It is one of the dominant genera in West and Central India; its range is from a section of the West coast (from Bombay to Baroda) and the Western Ghats in this neighbourhood, across Central India to the region of the Ganges delta in Bengal; one species comes from Dehra Dun, but this is an isolated station. The West and Central regions are the areas where the genus occurs thickly.

The worms which come under the above description were separated as a distinct genus by Michaelsen in 1902; the previously known species had been originally described as *Dichogaster* (or the synonym *Benhamia*), and had been included

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by him under *Trigaster* in the Tierreich volume. The separation of these genera was now made on the basis of the calciferous glands; *Trigaster* has none, *Eudichogaster* has them in segments xi and xii (with, it may be, x and xiii in addition), and *Dichogaster* has them in xiv, xv, and xvi, or xv, xvi, and xvii.

*Eudichogaster* is to be looked on as descended from *Ramiella* (not from *Trigaster*, in spite of the small difference between them); see the discussion in Stephenson, 1921 *sup.*; in this Michaelsen agrees (1921 *sup.*). The evolution has consisted in the duplication of the gizzard, and the development of calciferous glands in a more anterior situation than that in which they are found in the genus *Octochætus*.

*Key to the species of the genus* Eudichogaster.

1. One pair of prostates and spermathecæ ..... 2.
   Two pairs of prostates and spermathecæ ..... 5.
2. Spermathecal diverticulum cauliflower-like, consisting of a group, or two groups, of seminal chambers ..... *E. barodensis.*
   Spermathecal diverticulum single and simple .. *E. barkudensis.*
   No spermathecal diverticulum ..... 3.
3. Penial setæ absent; calciferous glands in xi, xii, and xiii ..... *E. parvus.*
   Penial setæ present; calciferous glands in x, xi, and xii ..... 4.
4. Conjoined testis sac and seminal vesicle in x; penial setæ wavy, pointed, no ornamentation . *E. chittagongensis.*
   Seminal vesicles in ix; penial setæ straight, tip flattened ..... *E. pusillus.*
5. Seminal vesicles in ix and xii (or ix, x, and xii). 6.
   Seminal vesicles in xi and xii ..... *E. bengalensis.*
   Seminal vesicles in xii only ..... 9.
6. Penial setæ at prostatic pores ..... *E. falcifer.*
   No penial setæ at prostatic pores; copulatory setæ in spermathecal region ..... 7.
7. Copulatory setæ without ornamentation, simple. *E. mullani.*
   Copulatory setæ with large scar-like depressions. 8.
8. Genital papillæ on xvi and xx ..... *E. ashworthi.*
   No genital papillæ on xvi and xx; ill-marked crescentic swellings, paired, concave medialwards, on xvii–xix ..... *E. prashadi.*
9. Penial setæ present, capillary in form ..... *E. trichochætus.*
   No penial setæ ..... 10.
10. Median papillæ on 9/10 and 10/11; lateral setæ not paired; *ab* less than half *cd* ..... *E. indicus.*
    No median papillæ on 9/10 and 10/11; lateral setæ paired; *ab* greater than half *cd* ..... 11.
11. Small paired papillæ in line with prostatic pores, posteriorly on xvii and anteriorly on xix ..... *E. poonensis.*
    No papillæ as for *poonensis* ..... 8.

The five species *barodensis*, *chittagongensis*, *parvus*, *barkudensis*, and *pusillus* show the microscolecine reduction of the posterior

male organs, and an accompanying reduction of the spermathecæ to one pair. In *barodensis* there is apparently no sign of a reduction in the anterior male organs; in *chittagongensis* these too have been reduced, and the species is proandric; in *parvus* nothing is said as to the testes and funnels, but the seminal vesicles, and therefore quite probably the testes and funnels also, are reduced to one pair; in *pusillus* there are two pairs of testes and funnels, but the seminal vesicles appear to have undergone reduction (only a single one, in ix, was found in the unique specimen); in *barkudensis* no seminal vesicles were found, and a proandric reduction may be taking place. Though according to their structure these five species would seem to be closely related, this is not necessarily so. The microscolecine reduction is a change which has taken place frequently and independently—it occurs in nearly all the subfamilies of Megascolecidæ, and the species of the present genus which show it are widely distributed; indeed, three of them represent the extreme limits of the genus on the West, East, and North respectively (Baroda, Chittagong, Dehra Dun). It is not unlikely, therefore, that these species have originated independently in various parts of the area covered by the genus.

*E. ashworthi* and *prashadi* are closely related, and with these are perhaps to be associated *indicus* and *poonensis*.

*E. barodensis* would appear to be distinctly anomalous in having the conjoined pores of the male deferent ducts and prostates on xviii instead of on xvii; the prostatic pores have been attracted backwards instead of, as usual, the pores of the male ducts forwards.

The nephridia show a number of interesting conditions in the species in which they have been carefully examined. Towards the hinder end of the body in *E. ashworthi* the innermost of the transverse series of micronephridia enlarges so as to resemble a meganephridium; the number of micronephridia in each segment seems to be small—in var. *kinneari* it is about six on each side. In *prashadi* much the same occurs; there are about five organs on each side, regularly arranged in longitudinal lines, till towards the hinder end, where the innermost enlarges and the others become smaller, less regular, and more numerous. In *barodensis* the three dorsally situated on each side are larger than the rest, while at the hinder end the innermost (most ventral) also enlarges. In *bengalensis* there are two pairs of large nephridia per segment, in addition to a number of small micronephridia; towards the hinder end the inner of the two larger nephridia becomes more conspicuous than the other. In *chittagongensis* there are three or four nephridia per segment on each side, arranged in longitudinal rows, the outer the longest; near the hinder end the ventralmost increases in size and becomes more conspicuous. Much the same is the case in *barkudensis*. In *trichochætus* there are four longitudinal rows on each side, but here the innermost series is the smallest. In *parvus*, though the nephridia are "diffuse," they are

of considerable size. In *mullani* there are 7–9 on each side of a segment, with no very great differences in size.

Thus the number of micronephridia per segment is often small, as in *Ramiella*.

### 1. Eudichogaster ashworthi *Mich.*

1902. *Eudichogaster ashworthi*, Michaelsen, Mt. Mus. Hamburg, xix, p. 14.
1910. *Eudichogaster ashworthi*, Michaelsen, Abh. Ver. Hamburg, xix, p. 92.
1910. *Eudichogaster ashworthi*, Stephenson, Mem. Ind. Mus. vii, p. 246, pl. xi, figs. 50, 51.

Length 45–190 mm.; maximum diameter 7 mm. Segments ca. 200. Unpigmented, a dirty yellowish grey. Prostomium prolobous. Anterior segments from iv or v divided, the anterior annulus, which bears the setæ, being longer than the posterior;

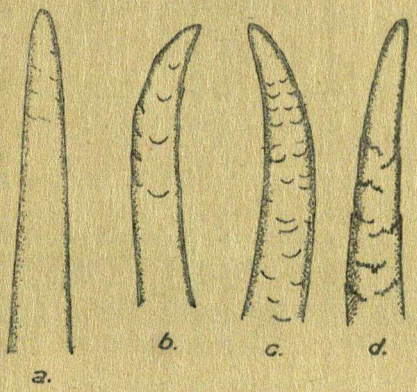



Fig. 206.—*Eudichogaster ashworthi* Mich.; tips of copulatory setæ from neighbourhood of prostatic apertures; *a*, from Wahi; *b*, from Poona; *c*, from Saugor; *d*, from Jubbulpore.

from about vii onwards further secondary annulations also; in the middle and hinder parts of the body the segments more or less plainly triannulate. First dorsal pore in 11/12 or 12/13. Setæ rather small, all ventral; $ab = \frac{1}{4}aa = \frac{1}{2}bc$ = ca. $\frac{4}{5}cd$; $dd = \frac{8}{13}$ of circumference. Clitellum ring-shaped, but ventrally less developed than dorsally; $\frac{1}{2}$xiii–xvi ($= 3\frac{1}{2}$). The rectangular male field comprises xvii–xix, extends outwards beyond the line of *b*, and is somewhat raised. Prostatic pores on xvii and xix, on small papillæ in *b*; the pores connected by E-shaped seminal grooves, with a double convexity outwards. Large roundish raised papillæ on xvi and xx, outside *b*, not absolutely constant; sometimes less obvious flatter papillæ on xvii and xix immediately medial to

the porophores, or these may be single and median; on xiii–xvi the ventral setæ placed on narrow transverse setal papillæ. Area of female pore or pores fairly large, median, transversely oval, situated anteriorly on xiv. Spermathecal pores two pairs, on papillæ in *ab* on the anterior annulus of viii and ix. Sometimes a pair of papillæ outside *b* posteriorly on viii, and another pair similarly on ix; sometimes a midventral papilla posteriorly on viii and a median papilla on x.

Septa 5/6–7/8 very strong, 8/9–10/11 successively less strong. Two almost spherical gizzards in v and vi. Two pairs of retort-shaped calciferous glands, in xi and xii. Intestine begins in xiv. Last heart in xii. A pair of larger nephridia in addition to the micronephridia, near the nerve cord in each segment of the hinder part. Two pairs of funnels, the anterior rather smaller, in x and xi. Two pairs of seminal vesicles, in xi and xii, the anterior rather smaller; or three pairs, in ix, x and xii; or one pair, in xii.



Fig. 207.—*Eudichogaster ashworthi* Mich.; tip of copulatory seta from spermathecal region.

Prostates with very long thin convoluted glandular portion; duct thinner, fairly short, bent. Spermathecal ampulla long, sac-like, flattened, irregularly ringed; duct narrow and very short; diverticulum enters ental end of duct, and consists of a number of chambers, being almost grape-like, with a short duct; diverticulum bound down to ectal part of ampulla and to duct (*cf.* text-fig. 209). Some setæ in neighbourhood of male field (but not at prostatic pores) may be slightly modified by fine sculpturings (text-fig. 206). Copulatory setæ (text-fig. 207) 0·4–0·5 mm. long, straight, somewhat thinner distally, pointed, with large transverse scars which have a rather projecting proximal border.

*Distribution.* Nagpur, Saugor, Bina, Teor near Jubbulpore, Central Provinces; Choral near Indore, Central India; Partabgarh, S. Rajputana.

*a.* var. **kinneari** (*Steph.*).

1920. *Eudichogaster kinneari*, Stephenson, Mem. Ind. Mus. vii, p. 255, pl. xi, figs. 58, 59.

Segments 120. Length 80 mm. Colour buff; no difference between dorsal and ventral surfaces. First segment small, divided

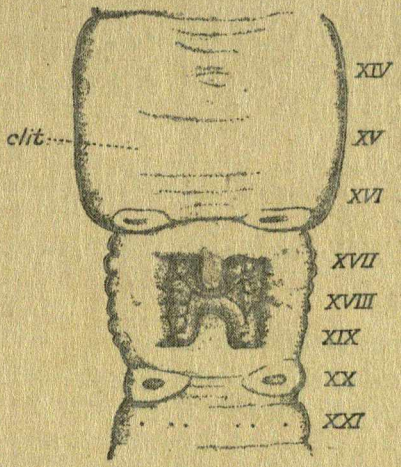



Fig. 208.—*Eudichogaster ashworthi* Mich. var. *kinneari*; clitellum and male genital region; seminal grooves not seen; the grooves shown are irregular fissures in the floor of the H-shaped depression.

by a median groove on dorsal surface. The interval $ab = \frac{3}{4}cd$. Clitellum well marked, xiii–xvi (= 4); deficient ventrally in a



Fig. 209.—*Eudichogaster ashworthi* Mich. var. *kinneari*; spermatheca.

V-shaped interval on xiii. Male field (text-fig. 208) rectangular, on xvii–xix; margins much thickened; from the anterior and posterior margins backward and forward projections respectively, so

that there is a central H-shaped depression; floor of depression deeply fissured. Prostatic pores in the four angles of the H, in *b* or *ab*; seminal grooves as in type form. In addition to the paired papillæ on xvi and xx there may be median papillæ in these segments. In the spermathecal region the paired papillæ on viii and ix (not those on which the spermathecal pores are situated) are further forward, and touch the spermathecal papillæ on the outer side of the latter, including the lateral setæ.

Septum 4/5 thin, 5/6–11/12 moderately strengthened. Micronephridia behind x arranged in transverse rows, about six on each side of each segment; towards the hinder end the innermost on each side becomes much thickened and more opaque, and hence much more conspicuous than the rest. Copulatory setæ 0·73–0·87 mm. long, 25 $\mu$ thick; the scars apparently more semicircular and fewer than in the type form; the setæ are exactly like those of *E. prashadi*.

*Distribution.* Nasik (ca. 80 m. N.E. of Bombay).

## 2. Eudichogaster barkudensis *Steph.*

1921. *Eudichogaster barkudensis*, Stephenson, Rec. Ind. Mus. xxii, p. 765, pl. xxviii, figs. 12, 13.

Length 57 mm.; maximum diameter 1·75 mm. Segments 130. Unpigmented. Prostomium proepilobous. Dorsal pores from 11/12. Setæ paired; in middle of body $ab = \frac{1}{2}aa$ or nearly

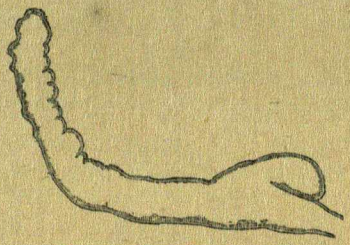


Fig. 210.—*Eudichogaster barkudensis* Steph.; spermatheca.

so $= \frac{2}{5}bc = \frac{3}{4}cd$; further back *bc* and *cd* may be almost equal; behind clitellum $ab = \frac{2}{5}aa = \frac{1}{2}$–$\frac{4}{7}bc$; $dd$ = half of circumference (or $\frac{4}{7}$ in anterior part of body). Clitellum xiii–$\frac{1}{2}$xvii ($= 4\frac{1}{2}$). Prostatic pores one pair, on xvii, on round papillæ between *a* and *b*; the pores slit-like, oblique, diverging behind. Female pores minute, in a circular white patch anteriorly on xiv. Spermathecal apertures one pair, as very minute white points on viii, just in front of setæ *a*.

Septum 4/5 thin, 5/6 extremely so, 6/7 and 7/8 also very thin, 8/9 thin, 9/10 and 10/11 slightly strengthened, 11/12–13/14 thin

but slightly thicker than those which follow. Gizzards in v and vi. Calciferous glands in x, xi, and xii, diminishing in size backwards. Last heart in xii. Nephridia of moderate size, behind clitellar region forming a transverse row of four on each side, those towards the ventral end of the row smaller and closer together; towards the hinder end of the body the innermost of each row enlarges, and there are here three on each side—a long thin loop between *d* and the middorsal line, a smaller organ in *c*, and the largest and thickest extending from *a* outwards to between *b* and *c*. Testes and funnels free in x and xi (testes not actually identified in x, but funnels in x larger than those in xi). No seminal vesicles. Prostates one pair, in xvii, transversely disposed; duct thin, transverse, equal in length to the glandular portion. Spermathecæ (text-fig. 210) one pair, each a narrow elongated cylindrical tube, with small sac-like diverticulum towards ectal end. Penial setæ (text-fig. 211) 0·53 mm. long, very slender, bowed

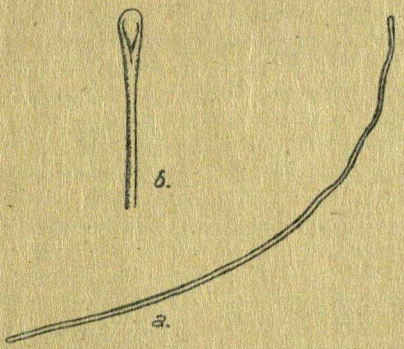



Fig. 211.—*Eudichogaster barkudensis* Steph.; penial setæ; *a*, general form, × 125; *b*, distal end more highly magnified, × 500.

towards distal end; shaft somewhat sinuous in outline in distal part; tip ends in a small flattened expansion of rounded outline. No copulatory setæ.

*Distribution.* Barkuda Island, Chilka Lake, E. coast.

### 3. Eudichogaster barodensis *Steph.*

1914. *Eudichogaster barodensis*, Stephenson, Rec. Ind. Mus. x, p. 358, pl. xxxvi, figs. 13, 14.

Length 74–100 mm.; diameter 3¼–4 mm. Segments 163–167. Colour pale yellowish brown, uniform all over, except clitellum which is darker. Prostomium prolobous, segment i partly divided by a middorsal groove. Segment iv biannulate, v triannulate, vi–xi 4-annulate, xii triannulate with other secondary rings in

addition; behind clitellum triannulate. Dorsal pores from 12/13. Setæ closely paired; $ab = \frac{1}{3}$–$\frac{1}{4}aa = \frac{2}{3}bc = cd$; $dd = \frac{1}{4}$ of circumference. Clitellum xiii–$\frac{1}{3}$xviii (= $5\frac{1}{3}$), or slightly shorter at each end. Male genital field with four flat pads; one on 17/18, transversely elongated, from between *a* and *b* to the corresponding point on the other side; another similarly placed on 18/19; the two remaining form a pair on xviii, small, including setæ *ab* and extending somewhat beyond them inwards and outwards; thus the ventral part of xviii is enclosed by four cushions. Prostatic pores not visible externally; from internal dissection duct ends on xviii, in *ab*, nearly in *b*; setæ of xvii and xix present; setæ *a* of xviii absent. Female pore midventral, indicated by a small whitish area in front of setal zone of xiv. An anterior genital area with a transversely elongated pad (often not well marked) in 7/8 extending outwards beyond *b*, including the hinder annulus of vii and the anterior one of viii; spermathecal pores probably represented by a pair of minute dots on the pad, in line with *b*; small darkish spots in a transverse line on the middle part of the pads (as also on the anterior of the four pads in the male area).

Septa 5/6 (the first) to 10/11 moderately to considerably thickened. Gizzards in v and vi, large, subglobular. Calciferous glands two pairs, in xi and xii, subglobular and set off from the gut. Intestine begins in xv. Last hearts in xiii. Micronephridia in regular transverse lines in all postclitellar segments, the three dorsal larger than the rest on each side; at hinder end the ventralmost has become much larger and is equal in size to any of the series. Testes and funnels free in x and xi. Seminal vesicles large and lobed in ix and xii; sometimes rudimentary vesicles in x also. Prostates a single pair in xviii–xix, much coiled; duct gently looped once or twice, ending in xviii; the two vasa deferentia of each side pierce the body-wall still ununited, close to and on the anterior side of the ending of the prostatic duct. Spermathecæ one pair, the ampulla somewhat conical with the base towards the surface; duct narrow and shining, in a gentle S-shaped curve, two-thirds as long as ampulla; diverticulum cauliflower-like, bound down to duct and base of ampulla, or the seminal chambers may be in two groups instead of one. No penial or copulatory setæ.

*Distribution.* Baroda.

### 4. Eudichogaster bengalensis *Mich.*

1910. *Eudichogaster bengalensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 96, pl. figs. 27, 28.
1916. *Eudichogaster bengalensis*, Stephenson, Rec. Ind. Mus. xii, p. 344.
1920. *Eudichogaster bengalensis*, Stephenson, Mem. Ind. Mus. vii, p. 248.

Length 40–54 mm.; diameter 2–$2\frac{1}{2}$ mm. Segments 94–124. Colour light grey, unpigmented. Prostomium tanylobous, borders

of tongue parallel; or proepilobous, with a pair of shallow grooves dorsally on i which do not reach 1/2. First dorsal pore in 10/11 or 11/12. Setæ fairly widely paired, especially the lateral; $aa : ab : bc : cd = 15 : 6 : 12 : 8$; $dd = \frac{1}{3}$ of circumference in middle and hinder parts of body, $= \frac{2}{3}$ of circumference in anterior part. Clitellum ring-shaped, xiv–$\frac{1}{2}$xvii ($= 3\frac{1}{2}$); ventrally does not include any of xvii. Prostatic pores on xvii and xix, immediately internal to *b*; seminal grooves straight, except that they are bent inwards at both ends. Spermathecal pores at the site of the (missing) setæ *a* of viii and ix, surrounded by small somewhat darker areas. Occasionally three pairs of papillæ, oval, in line with *ab*, on viii, ix, and x.

Septum 5/6 thin, 6/7–11/12 strengthened, especially 7/8–10/11. Gizzards large, in v and vi. Calciferous glands in x–xiii, as bulgings of œsophagus with low transverse lamellæ on the ventral wall. Last heart in xii. Micronephridia more numerous towards hinder end; in addition, two pairs of larger nephridia per segment from genital region onwards; towards the hinder end the inner of the two becomes more conspicuous. Two pairs of testes and funnels, in x and xi. Two pairs of grape-like seminal vesicles in xi and xii. Prostates with thick and long glandular part pressed together and flattened; duct thinner, shorter though still relatively long, with a few small undulations. Spermathecal ampulla almost spherical; duct as long as ampulla, scarcely half as thick at its ental end, thinner ectally; diverticulum at ental end of duct, knob-like, without stalk, enclosing a few irregular seminal chambers; or there may be two diverticula, each perhaps the equivalent of one of the seminal chambers. Penial setæ 0·7–1·3 mm. long, gently curved (more strongly at the distal end); tip claw-shaped or simple and blunt; proximal to tip shaft clothed with numerous fine spines which may or may not be longer nearer the tip.

*Remarks.* The specimens that I examined seem to differ from Michaelsen's originals in the spermathecæ and penial setæ; possibly also in the nephridia, though Michaelsen's specimens were badly preserved and hence the nephridial characters scarcely determinable.

*Distribution.* Rajmahal, and Tribeni near Calcutta, in Bengal; near Cuttack, in Orissa; Marble Rocks near Jubbulpore, in the Central Provinces.

### 5. Eudichogaster chittagongensis *Steph.*

1917. *Eudichogaster chittagongensis*, Stephenson, Rec. Ind. Mus. xiii, p. 411, pl. xviii, figs. 31–33.

Length 30 mm.; maximum diameter 2 mm. Segments ca 121. Colour an indefinite grey. Prostomium triangular, epilobous $\frac{1}{3}$. Dorsal pores from behind clitellum. $Ab = \frac{1}{3}aa = \frac{2}{3}bc = \frac{2}{3}cd$, *d* being below the lateral line; towards hinder end setæ less closely paired, $ab = \frac{1}{2}aa = \frac{2}{3}bc = \frac{2}{3}cd$, *d* being about the lateral line. Clitellum $\frac{1}{2}$xiii–$\frac{1}{2}$xvii ($= 4$); smooth, constricted. Posterior part of xvii,

behind clitellum, is depressed; prostatic pores on xvii as short oblique slits between *a* and *b*. Female pores on xiv, just in front of setæ *a* on each side. Spermathecal pores on viii at site of ventral setæ (?).

Septa 4/5–7/8 thin, 8/9–12/13 slightly strengthened. Gizzards large, in v and vi. Calciferous glands form small white swellings in x, xi, and xii. Last heart in xii. Micronephridia as looped tubes, behind prostatic region in three or four longitudinal rows, the dorsal loop the most elongated; behind middle of body three rows; near hinder end the ventralmost increases in size and becomes more conspicuous. A pair of conjoined testis sacs and seminal vesicles in x, large, opaque and white, attached to 10/11, meeting above alimentary canal. Prostates a single pair, very

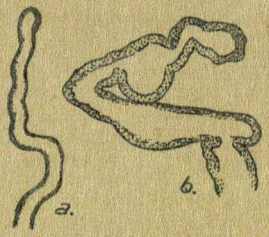



Fig. 212.—*Eudichogaster chittagongensis* Steph.; two spermathecæ; *a*, as seen in dissection; *b*, a second, seen by transparency under the low power.

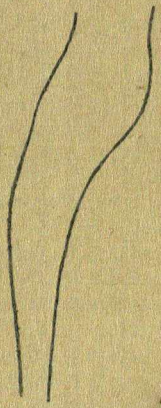


Fig. 213.—*Eudichogaster chittagongensis* Steph.; outline of penial setæ.

small, in xvii, placed transversely; duct thin, about as long as glandular portion. Relatively large ovisacs in xiv. Spermathecæ (text-fig. 212) one pair, each a twisted tube without distinction of ampulla and duct. Penial setæ (text-fig. 213) 0·58 mm. long, ca. 3·5 $\mu$ thick; rather whip-like, slender and rather wavy, without ornamentation.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

### 6. Eudichogaster falcifer *Steph.*

1920. *Eudichogaster falcifer*, Stephenson, Mem. Ind. Mus. vii, p. 252, pl. xi, fig. 55.

Length 40 mm.; diameter 2 mm. Segments 128. Colour a nondescript yellowish grey, no difference between the dorsal and ventral surfaces. Prostomium proepilobous. Dorsal pores from 12/13. In middle of body *ab* rather greater than $\frac{1}{2}$ *bc*, rather less than $\frac{1}{2}$ *aa*, and nearly equal to *cd*; behind genital region *ab* is

about equal to $\frac{1}{2}aa$ and $\frac{1}{2}bc$; in front of genital region $ab = \frac{3}{5}aa = \frac{3}{5}bc = \frac{3}{4}cd$; $dd$ = ca. $\frac{3}{5}$ of circumference. Clitellum indistinguishable. A slight whitening and thickening of ventral surface of xvii–xix, better marked laterally where there are definite ridges; these turn in at their ends so as to enclose the centre of the area as within brackets. Prostatic pores apparently in the position of setæ *a* of xvii and xix; seminal grooves crescentic, convex outwards. Female pores? Spermathecal pores?

Septa 6/7 and 7/8 thin, 8/9–10/11 slightly thickened. Large gizzards in vi and vii. Calciferous glands three pairs, in x, xi, and xii, roundly ovoid. Intestine begins in xv. Last heart in xii.



Fig. 214.—*Eudichogaster falcifer* Steph.; distal end of penial seta; × ca. 700.

Funnels free in x and xi. Seminal vesicles in ix and xii, somewhat lobulated and rather granular-looking. Prostates? Spermathecæ two pairs, the ampulla a small ovoid sac narrowing to become the duct, which is half as long and half as wide as the ampulla; diverticulum simple, finger-shaped, half as long as ampulla, arising from junction of ampulla and duct. Penial setæ 0·3 mm. long, 8–9 $\mu$ thick; distal portion gently curved in a sickle-shape, tip slightly bent in the opposite direction and bluntly pointed; towards the tip a number of indentations in the margin, which, however, do not form spines standing off from the shaft.

*Distribution.* Jubbulpore and Saugor, Central Provinces.

GSL



### 7. Eudichogaster indicus (*Bedd.*).

1896. *Benhamia indica*, Beddard, P. Z. S. 1896, p. 209, text-fig. 3.
1900. *Trigaster indica*, Michaelsen, Tier. x, p. 333.

Length 75–100 mm.; diameter ca. 4 mm. Prostomium large, no dorsal process. Dorsal pores present. Setæ *ab* closely paired; $cd = 2\frac{1}{2}ab$, not paired; all setæ ventral; setæ shed in xvii, xviii, and xix at maturity. Clitellum xiii–xvi (= 4). Genital papillæ present in spermathecal region; a pair of large papillæ on ix, which include the setæ (apparently both dorsal and ventral bundles); a single median papilla on 9/10, and another on 10/11; on each of these latter a row of pores "which appear to correspond to glands like the capsulogenous glands of *Perichæta*."

First septum is 4/5; 5/6–7/8 moderately thickened, also 8/9–11/12 to some extent. Gizzards stout, in v and vi. Calciferous glands in xi and xii. Intestine begins in xvi. Last heart in xii. Nephridia of the diffuse type. Testes in xi (? immature); funnels in x and xi, those in x smaller. Seminal vesicles a single pair, in xii. Prostates very long and coiled. Spermathecæ two pairs, in viii and ix; diverticulum near the external aperture, inconspicuous, apparently trifid or quadrifid. No penial setæ. Copulatory setæ of ix on papillæ, rather longer than the ordinary setæ, less curved, distal extremity ornamented with elegantly disposed semicircular ridges.

*Remarks.* The details of the male field can only be gathered uncertainly from the figure. There appears to be a rectangular male field, whitish, covering xvii–xix, with a transversely oval depression across the middle, *i. e.*, across segment xviii; the prostatic pores in *a* on xvii and xix, each pair connected across the middle line by a transverse groove.

*Distribution.* Thana, near Bombay.

### 8. Eudichogaster mullani *Steph.*

1922. *Eudichogaster mullani*, Stephenson, Rec. Ind. Mus. xxi, p. 438, text-fig. 4.

Length 134 mm.; diameter 6 mm. Segments 200. Colour an equable light grey. Anterior end rather bulbous; secondary annulation in anterior segments from iv to clitellum. Prostomium small, prolobous; a median dorsal groove divides segment i throughout its length. Dorsal pores from 12/13 (perhaps a small or rudimentary pore in 11/12). Setæ not visible in ii–iv, and only a few in v and vi; in middle of body $ab = \frac{2}{7}aa = \frac{2}{5}bc = \frac{2}{3}cd$, and $dd$ = ca. $\frac{4}{7}$ circumference; behind the genital region $ab = \frac{1}{4}aa = \frac{1}{3}bc = \frac{1}{2}cd$, and $dd = \frac{2}{3}$ circumference; ratios in anterior segments about the same as the last. Clitellum $\frac{1}{2}$xiii–$\frac{1}{2}$xvii (= 4)? Segments xvii–xix depressed midventrally, with an irregular raised rough patch in the middle of the depression. Prostatic pores apparently on four small papillæ at the angles of the

depression, in line with *b*, slightly in front of the setal zone of xvii and behind that of xix. Two unpaired midventral small papillæ, posteriorly on xvii and xix. Spermathecal pores in front of the setal zones of viii and ix, between *b* and *c* but nearer to *b*. A transversely elongated roughened slightly elevated patch, including both pairs of setæ, but on the whole rather behind the middle of segment viii.

Septa 5/6–10/11 moderately strong, 8/9 and 9/10 the thickest: 11/12 also somewhat thickened. Gizzards in v and vi, the posterior of the two rather smaller. Calciferous glands in xi and xii, kidney-shaped, well set off, attached by one edge to the œsophagus. Last heart in xii. Micronephridia behind genital region in a transverse row in each segment, about nine on each side, no marked difference in size, but the inner of the series rather smaller; towards hinder end about seven on each side, the innermost a little larger than the rest. Testes and funnels free in x and xi. Seminal vesicles in ix, x, and xii, all small, those in x smallest of all, and may be wanting on one side. Prostates small, in xvii and xix, the glandular part in a few loose loops; duct thin, shining, of same diameter as glandular part. Spermathecæ in viii and ix; ampulla small, ovoid; duct short, relatively wide; diverticulum small, wart-like, on side of duct. Copulatory setæ in site of ventral bundles of viii, 0·7 mm. or more in length, 16 $\mu$ thick in the middle; distal half curved through a quarter of a circle, or bent or twisted more irregularly; tip ends in a blunt point; no ornamentation.

*Distribution.* Bombay.

### 9. **Eudichogaster parvus** (*Fedarb*).

1898. *Dichogaster parvus*, Fedarb, P. Z. S. 1898, p. 499.
1900. *Trigaster parva*, Michaelsen, Tier. x, p. 334.

Length 40 mm.; diameter 2 mm. Segments 132. Dorsal spores from 11/12. Ventral setæ paired, lateral distant (as far apart as *bc*); $bc = 2ab = cd$. Clitellum xiii–xvii (= 5), saddle-shaped on xvii only. Prostatic pores one pair, on xvii, on ill-defined wrinkled papillæ, which approach each other anteriorly; pores also obliquely placed on the papillæ. Female pores on a kidney-shaped area. Spermathecal pores inconspicuous, on viii, just in front of and between the lines of setæ *a* and *b*.

Gizzards in v and vi, the anterior rather more globular. Calciferous glands small, in xi, xii, and xiii, the anterior pair the largest. Nephridia diffuse, but of considerable size. Seminal vesicles in xi, tongue-shaped. Prostates one pair, zigzag; duct about as thick as glandular portion. Spermathecæ one pair, in viii, tubular, slightly bulbous at the inner end; no diverticulum. No penial setæ.

*Distribution.* Dehra Dun, U.P.

### 10. Eudichogaster poonensis (*Fedarb*).

1898. *Benhamia poonensis*, Fedarb, J. Bombay Soc. xi, p. 434, pl. i, fig. 10, pl. ii, figs. 3, 4, 9.
1900. *Trigaster poonensis*, Michaelsen, Tier. x, p. 333.

Length 134 mm.; diameter 3 mm. Segments 157. Setæ closely paired; *bc* rather less than *aa*, *cd* = 1 ⅓ *ab*; *dd* greater than the half circumference. Clitellum not well marked, appears to end at xvi dorsally, but continued to xx ventrally (?). Prostatic pores on xvii and xix, in *ab*. Small papillæ, in line with the male pores, at the posterior edge of xvii and anterior edge of xix; ventral setæ of xx on a papilla. Spermathecal pores two pairs, in 7/8 and 8/9.

Gizzards in v and vi, subglobular, the anterior larger. Calciferous glands globular, in xi and xii. Last hearts in xii. Intestine begins in xiv. Seminal vesicles in xii, bent and tongue-shaped. Prostates with very twisted glandular part, almost forming a knot, pigmented; duct long, straight, of same diameter as glandular part. Spermathecæ two pairs, in viii and ix; ampulla oval, faintly annulated; duct of same length as ampulla, relatively very thin, sinuous near its ectal end; diverticulum from junction of ampulla and duct, with numerous projecting seminal chambers. No penial setæ. Copulatory setæ 3–4 times as long as ordinary setæ, shaft almost straight, the end notched, and with a small number of relatively stout spines.

*Remarks.* Some details in the above are not mentioned in the original text, and are taken from the figures.

*Distribution.* Poona.

### 11. Eudichogaster prashadi *Steph.*

1920. *Eudichogaster prashadi*, Stephenson, Mem. Ind. Mus. vii, p. 250, pl. xi, fig. 54.

Length 35–67 mm.; diameter 3–4·5 mm. Segments 140–168. Colour yellowish brown, with only a slight difference between dorsal and ventral surfaces. Prostomium prolobous. Dorsal pores from 11/12 or 12/13. In general $ab = \frac{1}{5}$–$\frac{1}{3} aa = \frac{2}{5} bc = \frac{3}{4} cd$; in front of the male apertures *bc* becomes rather smaller and *cd* increases; *dd* = ca. $\frac{2}{3}$ circumference. Clitellum absent (?). On xvii and xix a pair of ill-defined papillæ or whitish thickenings of the body-wall, transverse in direction, with their centres near *b*; on xviii a similar thickening which unites the outer ends of those on xvii and xix, thus making a crescentic swelling on each side with its concavity inwards (text-fig. 215). Prostatic pores in or just internal to the line *b*; seminal grooves slightly bent inwards at the middle of their length. Female pore or pores perhaps within a minute white spot anteriorly on xiv. Small transversely elongated white cushions on viii and ix, in the position of the ventral setal bundles; from internal dissection the spermathecal pores appear to be between the sites of setæ *a* and *b* on these segments.

GSL



Septum 4/5 thin, 5/6–9/10 moderately strengthened, 10/11 slightly so, 11/12 still less so. Gizzards in v and vi, large, rounded and firm. Calciferous glands shortly stalked, in xi and xii. Intestine begins in xv. Last heart in xii. Nephridia in five longitudinal rows on each side of the body; towards the hinder end the innermost on each side increases in size, while the others become smaller and more numerous, losing their regularity of arrangement. Testes and funnels free in x and xi. Seminal vesicles in ix and xii, or perhaps sometimes in xii only. Prostates two pairs of small thin convoluted tubes; ducts of the same diameter as the glandular portion, a little more shiny in appearance. Spermathecæ two pairs, in viii and ix; ampulla an elongated ovoid sac; duct as long as ampulla; diverticulum single, ovoid, apparently not chambered, attached by a short thick stalk to base of ampulla, bound down to duct and base of ampulla by connective

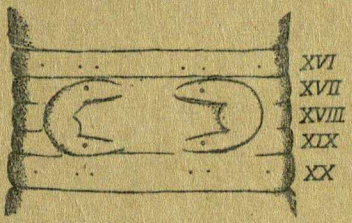



Fig. 215.—*Eudichogaster prashadi* Steph.; male genital area.



Fig. 216.—*Eudichogaster prashadi* Steph.; distal end of copulatory seta; × 500.

tissue. No penial setæ. Copulatory setæ (text-fig. 216) like those of *E. ashworthi*; 0·47 mm. long, 16 $\mu$ thick, almost straight, slightly bowed towards distal end; tip pointed and rather claw-shaped; distal fifth of shaft marked by a number of large hollows scooped out of the shaft with sharply defined crescentic proximal border.

*Remarks.* In this as well as in several other species the period of full sexual maturity must be limited to a relatively short period, if this is to be measured by the presence of the clitellum.

This species has much in common with *E. indicus*.

*Distribution.* Poona and Surat in W. India; Palia, Indore, and Mhow in Central India; Khandwa, Saugor, and near Jubbulpore in the Central Provinces.

GSL



### 12. Eudichogaster pusillus *Steph.*

1920. *Eudichogaster pusillus*, Stephenson, Mem. Ind. Mus. vii, p. 253, pl. xi, figs. 56, 57.

Length 28 mm.; maximum diameter 1½ mm. Segments ca. 110. Colour greyish. Prostomium procpilobous. Dorsal pores not visible in front of clitellum. In middle of body $ab=\frac{1}{2}aa=\frac{2}{3}bc=\frac{3}{4}cd$ or nearly; the same immediately behind the clitellum; in front of the clitellum *bc* and *cd* are equal, $ab=\frac{2}{3}cd$. Clitellum swollen, well defined, including xiii–xvi ventrally, and xvii also laterally and dorsally (= 4 or 5). Prostatic pores a single pair on xvii, as transverse slits which take up the interval *ab*. Female pores probably in a whitish area, slightly hollowed, anteriorly on xiv. Spermathecal pores?

Septa 7/8–13/14 slightly strengthened. Gizzards relatively very large, probably in v and vi (possibly in vi and vii). Calciferous glands three pairs, in x, xi, and xii, not sharply set off;



Fig. 217.—*Eudichogaster pusillus* Steph.; spermatheca.



Fig. 218.—*Eudichogaster pusillus* Steph.; tip of penial seta.

those in x the largest, those in xi the smallest. Intestine begins in xv. Last hearts in xii. Testes and funnels free (probably) in x and xi. Seminal vesicles in ix only. Prostates one pair, in xvii, short tubes bent once or twice; duct opaque white, not shining, almost as long as the gland, very fine, but widens gradually towards ectal end. Ovisacs present in xiv. Spermathecæ (text-fig. 217) a single pair, in vii, appearing to open in or near 7/8; each is a long narrow twisted tube, somewhat wider at its ectal end, where a short muscular duct about one-third as wide as the ampulla leads to the exterior; no diverticulum; the whole organ looks at first sight remarkably like a nephridium. Penial setæ (text-fig. 218) 0·56 mm. long, and only 4 $\mu$ thick; shaft almost straight, tapering very gently towards the tip, which is flattened and slightly expanded.

*Remarks.* The species was described from a single specimen. There was only a single seminal vesicle, on the right side.

*Distribution.* Saugor, C.P.

### 13. Eudichogaster trichochætus *Steph.*

1920. *Eudichogaster trichochætus*, Stephenson, Mem. Ind. Mus. vii, p. 249, pl. xi, figs. 52, 53.

Length 32–45 mm.; diameter 1·75–2·25 mm. Segments 103–128. Colour a yellowish grey, with no difference between dorsal and ventral surfaces. Prostomium epilobous $\frac{2}{5}$, pointed behind, the point continued back as a groove as far as the first furrow.

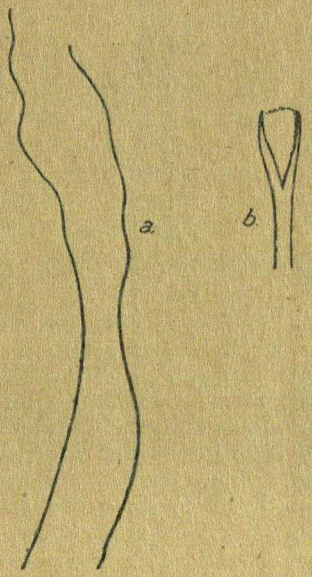



Fig. 219.—*Eudichogaster trichochætus* Steph.; penial seta; *a*, entire setæ; *b*, the tip, more highly magnified; × 550.

Dorsal pores 12/13 or 13/14. In general $ab = \frac{1}{3}$ to $\frac{2}{3}aa = \frac{1}{2}bc = \frac{3}{4}cd$; in front of clitellum *ab* is wider, = ca. $\frac{1}{2}aa$; $dd$ = nearly half of circumference. Clitellum absent. Male field a whitish rectangular thickening, including xvii–xix, extending laterally to between *b* and *c*. Prostatic pores small transverse slits corresponding in position to *ab*, on xvii and xix; seminal grooves longitudinal between the outer ends of the slits, in line with *b*. Female pores as a pair of tiny white thickenings just in front of and internal to setæ *a* on xiv. Some thickening ventrally on viii and ix; but spermathecal pores not seen externally (*v. inf.*).

Septum 4/5 somewhat strengthened, 5/6–7/8 thin, 8/9 somewhat strengthened, 9/10 slightly so. Gizzards relatively large, in v and vi. Calciferous glands in x, xi, and xii, not set off. Intestine begins in xiv? Last heart apparently in xii. Micronephridia in four longitudinal rows on each side, the innermost series the smallest. Testes and funnels free in x and xi. Seminal vesicles in xii only, with lobed margins. Prostates two pairs, twisted tubes. Spermathecæ two pairs, in viii and ix, ending on body-wall apparently between the site of setæ *a* and *b*; ampulla ovoid; duct as long as ampulla, not constricted off, a little wider above;



Fig. 220.—*Eudichogaster trichochætus* Steph.; tip of copulatory seta; × ca. 400.

diverticulum single, shortly finger-shaped, one-third as long as ampulla, to the base of which it is attached. Penial setæ (text-fig. 219) up to 2 mm. long and only 5–6 $\mu$ thick, capillary, undulating; no ornamentation; tip bifid with a web spanning the angle. Copulatory setæ (text-fig. 220) 0·42 mm. long, 13 $\mu$ thick; shaft almost straight, with a bend at the proximal end; tip slightly claw-shaped, bluntly pointed; ornamentation of short transverse ridges on the distal part of the shaft.

*Distribution.* Bombay, and Palchar (N. of Bombay).

### 5. Genus **EUTYPHŒUS** *Mich.*

1883. *Typhæus*, Beddard, Ann. Mag. N.H. (5) xii, p. 219.
1888. *Typhæus*, Beddard, Quart. J. Mic. Sci. xxix, pp. 111, 117.
1895. *Typhæus*, Beddard, Monog. p. 472.
1900. *Eutyphœus*, Michaelsen, Tier. x. p. 322.
1901. *Typhœus*, Beddard, P. Z. S. 1901, i, p. 205.
1909. *Eutyphœus*, Michaelsen, Mem. Ind. Mus. i, p. 216.
1921. *Eutyphœus*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 37.

Setal arrangement lumbricine. An enlarged œsophageal gizzard in a space formed by the fusion of several segments. A pair of calciferous glands imbedded in the œsophageal wall in xii. Purely micronephridial. Sexual apparatus purely microscolecine (conjoined pores of prostates and male ducts on xvii; spermathecal pores one pair, in 7/8); holandric or metandric.

The genus was instituted by Beddard in 1883 for *E. orientalis*; *E. gammiei* was added, and a definition of the genus was given, in 1888; Bourne added *E. masoni* in 1889, and Rosa *E. foveatus* in 1890, with *E. levis*, which however is insufficiently described. With the exception of the addition of *E. incommodus* and *nicholsoni* by Beddard in 1901, nothing more was added to the genus till the publication of Michaelsen's work (1907, 1909) on the Indian Oligochæta. Since then the genus has grown rapidly.

The species may be divided into two groups, those of each group having a very considerable resemblance to each other. The larger group especially has a particularly uniform facies, its species having the following characters (or most of them) in common :—

Certain septa in the anterior part of the body are wanting; these are (perhaps always) 6/7 and 7/8, and the two septa which are present in front of the gap are 4/5 and 5/6. After the interval come three septa extremely close together, and all thickened; these three are displaced backwards, the first of them very considerably. The next septum should be 11/12; but typically in this group of species it does not exist as a definite septum at all; there is, however, on the floor of the body-cavity in this region a quantity of matted connective tissue, which also surrounds the alimentary canal, and which envelops the heart of segment xi; the tissue binds down the heart to the gut.

The numbering of the segments in the dissection is thus not without difficulty, since confusion necessarily arises from the absence of some and the displacement of other septa; but if the numbering is carefully worked out from the segmentally arranged vascular commissures the above arrangement will be found to hold.

The dorsal vessel does not extend to the anterior end of the body, but comes to an end behind the gizzard by dividing into two branches, of which one goes to each side as the vascular commissure of segment vii; these are situated immediately behind the gizzard and immediately in front of another pair of lateral commissures, those belonging to segment viii, which run on the anterior face of the septum behind the large gap. The position of the first pair of commissures in relation to the gizzard enables us to place this organ morphologically in segment vii, though septa are absent from this region.

The seminal vesicles (morphologically to be accounted to segment xii) take origin from the matted connective tissue which represents septum 11/12; they are thus not seated on a septum in the normal way; under cover of this tissue they communicate with the testis sacs. The vesicles may project forwards so as to occupy segment xi, which they could not do if there were a septum between xi and xii; they have a flattened form and extend backwards, embracing the sides of the alimentary canal, for the space of a few segments; their margins are lobulated, and their surface often granular.

This group of species is metandric; the testis sacs lie on the floor of segment xi, and often communicate with each other.

The other section of the genus is holandric, having testes and funnels in segments x and xi, and seminal vesicles in ix and xii. Here too septa 6/7 and 7/8 are absent, but 11/12 is normal; the heart of segment xi is not bound down to the gut. The dorsal vessel is continued forwards over the gizzard as far as the pharynx, giving off lateral commissures in the usual way.

Certain characters appear to be common to the whole genus—to both the metandric and holandric species.

The calciferous glands are a single pair, in segment xii, of a peculiar type described by Stephenson and Prashad (**91**). They show externally only as a swelling of the gut, but project into and narrow the lumen of the canal. In some species of the genus a series of paired sacculi have been described on the intestine, in about five successive segments in the middle of the body; they may not improbably be a general character of the genus, though they have not as a rule been noted by recent observers, who have not usually opened the worms in this region.

The spermathecæ are always very shortly stalked, and the diverticula are usually in the form of small seminal chambers, sessile on the duct singly or in groups. The penial setæ, present in a considerable majority of the species, are often disappointingly difficult to describe, owing to their softened or deformed ends.

The genus is to be derived from *Eudichogaster*. The microscolecine reduction is completed; *i. e.*, the posterior pair of prostates disappears, and the openings of the vasa deferentia are shifted forwards to join those of the anterior prostates on segment xvii; since only one pair of spermathecal pores can be apposed to the single pair of prostatic pores in copulation, the posterior pair of spermathecæ also disappears. In the holandric species the process of reduction has stopped here. In the majority, however, the metandric condition has supervened—the anterior pair of testes and funnels have disappeared, along with their ducts and testis sacs. Even in some of the holandric species we see this change beginning, the anterior pair of testes, or funnels, or seminal vesicles, or all of these, being smaller than the posterior.

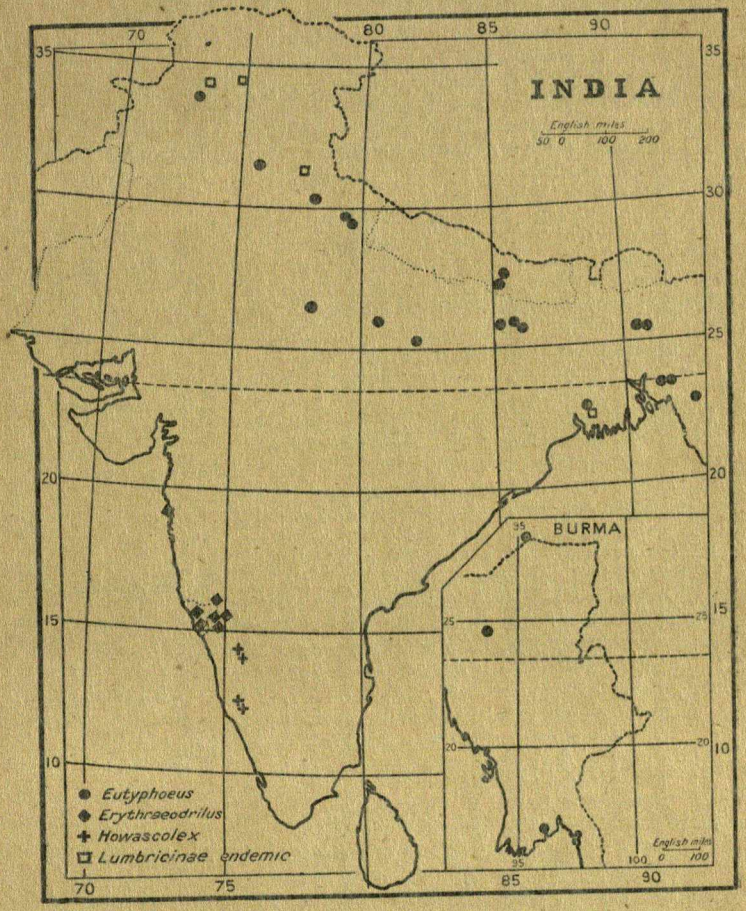
The two gizzards of *Eudichogaster* have fused, after the disappearance of the intervening septum; and the calciferous glands are restricted to segment xii.

*Distribution* (Chart V). The genus is entirely confined to India. It inhabits the entire Gangetic plain, and the Himalayas to the north of this; its range is from the South Punjab (one or two widely distributed species even in the North Punjab) to Rangoon; the widely wandering species *E. waltoni* has spread into Central India and westward as far as Baroda.

The species with the widest distribution are *waltoni* (Hoshiarpur to Calcutta, with the extension to the west just mentioned); *incommodus* (Rawal Pindi in the extreme north to Calcutta);

*masoni* (the whole of the Gangetic plain from Dehra Dun downwards); *nicholsoni* (the whole of the Gangetic plain); and *mohammedi* (Rawal Pindi and Allahabad).

CHART V.




*Key to the species of the genus* Eutyphœus.

| | | |
|---|---|---|
| 1. | Two pairs testes; two pairs of seminal vesicles in ix and xii | 2. |
| | One pair testes; one pair seminal vesicles, in xii (and following segments) only | 5. |
| 2. | No penial setæ | *E. quadripapillatus.* |
| | Penial setæ present | 3. |
| 3. | No genital markings | *E. mohammedi.* |
| | Genital markings present | 4. |

| | | |
|---|---|---|
| 4. | Spermathecal diverticula in a ring round base. | *E. incommodus.* |
| | Spermathecal diverticula two, stalked, opposite | *E. annandalei.* |
| | Spermathecal diverticulum single, sessile | *E. manipurensis.* |
| 5. | Genital markings absent | 6. |
| | Genital markings present, unpaired | 8. |
| | Genital markings present, paired | 11. |
| 6. | Penial setæ ornamented with fine hairs | *E. ibrahimi.* |
| | Penial setæ ornamented with fine points | 7. |
| 7. | Points on penial setæ scattered; two simple spermathecal diverticula | *E. foveatus.* |
| | Points on penial setæ very close set; two or three compound diverticula, or a fan-shaped series of seminal chambers | *E. gammiei* (part.). |
| 8. | Penial setæ absent | *E. nainianus.* |
| | Penial setæ present | 9. |
| 9. | Genital marking as a large transverse papilla on 15/16, in front of an hexagonal male area | *E. scutarius.* |
| | Genital markings otherwise | 10. |
| 10. | Spermathecal diverticula two, relatively long, simple | *E. comillahnus.* |
| | Spermathecal diverticula two or three, short and compound, or a single series of seminal chambers, broad and fan-like | *E. gammiei* (part.). |
| 11. | No penial setæ; some of the spermathecal diverticula large, like separated lobes of the ampulla | *E. nepalensis.* |
| | Penial setæ present; spermathecal diverticula as small seminal chambers variously arranged | 12. |
| 12. | Genital markings constantly on 15/16 only, large and conspicuous | *E. nicholsoni.* |
| | Genital markings not, or not only, on 15/16 | 13. |
| 13. | Spermathecal diverticula as a single but interrupted series in a circle round the duct; seminal vesicles extraordinarily long (to segm. xxxiii) | *E. pharpingianus.* |
| | Spermathecal diverticula as a small group of elongated seminal chambers, independent but close together | *E. paivai.* |
| | Spermathecal diverticula as two or three associated groups of seminal chambers | 14. |
| 14. | Paired copulatory areas in front of clitellum only; penial setæ without ornamentation | *E. aborianus.* |
| | Paired copulatory area behind clitellum only; a special V-shaped depression on xvi; penial setæ with transverse rows of fine dot-like sculpturings | *E. bishambari.* |
| | Paired copulatory areas constantly on clitellar segments, sometimes on others also; penial setæ ornamented | 15. |
| 15. | Copulatory areas confined to 15/16 and xvi (pits in 15/16, oval areas on hinder part of xvi) | *E. gigas.* |
| | Copulatory areas (at least when fully developed) not confined to the above situations | 16. |

16. Markings of penial setæ as a single series of chevron-like ridges ..... *E. orientalis.*
Markings of penial setæ as fine points or spines, or crowded short rows of minute teeth ..... 17.
17. Spermathecal pores in *c*; markings of penial setæ as fine spines over the spoon-shaped end ..... *E. waltoni.*
Spermathecal pores in *b*; ornamentation as fine dots on the bluntly pointed somewhat claw-like end of the penial seta ..... *E. turaensis.*
Spermathecal pores between *b* and *c*; ornamentation of penial setæ as minute curved sculpturings looking like fish-scales ..... *E. masoni.*

*Eutyphœus levis* (Rosa) (*Typhœus lævis*, Rosa, Ann. Mus. Genova, (2) ix, 1890, p. 388; *Typhœus lævis*, Rosa, Ann. Mus. Wien, vi, 1891, p. 388; *Eutyphœus levis*, Michaelsen, Tier. x, p. 323; *Typhœus lævis*, Beddard, P. Z. S. 1901, i, p. 206) from Burma and Ceylon, is insufficiently known. The internal anatomy of the single (type) specimen from Burma was not investigated because of its state of preservation; in the case of the specimens from Ceylon the small size and condition of preservation also prevented examination. The known characters are as follows:—

Length 35 mm.; diameter at clitellum 2 mm. Segments 180 (100 in Ceylon specimens). Colour brown. Prostomium pro-epilobous. Setæ all ventral, paired, *cd* greater than *ab*; in the anterior part of the body *bc* greater than *cd*, but posteriorly *cd* greater than *bc* (*i. e.*, the lateral setæ not paired in this part of the body). Dorsal pores at least from 12/13. Clitellum ring-shaped, $\frac{1}{2}$xiii–$\frac{3}{4}$xvii (=$4\frac{1}{4}$). Male pores on xvii, between *a* and *b*, on papillæ which are joined in the middle line. Spermathecal pores in *b*. In the first specimen (Burma) there were no genital markings; in the second lot of specimens (Ceylon) there were two pairs of papillæ, on xvii and xviii, in *b*. Only three species of the genus were known at the time when the description was written, and the characters given might be sufficient then to distinguish it; at the present day, however, more is necessary. In addition, it seems hazardous to identify the Ceylon specimens with the earlier one from Burma when even the external characters are not the same.

Numerous species described as separate have been found to require merging, on account of the variability of such characters as the external markings, the shape of the tip of the penial setæ, and the arrangement of the seminal chambers of the spermathecal diverticula. Thus Michaelsen united his species *bastianus* and *andersoni*, and thought both might be identical with *masoni*; this I believe to be the fact. He also united his species *lchani* with *nicholsoni*. I believe it is necessary to subsume *bengalensis* under *waltoni*, and to unite a number now to be discussed.

In undertaking a revision of the species which have been

described as *gammiei*, *chittagongianus*, *kempi*, *koboensis*, *magnus*, and *aborianus*, the following points are important.

*E. chittagongianus* is a variable species, as I have recently shown (93), and there can be no doubt as to the inclusion of *kempi* under the same name (this I have already noted in the paper just mentioned). The variability of the species shows itself in the various shades of colour (from olive or brown to pale, *i. e.*, without pigment or nearly so); the first dorsal pore may be in 10/11 or 11/12; the relations of the setal intervals also vary within fairly wide limits; the male pores sometimes lie in a common transverse depression, sometimes not; the spermathecal pores may be midway between *b* and *c*, or nearer to *b*, or in *b*; the genital markings, most commonly on 20/21 and 21/22, may be on any of the furrows 10/11, 13/14, 19/20, 20/21, 21/22, 22/23, and may be single, or may show a narrowing in the middle line so as to be almost divided into two; the tip of the penial setæ shows various conditions of curving and shape, due apparently to its being always soft—it does not seem to harden in the normal way; and the seminal chambers of the diverticulum may be arranged in a single series to form a fan or semicircle, or the series may be split up into two or even three discontinuous chambered diverticula.

So much having been established by the comparison of Michaelsen's description with my specimens from Assam and Darjiling, and with the description of *E. kempi*, it is evident that *E. koboensis* must come under the same head; indeed I ought to have included it when I merged *E. kempi* (93). The supposed differences in the penial setæ are explained by the above considerations; the only other point that could occasion hesitation is the fact that the testis sacs are apparently double instead of single.

The species after these additions has a range which includes Darjiling District, the Garo Hills in Assam, the Abor country, and Chittagong District.

In the revision of the genus for the purpose of this work, my attention was turned to the similarity between this group and *gammiei*, described in 1889 by Beddard. Naturally a description written in that year is not as full as we could wish; the following points call for comment:—(1) The male field. Beddard only says that the pores "are upon segment xvii, and correspond to the ventral pair of setæ"; Michaelsen (38), however, infers from the figure that they are situated on a median cushion-like elevation. There is, however, nothing in the figure to show that it is not a depression that is intended. (Michaelsen says that the male pores and prostatic pores are separate, but close together. They are indeed shown so in Beddard's figure; in the text, too, it is said that the vas deferens "opens onto the exterior near to the atrium and a bundle of penial setæ." But in almost the next sentence it is stated that "a series of

transverse sections through this part of the body show that the vas deferens does ultimately join the atrium, though only just beneath the epidermis.") (2) The spermathecal pores are said in the text to "correspond to the interval between the dorsal and ventral pairs of setæ," while the figure to which reference is made shows them as in *ab*; this, however, does not matter, as the pores are found in both situations in *chittagongianus*. (3) The penial setæ differ from any that have been figured for *chittagongianus*, but both the figures and descriptions of the penial setæ of *chittagongianus* (including *kempi* and *koboensis*) differ among themselves, as has been seen. The teeth on the setæ of *gammiei* are perhaps coarser than those which occur in *chittagongianus*; it is a question, however, as we have seen with regard to both the male area and the spermathecal pores, how far Beddard's figures can claim a minute accuracy.

The specimens of *gammiei* came from Darjiling. If now we interpret the figure of the male pores as indicating a transverse dumbbell-shaped depression, the whole of the description corresponds with *chittagongianus*, and the locality is within the range of *chittagongianus*.

Two small points are confirmatory. In none of the species so far considered is the prostomium distinctly visible (Michaelsen does not mention it in his account of *chittagongianus*). Secondly, setæ are absent from segment ii in *gammiei*, and may be absent from the first four or five in *chittagongianus*. I think we are justified in uniting the two, under the name *E. gammiei* (Bedd.).

There remain *magnus* and *aborianus*. As to *magnus*, the only feature that is not found in the *gammiei* group is the absence of genital markings; the testis sacs are apparently double, as in the specimens described as *koboensis*; the spermathecal diverticula are two, each compound, as in some specimens of *chittagongianus* and in *gammiei*; they are described as being opposite, which seems to show that the separation of the originally single series of seminal chambers has gone further than elsewhere. But the absence of genital markings is the only character that could necessitate a separation of the species; and since this has been found to be of no value as a distinction between *waltoni* and *bengalensis* (93), it is perhaps scarcely justifiable to use it here. *E. magnus* comes from the same country as a number of the others (Abor country), and was in the same tube as *koboensis*. I therefore unite it also with *gammiei*.

As regards *E. aborianus*, the definite differences from the group just discussed are: (1) dorsal pores from 17/18 (instead of from 10/11 or 11/12); (2) paired genital markings on 9/10 only; (3) no ornamentation on the penial setæ. Of these the position of the first dorsal pore is scarcely a decisive character (and see remark on this point under description of the species); but markings on 9/10 have not been described

in any of the numerous specimens of the other group, nor do the characteristic postclitellar markings of the other group occur in *aborianus*. The absence of ornamentation on the penial setæ would also seem to be a good ground for separation. As the evidence goes at present, I consider *aborianus* to be distinct, though it is doubtless closely connected with the former group (note the curious character of absence of setæ from the first four segments). I should not, however, be surprised if evidence is forthcoming sooner or later to necessitate its union with the others.

The genus is thus reduced from 31 species which have at various times been described to 22. Among these there are several well-defined groups.

The first is that of the holandric forms—the more primitive species of the genus; this group comprises *incommodus*, *annandalei*, *quadripapillatus*, *manipurensis*, and *mohammedi*; and of these it is possible that *mohammedi* may in the future have to be merged in *incommodus*. The range of *incommodus* alone comprises nearly the whole of what may be looked on as the proper range of the genus; so that it is not possible to locate the place of origin of the genus from a consideration of the habitat of its more primitive species.

The relation between *gammiei* with its numerous forms and *aborianus* has already been considered.

*E. waltoni*, *masoni*, and *orientalis* are closely related, and with them may probably be associated *turaensis*, *gigas*, and *bishambari*. *Orientalis* is somewhat of a puzzle: described from two places so far apart as Calcutta and Dehra Dun in 1883 and 1898 respectively, it is strange that it should not have turned up again from these or from any intervening places; one is inclined to suppose that the penial setæ were described from an abnormal example, such as are only too common, and that it is perhaps identical with *E. masoni*.

But the whole of the metandric forms are essentially similar, and their discrimination depends almost wholly on external markings and the characters of the penial setæ and spermathecal diverticula. Hardly any other feature is capable of being used, and even these are often extraordinarily variable. Thus I consider the absence of genital markings to be of doubtful value, though in the present state of our knowledge I have admitted it as a means of discrimination in several cases.

1. **Eutyphœus aborianus** *Steph.*

1914. *Eutyphœus aborianus*, Stephenson, Rec. Ind. Mus. viii, p. 406, pl. xxvii, fig. 22.

Length 210 mm.; maximum diameter 6 mm. Colour pale. Prostomium minute. Segments triannulate over most of the body; some of the preclitellar segments of four or five annuli. Dorsal pores from 17/18 (*? v.* Remarks *inf.*). Setæ small, the lateral

rather widely paired; in front of clitellum $ab=\frac{3}{4}aa=\frac{2}{3}bc=\frac{3}{4}cd$; behind clitellum $ab=\frac{1}{2}aa=\frac{2}{3}bc=\frac{2}{3}cd$; further back $ab=\frac{1}{3}aa$; no setæ discoverable on ii, iii, or iv. Clitellum includes $\frac{2}{3}$xiii–xvii ($=4\frac{2}{3}$); setæ present. Male pores a pair of deep pits, oval in shape, their centres in line with *b*; the pit extends inwards to *a*, and outwards a corresponding distance beyond *b*. Female pore on left side only, in front of *a* on xiv. Spermathecal pores a little outside *b*. A pair of oval depressions in 9/10, small, between *a* and *b*, or extending outwards a little beyond *b*: an almost circular clean-cut depression, on the right side only, over 13/14 or on the hinder part of xiii, taking up the interval *ab* and extending a little outside *b*.

Septa and calciferous glands as usual in metandric forms. Gizzard ovoid. Intestine begins in xv. Last heart in xiii.



Fig. 221.—*Eutyphœus aborianus* Steph.; distal end of penial seta; × ca. 200.

Testis sac on each side in xi, unconnected with its fellow (?). Seminal vesicles overlapping the testis sacs anteriorly and extending back so as to bulge septum 13/14 backwards, margins slightly lobed. Prostates occupy xviii–xx, the tube becoming narrower and more glistening towards its end. Spermathecal ampulla ovoid, compact; duct very short and moderately stout; diverticulum fan-shaped, posteriorly situated at junction of duct and ampulla, consisting of seven or eight lobes arranged in two or three groups, fairly well separated or partly joined together. Penial setæ (text-fig. 221) 3·3 mm. long, 32 $\mu$ thick; shaft with a gentle S-shaped curve, tip bluntly pointed and

flattened and slightly excavated on one face, hence spoon-shaped; small longitudinal ridges in the bowl of the spoon; no ornamentation.

*Remarks.* I have re-examined the original specimens, and hence the above account differs in a few points from my former description. I may add that dorsal pores appear to be present as far forwards as 11/12, possibly 10/11, though as the specimen (which was single) had been cut up nearly in the middorsal line the determination was not very easy. The testis sacs seem to me now to be joined ventrally.

Related to *E. gammiei* (see introduction to the genus).

*Distribution.* Kobo (Abor country, E. Himalayas).

### 2. Eutyphœus annandalei *Mich.*

1907. *Eutyphœus annandalei*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 174, text-fig. 18.
1909. *Eutyphœus annandalei*, Michaelsen, Mem. Ind. Mus. i, p. 217, pl. xiv, fig. 44, text-fig. 24.

Length 65 mm.; diameter $1\frac{2}{3}$–$2\frac{1}{3}$ mm. Segments 91. Colour in general grey, clitellum dark brown. Prostomium indistinctly tanylobous. Dorsal pores distinct only in the middle and posterior parts of the body. Setæ not closely paired in general,



Fig. 222.—*Eutyphœus annandalei* Mich.; spermatheca; × 8.

the ventral behind the clitellum most closely; behind clitellum $aa : ab : bc : cd = 8 : 4 : 10 : 5$; immediately in front of clitellum *ab* almost equals *cd*, and the ventral setæ (*a* and *b*) here are somewhat enlarged; *dd* = half the circumference. Clitellum ring-shaped, xiii–xvii (=5), but wanting ventrally on xvii. Male pores as transverse slits on large transversely oval, almost circular papillæ, the centres of which are in *a* or somewhat lateral to this. Spermathecal pores in 7/8, transversely oval slits between *b* and *c*, laterally reaching the latter line. Copulatory organs as paired transversely oval areas in 13/14 and 14/15, in the line of the ventral pairs of setæ.

Septum 4/5 strong, 5/6 very strong, 6/7 and 7/8 wanting, 8/9 scarcely strengthened, 9/10 and 10/11 moderately strong. A large gizzard between 5/6 and 8/9. Calciferous glands large, laterally placed, in xii, closely united with the œsophagus. Testes and funnels free in x and xi, those of x smaller than those of xi. Seminal vesicles two pairs, in ix and xii–xviii, much incised. Prostates very long, extending backwards to about xxiii, much bent or coiled, not forming a compact mass;

duct thin, relatively rather long though much shorter than the glandular part, describing some large loops; vasa deferentia notably thick. Penial setæ strong, ca. 20 $\mu$ thick (points all broken). Spermathecal ampulla nearly globular, with transverse folds in the walls; duct somewhat thinner and shorter; diverticula two, opening into the duct opposite to each other, longer than broad, with a short stalk and one or two globular seminal chambers (text-fig. 222).

*Remarks.* Michaelsen's two accounts differ as regards the situation of the male pores; I have taken the one (from the earlier paper) which corresponds with the diagrammatic figure of the external characters.

The species is closely related to *incommodus*; I keep it separate on account of the two stalked diverticula (in *incommodus* the diverticulum forms a frill round the duct).

*Distribution.* Bhim Tal, Kumaon Dist., W. Himalayas.

### 3. Eutyphœus bishambari *Steph.*

1914. *Eutyphœus bishambari*, Stephenson, Rec. Ind. Mus. x, p. 355, pl. xxxvi, figs. 10, 11.

Length 180 mm.; maximum diameter 5½ mm. Segments 164. Colour dark brown dorsally, with purplish strip in middle line, pale grey ventrally. Prostomium a minute projection within the mouth aperture; a pair of longitudinal grooves dorsally on segment i, diverging as they approach groove 1/2. Secondary annulation on some of anterior segments, but not extending as far as clitellum. Dorsal pores from 11/12; none on clitellum. In general $ab=\frac{2}{5}aa=\frac{4}{7}bc=\frac{4}{7}cd$; in front of clitellum $ab=\frac{5}{8}aa$ and is somewhat less than $cd$; $dd=6$ of circumference. Clitellum includes $\frac{1}{3}$ of xiii and $\frac{1}{2}$ of xvii (=4); setæ visible. Male pores conspicuous triangular pits, the narrowest angle internal, margins puckered; centre of pit between *a* and *b*, the pit extending rather beyond these lines; penial setæ project close to outer margin of aperture. Spermathecal pores slit-like, centre between *b* and *c*, rather nearer *b*; the whole slit extending from *c* to rather inside *b*. Copulatory organs as three pairs of eye-like markings on 18/19 and the two following grooves, their centres in or just internal to *b*; on xvi, behind the setæ, a V-shaped depression, median, the legs of the V rather wide apart, rather broadened at their anterior separated ends; in these broadened ends a pair of small round papillæ; these ends of the V just behind the ventral setæ on each side.

Septa, calciferous glands, and anterior male organs as usual in the metandric species. Gizzard comparatively small, subglobular. Male funnels contained in a common sac. Seminal vesicles extend forwards to the level of 10/11, and backwards to that of 14/15 by bulging backwards septum 13/14; deeply lobed and flattened against the sides of the gut. Prostates large, occupying

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xvii–xx ; duct much coiled and of considerable length, narrow at first but soon becoming stouter and more muscular, widest in the middle of its course. Penial setæ 4 mm. long, 36$\mu$ thick at the middle ; almost straight for the greater part, the terminal 0·25 mm. bent at an angle of 120°, and a second, much sharper kink, not in the same plane as the first, 0·1 mm. from the tip ; short transverse rows of fine sculpturings near the free end. Spermathecal ampulla elongated egg-shaped ; duct broad and very short ; diverticula two, one smaller, on the posterior and inner side of the duct, the other larger, on the outer ; the smaller has about six seminal chambers, the larger more numerous chambers ; the chambers only slightly separated externally.

*Remarks.* The "much sharper kink" near the tip of the penial setæ appears from the figure to be perhaps abnormal—due to the doubling up of the softened extremity within the setal sac.

*Distribution.* Pusa (Bihar).

### 4. Eutyphœus comillahnus *Mich.*

1907. *Eutyphœus comillahnus*, Michaelsen, Mt. Mus. Hamburg. xxiv, p. 187, text-fig. 30.
1909. *Eutyphœus comillahnus*, Michaelsen, Mem. Ind. Mus. i, p. 242, pl. xiv, figs. 49, 50 ; text-fig. 36.

Length 90 mm. ; diameter 3–4 mm. Segments ca. 240. Colour in general yellowish grey, anteriorly with violet-grey tints. Prostomium tanylobous, first segment very long. Dorsal pores from 11/12. Setæ all ventral, paired, the ventral closer than the lateral ; on xviii $aa : ab : bc : cd = 3 : 1 : 4 : 3$ ; towards the head the ventral setæ become somewhat separated, $= 3 : 2 : 4 : 5$ ; towards hinder end *aa* becomes larger, $= 6 : 3 : 5 : 4$ ; *dd* greater than half of circumference. Clitellum ring-shaped, xiv–xvii (= 4). Male pores about in *a*, setæ *aa* being very near each other in the anterior part of the body ; pores surrounded by a transversely oval scarcely depressed common area, not sharply bordered, somewhat glandular. Female pores on a median ventral transverse glandular area in front of setal zone of xiv. Spermathecal pores in 7/8, just outside *a*. Copulatory organs as transverse glandular cushions on 12/13 and 13/14, each apparently formed by the fusion of a pair, that on 13/14 narrower than the one in front of it.

Septa and calciferous glands as usual. Gizzard large. Intestine beginning in xv (?). Last hearts in xiii. Large male funnels in globular testis sacs which are united in the middle line. Seminal vesicles broad, much incised at the margins, extending back to xiv. Prostates with moderately long coiled glandular part, occupying three segments ; duct relatively short, hardly 2 mm. long, nearly straight or slightly undulating ; the whole organ much smaller than in other species of the genus. Vasa deferentia relatively very thick. Spermathecal ampulla irregularly sac- or pear-shaped ; duct short and narrow ; diverticula two, simple, hardly narrowed at base, unequal in size, the larger nearly as long

as ampulla (text-fig. 223). Penial setæ (text-fig. 224) ca. 2 mm. long and 40 $\mu$ thick in the middle, nearly straight proximally, somewhat bent in the distal fourth; tip simple, rather blunt, seta



Fig. 223.—*Eutyphœus comillahnus* Mich.; spermatheca; × 12.



Fig. 224.—*Eutyphœus comillahnus* Mich.; distal end of penial seta; × ca. 200.

somewhat broadened just proximal to tip; ornamentation begins proximal to the broadening and extends over distal fourth of shaft, as irregular transverse rows of moderately large triangular teeth.

*Distribution.* Comillah, Chittagong Dist.

### 5. Eutyphœus foveatus (*Rosa*).

1890. *Typhœus foveatus*, Rosa, Ann. Mus. Genova, (2) ix, p. 389.
1900. *Eutyphœus foveatus*, Michaelsen, Tier. x, p. 323.
1901. *Typhœus foveatus*, Beddard, P. Z. S. 1901, i, p. 206.

Length 170–180 mm.; diameter 5 mm. Segments 150–170. Prostomium retractile or absent. Dorsal pores from 11/12. Setæ all ventral; *aa* greater than *bc*, *bc* greater than *cd*, and $cd=2ab$ throughout the body. Male pores in a median fossa more or less hexagonal in shape, margins thickened, especially laterally, where the fossa extends to the line of *b*. Female porēs each in front of and a little internal to *a* on xiv. Spermathecal pores in 7/8, in *b*.

Septa 4/5, 5/6, 8/9–10/11 thickened. Gizzard large, in the form of a flattened bulb, between 5/6 and 8/9. Seminal vesicles one pair, much lobed. Prostates much coiled; duct forms a curve with its concavity facing towards the middle line. Spermathecæ with two simple diverticula on the duct, which is somewhat swollen. Penial setæ numerous, strongly curved, ending in a simple conical point; distal end ornamented with irregularly scattered small points.

*Distribution.* Rangoon.

### 6. Eutyphœus gammiei (*Bedd.*).

1888. *Typhœus gammii*, Beddard, Quart. J. Mic. Sci. xxix, p. 111, pl. xii, figs. 1–9, pl. xiii, fig. 1.
1900. *Eutyphœus gammiei*, Michaelsen, Tier. x, p. 323.
1901. *Typhœus gammii*, Beddard, P. Z. S. 1901, i, p. 205.
1907. *Eutyphœus chittagongianus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 181, text-fig. 25.
1909. *Eutyphœus chittagongianus*, Michaelsen, Mem. Ind. Mus. i, p. 231, pl. xiv, fig. 54, text-fig. 31.
1914. *Eutyphœus kempi* + *E. koboensis* + *E. magnus*, Stephenson, Rec. Ind. Mus. viii, pp. 401, 404, 408, pl. xxvii, figs. 18–21, 23, 24.
1920. *Eutyphœus chittagongianus*, Stephenson, Mem. Ind. Mus. vii, p. 241.

Length 182–405 mm., in general about 250 mm.; maximum diameter 7–10 mm. Segments 195–263; iv and v biannular, vi with two chief and two subsidiary furrows, succeeding segments

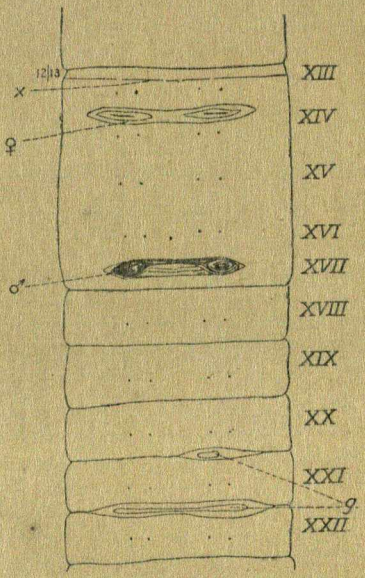


Fig. 225.—*Eutyphœus gammiei* (Bedd.); genital area; *g*, genital markings ("copulatory organs"); *x*, anterior limit of clitellum; ♂, male aperture; ♀, female aperture.

as far as clitellum primarily triannular, with secondary grooves on first and last annuli. Colour in general grey or a medium olive dorsally, pale or a light olive-green laterally and ventrally, some specimens unpigmented. Prostomium indistinct. Dorsal pores from 10/11 or 11/12. Setæ small, sometimes absent from the first four or five segments; paired, but not closely; behind

clitellum in general $ab = \frac{1}{3}aa = \frac{1}{2}–\frac{2}{3}bc = \frac{2}{3}–\frac{4}{5}cd$; in front of clitellum $ab = \frac{2}{3}aa = \frac{2}{3}bc = \frac{4}{5}cd$; $dd$ = ca. $\frac{2}{5}$ of circumference. Clitellum ring-shaped, $\frac{1}{2}$xiii–xvii (=$4\frac{1}{2}$), slightly variable. Male pores (text-fig. 225) in deep transverse pits or grooves, with their centres in $b$; or in a large transverse furrow extending across the ventral surface. Female pores on small transversely elongated glandular areas in front of setal zone of xiv; the two areas nearly meet in the middle line, and extend outwards as far as $b$. Spermathecal pores as small slits midway between $b$ and $c$, or on the outer side of $b$, or even in $b$. Copulatory organs as unpaired transversely elongated areas, when best marked appearing as clean-cut depressions sometimes containing low, flat papillæ; they may be constricted in the middle so as to appear dumbbell-shaped, or one-half the dumbbell may be absent, the marking being then confined to one side; extraordinarily variable in distribution, commonest on 20/21 and 21/22, may occur on 19/20 and 22/23, occasionally more anteriorly, 10/11 and 13/14, and may perhaps be absent altogether.



Fig. 226.—*Eutyphœus gammiei* (Bedd.); spermatheca; × 6.



Fig. 227.—*Eutyphœus gammiei* (Bedd.); distal end of penial seta; × ca. 175.

Septa, calciferous glands, and last heart as usual. Gizzard large. Male funnels enclosed in a common testis sac (? sometimes double). Seminal vesicles extend back as far as xiv, xv, or xvi, with lobed margins. Prostates with long glandular part, much bent, reaching back to xx; duct thinner, especially at ectal end, relatively long, looped with the bend forwards. Spermathecal ampulla an irregular sac, duct very short and thick, practically absent; so that the ampulla is attached to the body-wall by a portion of its under surface and is practically sessile; diverticulum single, broad, fan-like, notched along its free edge, the notches separating from 6 to 20 seminal chambers; or the series of

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chambers may be divided into two groups (text-fig. 226). Penial setæ (text-fig. 227) 2–5 mm. long, 26–40 $\mu$ thick, shaft with a slight S-shaped curve, tapering towards distal end; the tip, which may be variously bent or hooked, is typically broadened or spoon-shaped, but often softened and hence distorted; ornamentation of densely crowded rows of fine dots or teeth covers distal portion of seta except extreme tip.

*Remarks.* A very variable species; it was the examination of specimens from two places in the Garo Hills and two places in Darjiling District that first directed my attention to the width of variation, and to the fact that one or more of my species from the Abor Country would have to be merged in it.

Beddard in his original description appears to have made a slight error in the numbering of the segments; the thickened septa are 8/9–10/11, and the last heart is in xiii, as usual; the extent of the seminal vesicles should doubtless be xi–xviii (not x–xvii).

*Distribution.* Comilla, Chittagong Dist.; Garo Hills, Assam; Darjiling Dist. and Abor Country, E. Himalayas.

### 7. Eutyphœus gigas *Steph.*

1917. *Eutyphœus gigas*, Stephenson, Rec. Ind. Mus. xiii, p. 408, pl. xviii, figs. 28–30.
1919. *Eutyphœus gigas*, Stephenson and Prashad, Tr. Roy. Soc. Edin. lii, p. 465, pl. fig. 7.

Length 250 mm.; diameter behind clitellum 9 mm. Segments 212; iv biannulate, v and vi triannulate, vii with four and viii with five annuli; the rest up to the clitellum with five or even

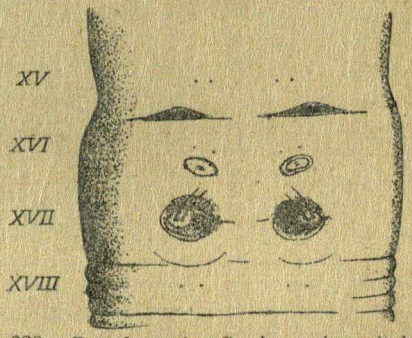


Fig. 228.—*Eutyphœus gigas* Steph.; male genital field.

more annuli. Colour purplish brown dorsally, with darker median stripe, pale ventrally. Prostomium minute, prolobous. Dorsal pores from 11/12. Setæ paired; in front of clitellum $ab=\frac{1}{3}$–$\frac{2}{5}$ $aa=\frac{2}{5}cd$, $aa=bc$, and $dd=\frac{2}{5}$ of circumference; behind clitellum $ab=\frac{1}{5}aa=\frac{2}{5}$–$\frac{1}{4}cd$, $aa$ greater than $bc$, and $dd=\frac{2}{5}$ of circumference; behind middle of body $ab=\frac{2}{5}aa=\frac{3}{4}cd$, $aa=1\frac{1}{2}bc$, and $dd$ is little more than half of circumference. Clitellum includes nearly half

xiii and extends back to include xvii (=nearly 4½). Male pores (text-fig. 228) as transverse slits on papillæ within large circular pits, the centres of the pits in line with *b*; the papilla being in the lateral part of the pit, the middle of the pore is rather outside *b*. Female pore seen only on left side, in front of *ab*. Spermathecal pores small, slit-like, just outside *b*, in 7/8. Genital markings in 15/16 as a pair of transverse depressions, pointed at both ends, almost meeting each other in the middle line; also a pair of small oval areas on the hinder part of xvi, behind *ab*, each surrounded by a narrow groove and somewhat depressed in the middle.

Septa, calciferous glands, and vessels as usual in metandric species. Gizzard large, firm, and subspherical. Intestine begins at xv; in xxviii a pair of cæca like those of *Pheretima*. Micronephridia behind clitellum in regular transverse rows, one row in each segment, and about a dozen nephridia on each side. Testis

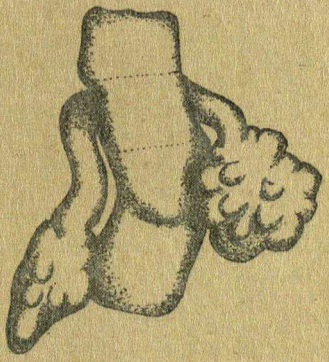

Fig. 229.—*Eutyphœus gigas* Steph.; spermatheca; the dotted lines indicate the portion of the under surface which is attached to the body-wall.



Fig. 230.—*Eutyphœus gigas* Steph.; distal end of penial seta; × 160.

sacs in xi. Seminal vesicles extending forwards to 10/11 and bulging back 12/13 to the level of 13/14. Prostates extend back to xx; duct one-third the thickness of the glandular portion, firm and shining, in many coils and loops. Spermathecæ (text-fig. 229) antero-posteriorly elongated sacs, irregular in shape, attached to parietes by a broad base, in front of and behind which the sac projects; no separate duct; diverticula two, each a compound sac with 12–20 chambers, attached to base of ampulla by a stout stalk. Penial setæ (text-fig. 230) 5·3 mm. long, 50 μ thick near base, shaft slightly bowed towards tip, tapering rather rapidly to a fine point; distal portion (except extreme tip) ornamented with

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very numerous and densely crowded transverse markings, each consisting of a few points set side by side.

*Distribution.* Rangamati, Chittagong Hill Tracts, Bengal.

8. **Eutyphœus ibrahimi** *Steph.*

1914. *Eutyphœus ibrahimi*, Stephenson, Rec. Ind. Mus. x, p. 357, pl. xxxvi, fig. 12.

Length 70 mm.; maximum diameter 3 mm. Colour light olive-green, with browner tinge anteriorly. Segments 185. Prostomium tanylobous, sides of tongue parallel. Dorsal pores from 12/13. Behind clitellum *ab* approximately = *cd* = $\frac{1}{3}$–$\frac{2}{5}$*aa* = $\frac{4}{5}$*bc*; in front of clitellum *ab* = $\frac{1}{2}$*aa* = $\frac{2}{3}$*bc* = slightly less than *cd*; thus pairing is rather closer behind than in front of clitellum; *dd* = $\frac{3}{5}$ of circumference. Clitellum indefinite. Male pores just external to *b*, on small papillæ, on the outer side of each of which is a slightly raised horseshoe-shaped ridge, partly surrounding the papilla, with the concavity of the horseshoe inwards. Female pore apparently single, on the left side in front of seta *a* of xiv. Spermathecal pores small, in *c* in 7/8, with tumid lips. No genital markings.

Septa (probably), calciferous glands, and last heart as usual. Gizzard of moderate size, cylindrical. Intestine begins in xv. Male funnels apparently enclosed each in a separate sac. Seminal vesicles a single pair, flattened against the alimentary canal. Prostates of moderate size. Spermathecæ small; ampulla small, ovoid; duct short, broad, about as long and nearly as broad as ampulla; diverticula two to four, rounded knobs at the upper part of the duct, none attached to anterior side of duct. Penial setæ ca. 2 mm. long, 20 $\mu$ in maximum thickness, the whole curved through about a quarter of a circle; distal end spoon-shaped, with curved tip, slightly constricted proximal to the spoon; ornamentation of fine hairs distal and proximal (mainly proximal) to the constriction; apparently a faint longitudinal grooving immediately distal to the constriction.

*Remarks.* Only a single specimen came to hand, and that in bad condition and possibly not fully mature. Probably the first septa should be 4/5 and 5/6, as in other species, not as given in the original, 5/6 and 6/7. The hairs on the penial setæ might be called fine spines.

*Distribution.* Kapurthala, Punjab.

9. **Eutyphœus incommodus** (*Bedd.*).

1901. *Typhœus incommodus*, Beddard, P. Z. S. 1901, i, p. 200, text-figs. 56, 57.
1909. *Eutyphœus incommodus*, Michaelsen, Mem. Ind. Mus. i, p. 222.
1910. *Eutyphœus incommodus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 90.

1914. *Eutyphœus incommodus*, Stephenson, Rec. Ind. Mus. x, p. 349, pl. xxxvi, fig. 8.
1916. *Eutyphœus incommodus*, Stephenson, Rec. Ind. Mus. xii, p. 342.
1917. *Eutyphœus incommodus*, Stephenson, Rec. Ind. Mus. xiii, p. 408.
1920. *Eutyphœus incommodus*, Stephenson, Mem. Ind. Mus. vii, p. 240.

Length 90–112 mm.; diameter 4 mm. Segments 124–162; first three simple, next three biannulate, rest of preclitellar segments triannulate, and so also those behind clitellum. Colour brownish olive. Dorsal pores from 11/12 or 12/13. Prostomium combined pro- and epilobous, or combined pro- and tanylobous. Setæ all ventral; in middle of body $ab=\frac{1}{3}$ or $\frac{2}{5}aa=\frac{4}{5}bc=\frac{3}{4}cd$; in front of genital region $ab=\frac{1}{2}aa=\frac{1}{2}$–$\frac{4}{5}bc=\frac{2}{3}cd$ or more. Clitellum embracing $\frac{1}{3}$, $\frac{2}{3}$, or all of xiii to xvii or $\frac{1}{3}$xviii (ca. 5). Male pores in line with *b*, on circular papillæ which are limited by grooves round their bases. Female pores in front of setæ *a*. Spermathecal pores slit-like, in 7/8, between *b* and *c*. Genital papillæ four pairs, close to the posterior border of their respective segments, on xiii–xvi (almost on grooves 13/14–16/17), almost circular, with a rim of white surrounding a darker central area, in *ab*, their diameter equal to *ab*.

Septa 4/5, 5/6, 8/9–10/11 strengthened, 6/7 and 7/8 absent; 11/12 present. Gizzard large. Calciferous glands in xii and extending into xi also. Intestinal cæca in middle of body. Last heart in xiii; dorsal vessel continued forwards on to pharynx. Testes and funnels free in x and xi, those in x usually smaller than those in xi, or perhaps occasionally absent. Seminal vesicles in ix and xii, the latter the larger. Prostatic duct much thinner than glandular part, short, bent once or twice. Spermathecal ampulla large, globular; diverticula forming a complete frill of seminal chambers round the duct. Penial setæ 1 mm. long, almost straight, distal end curved slightly, terminal portion faintly ornamented with short transverse rows of fine points; bluntly pointed, with a slight bulbous swelling at the end.

*Distribution.* Rawal Pindi, Hoshiarpur Dist., Ambala (Punjab); Rurki, Agra (U.P.); Bharatpur (E. Rajputana); Pusa (Bihar); Calcutta, Rajmahal (Bengal).

*a.* var. **fulgidus** (*Steph.*).

1916. *Eutyphœus annandalei* var. *fulgidus*, Stephenson, Rec. Ind. Mus. xii, p. 342, pl. xxxiii, fig. 34.

Length 56 mm.; maximum diameter 4 mm. Segments 164. Unpigmented, clitellum a light brownish grey. A number of preclitellar segments multiannulate. Prostomium combined pro- and tanylobous. First dorsal pore in 11/12. Behind clitellum $ab=\frac{2}{3}aa=$ nearly $\frac{1}{2}bc=$ rather less than $cd$; in front of clitellum $ab=\frac{1}{2}aa=\frac{1}{2}$–$\frac{2}{3}bc=cd$. Clitellum saddle-shaped, or at least much

less marked ventrally, includes $\frac{2}{3}$ of xiii and $\frac{1}{3}$ of xviii (=5). Male pores on penis-like porophores which take up the whole length of the segment, as transverse slits on the summits, their centres in line with *b* or the interval *ab*. Spermathecal pores in 7/8, between *b* and *c*, rather nearer *b*. Copulatory organs in or rather just in front of 13/14, 14/15, and 15/16, sometimes also on 16/17, in *ab*.

Septum 4/5 thin, 5/6 moderately thickened, next two missing, 8/9 thin, 9/10 and 10/11 considerably thickened, 11/12 normal. Gizzard subspherical. Calciferous glands only discovered on opening the œsophagus, in xii. Testes and funnels in x and xi, those in x not vestigial. Seminal vesicles in ix and xii, the anterior of moderate size and lobulated, the posterior extending back through xiii and xiv, or bulging back the septum 12/13.



Fig. 231.—*Eutyphœus incommodus* (Bedd.) var. *fulgidus*; distal end of penial seta.

Prostates begin behind in xix. Spermathecal ampulla large, globular, and sessile; no duct; diverticula numerous, attached in a complete circle round the base of the ampulla, 8–15 in number, each free from the others or bound up with them by connective tissue. Penial setæ (text-fig. 231) 0·9 mm. long and 17 $\mu$ thick in the middle; shaft slightly curved, tip bluntly pointed; ornamentation of short transverse rows of fine points over the tip and distal part of the shaft.

*Remarks.* The distinctions between this form and the type of the species are not great—the colour, the shape of the tip of the penial setæ, and the considerably greater extent of the ornamentation in the present form are the chief.

*Distribution.* Anwarganj, Cawnpore Dist.

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### 10. Eutyphœus manipurensis *Steph.*

1921. *Eutyphœus manipurensis*, Stephenson, Rec. Ind. Mus. xxii, p. 763, pl. xxviii, fig. 11.

Length 120 mm.; diameter 5 mm. Segments 162; after the first few the segments are divided by secondary furrows, triannular behind the clitellum, and some segments in front of the clitellum still further subdivided. Colour dark grey. Prostomium tanylobous. Dorsal pores from 10/11. Setæ paired; in middle of body $ab=\frac{2}{5}aa=\frac{1}{2}bc=\frac{2}{3}cd$; behind clitellum $ab=\frac{2}{3}aa=\frac{2}{5}bc=\frac{1}{7}cd$; in front of clitellum $ab=\frac{1}{4}aa=\frac{1}{2}bc=\frac{2}{5}cd$; $dd=\frac{1}{4}$ of circumference. Clitellum includes $\frac{2}{3}$xiii–$\frac{2}{3}$xvii ($=4\frac{1}{3}$). Male pores on prominent round papillæ, on xvii between $a$ and $b$; a trench round each papilla, the outer margin of the trench slightly swollen and indented. Ventral surface of xvi depressed and fissured; genital markings usually present as oval areas with raised margin, in, behind, or in front of the setal zone, their number varying, 3–6



Fig. 232.—*Eutyphœus manipurensis* Steph.; distal end of penial seta; × ca. 150.

in all. Spermathecal pores in 7/8, with centre in *ab*. Small papillæ variously in spermathecal region, behind the apertures, or midventrally on viii or ix.

Septum 4/5 slightly, 5/6 much thickened; 8/9 the next, somewhat thickened, 9/10 considerably so, 10/11 very stout; 11/12 present, thin; 8/9 and 9/10 displaced backwards. Gizzard large. Calciferous glands as usual in the genus. Last heart in xiii; dorsal vessel continued forwards on to the pharynx. Micronephridia behind clitellum in a single row per segment. Two pairs of funnels, apparently free, in x and xi. Seminal vesicles in ix and xii or xii–xiii. Prostates a close coil; duct also coiled, narrower than glandular part, only slightly shining. Spermathecæ as ovoid sacs, sessile on parietes; diverticulum

single, sessile, slightly lobulated, one-third as broad and half as high as ampulla. Penial setæ (text-fig. 232) 1·5 mm. long, shaft straight, tip slightly curved, tapering to a blunt point, a number of fine triangular teeth on the tip.

*Distribution.* Manipur, Assam.

11. **Eutyphœus masoni** (*A. G. Bourne*).

1889. *Typhœus masoni*, Bourne, J. Asiatic Soc. Bengal, lviii, p. 112, pl. iii, figs. 1–3.
1895. *Typhœus masoni*, Beddard, Monog. p. 474.
1900. *Eutyphœus masoni*, Michaelsen, Tier. x, p. 323.
1901. *Typhœus masoni*, Beddard, P. Z. S. 1901, i, p. 202, text-fig. 58.
1907. *Eutyphœus bastianus* + *E. andersoni*, Michaelsen, Mt. Mus. Hamburg, xxiv, pp. 183, 185, text-figs. 27, 28.
1909. *Eutyphœus bastianus* + *E. andersoni*, Michaelsen, Mem. Ind. Mus. i, pp. 236, 238, pl. xiv, figs. 40, 41, 58–61, text-figs. 33, 34.
1910. *Eutyphœus bastianus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 91.
1916. *Eutyphœus bastianus*, Stephenson, Rec. Ind. Mus. xii, p. 342.

Length 130–220 mm.; diameter 4½–6½ mm. Segments ca. 215. Colour dorsally dark violet-grey, ventrally dark grey. Prostomium tanylobous. Segments in front of clitellum multi-annulate from iii onwards, those just in front of clitellum with as

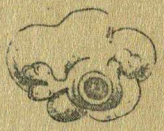

Fig. 233.—*Eutyphœus masoni* (A. G. Bourne); nder side of spermatheca; × 8.



Fig. 234.—*Eutyphœus masoni* (A. G. Bourne); distal end of penial seta (flat side); × 200.

many as seven annuli. Dorsal pores not visible in front of clitellum. Setæ rather small, widely paired to almost separated; behind clitellum $ab = \frac{2}{3}aa = \frac{2}{3}bc =$ or is slightly less than $cd$; at ends of body $ab = \frac{2}{3}aa = bc$ and $cd$ or nearly. Clitellum ring-shaped, somewhat less prominent ventrally, ⅓xiii–xvii (= 4⅓). Male pores approximately in $ab$, in deep grooves, each of which is

surrounded by a broad wall forming three-fourths of a circle, open in front. Genital markings as paired oval areas on 15/16 in *ab*, 16/17 in *a* or *ab*, more rarely on 14/15 and 18/19, sometimes on 9/10, 19/20 and 20/21 in *ab*. Spermathecal pores in 7/8 between *b* and *c*.

Septa and calciferous glands as usual in metandric species. Gizzard large. Typhlosole large, simple, with broad base, triangular in transverse section. Funnels in xi, enclosed in a common sac which extends forwards on each side to enclose the testes also. Seminal vesicles extend through several segments. Prostates long, glandular part much coiled; duct 6 mm. long, thinner than glandular part, winding irregularly. Spermathecal ampulla irregular, with broad short lobes and thick very short duct; diverticula two, opposite, hidden beneath ampulla, each consisting of about three rounded seminal chambers united on a common stalk (text-fig. 233). Penial setæ (text-fig. 234) up to 5 mm. long and 50$\mu$ thick, very slightly curved, distal end not broadened but flattened, and on one side somewhat hollowed, ending in a simple triangular point; distal third, except extreme tip, beset with a large number of minute sculpturings, convex towards the tip of the seta, arranged in transverse rows, the appearance being that of fish-scales.

*Remarks.* The chief difference between *E. bastianus* and *andersoni* was the penial setæ; the condition described in *andersoni* was later recognized by Michaelsen as being an artificial production; a minor difference was that the setal interval *aa*=*bc* in *andersoni*.

Michaelsen in 1910 suspected the identity of his species with *E. masoni*; the difficulty was that Bourne said nothing about any ornamentation of the penial setæ; he also described two forms of these setæ, but one of these is doubtless only an immature stage of the other. The sculpturing of the penial setæ is fairly fine, and may have been neglected by Bourne; it is always to be remembered that in the days of the earlier writers, it was not known what characters would ultimately be important for systematic distinctions (and therefore should be minutely described). I consider that the fact that I received specimens of Michaelsen's *E. bastianus* from Dehra Dun, the locality from which Bourne and Beddard received *E. masoni*, turns the scales sufficiently in favour of the identity to warrant the above synonymy.

*Distribution.* Dehra Dun, Basti Dist., Bara Banki (United Provinces); Sirsiah (Muzaffarpur Dist., Bihar); Calcutta, Rajshahi (Bengal).

12. **Eutyphœus mohammedi** *Steph.*

1914. *Eutyphœus mohammedi*, Stephenson, Rec. Ind. Mus. x, p. 350, pl. xxxvi, fig. 9.
1920. *Eutyphœus mohammedi*, Stephenson, Mem. Ind. Mus. vii, p. 241.

Length 39–75 mm.; diameter 4·5 mm. Segments 149; some

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preclitellar segments multiannular. Colour light grey, mid-dorsal purple streak anteriorly. Prostomium tanylobous, or combined pro- and tanylobous. Dorsal pores from 11/12. In general $ab=\frac{1}{3}aa=\frac{2}{5}bc=\frac{3}{5}cd$; in front of clitellum $ab=\frac{2}{7}-\frac{1}{2}aa=\frac{1}{2}bc=\frac{3}{4}cd$; behind clitellum $ab=\frac{1}{4}aa=\frac{1}{3}-\frac{2}{7}bc=\frac{3}{4}cd$; $dd$ = rather less than $\frac{2}{3}$ of circumference. Clitellum indistinct, $\frac{1}{2}$xiii–xvii (= $4\frac{1}{2}$). Male pores in *b*, on distinct papillæ. Spermathecal pores external to *b*. No genital markings.

Septum 4/5 slightly, 5/6 moderately thickened, 6/7 and 7/8 absent, 8/9–10/11 moderately thickened and close together, 11/12 present and slightly thickened. Gizzard of moderate size. Calciferous glands as swellings of alimentary tube in xii and neighbouring part of œsophagus. Intestine begins in xv. Last heart in xiii; dorsal vessel continued forwards as far as pharynx, heart of xi with normal relations. Micronephridia few and of moderate size behind genital region, arranged in a transverse row in each segment. Testes and funnels free in x and xi. Seminal vesicles small, in ix and xii. Prostates confined to xviii; duct in xvii, looped once, with convexity outwards. Spermathecæ very small, ampulla hemispherical, sessile on body-wall; a ring of seven diverticula round base. Penial setæ small, 0·5 mm. long, 18 $\mu$ in maximum thickness; shaft gently curved, curvature increasing towards tip, which is bluntly pointed; a few minute triangular teeth near tip.

*Remarks.* The description raises the suspicion that the specimens were not fully mature, and that they may belong to *E. incommodus*; perhaps the penial setæ will distinguish them—in the present form there is no swelling of the tip, and the extent of the ornamentation is rather more limited (*cf.* the two figs. on pl. xxxvi, Rec. Ind. Mus. x). The absence of genital markings in the present case might be paralleled by their absence in *E. bengalensis*, which I have shown to be a form of *waltoni*. I confess to being doubtful, and should not be surprised if further investigations show that the present form is to be united with *E. incommodus*.

*Distribution.* Rawal Pindi; Allahabad.

13. **Eutyphœus nainianus** *Mich.*

1907. *Eutyphœus nainianus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 177, text-fig. 21.
1909. *Eutyphœus nainianus*, Michaelsen, Mem. Ind. Mus. i, p. 225, pl. xiv, fig. 64, text-fig. 27.

Length 60 mm.; diameter 3–4½ mm. Segments 138. Colour grey. Prostomium tanylobous, tongue broader behind. Setæ not closely paired, at hinder end separated; in postclitellar region $aa:ab:bc:cd=7:4:6:5$; $dd$=ca. $\frac{5}{9}$ of circumference. Dorsal pores inconspicuous, only seen behind clitellum. Clitellum ring-shaped, xiii–xvii (= 5). Male pores on very prominent almost circular papillæ, the centres of papillæ in *b* or nearly so. Female

pores just in front of setæ *a* of xiv. Spermathecal pores in or rather internal to *c*. A transversely oval area in 16/17, extending slightly beyond *a* on each side, surrounded by a whitish wall, and divided down the middle by a similar wall.

Septa and calciferous glands as usual in metandric species. Gizzard large. Intestine begins in xiv (? xv). Large funnels in xi, enclosed in a common sac, which extends upwards at the sides of the segment. A pair of seminal vesicles extending backwards



Fig. 235.—*Eutyphœus nainianus* Mich.; spermatheca; × 10.

to xx, constricted by the septa. Glandular part of prostate large, occupying about four segments; duct muscular, narrower than gland, relatively long, looped, the loop extending laterally. Spermathecal ampulla nearly globular; duct very short, about half as thick as ampulla; diverticula in two groups of small round chambers, which form an incomplete circle round the base of the ampulla, interrupted at two points (text-fig. 235). No penial setæ.

*Distribution.* Naini Tal, Kumaon Dist., W. Himalayas.

### 14. Eutyphœus nepalensis *Mich.*

1907. *Eutyphœus nepalensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 176, text-fig. 20.
1909. *Eutyphœus nepalensis*, Michaelsen, Mem. Ind. Mus. i, p. 233, pl. xiv, fig. 37, text-fig. 26.

Length 110–140 mm.; diameter from 6 mm. in clitellar region to ca. 3·5 mm. at hinder end. Segments 150–180. Colour greyish. Prostomium more or less distinctly tanylobous; lateral borders of tongue not always distinctly different from the crowd of longitudinal furrows on i. Segments iv–x bi-, tri- or multiannular. Setæ moderately large, especially the ventral setæ of the anteclitellar region; all ventral, all widely paired or separated; *aa* a little greater than *bc*, *bc* about the same as *cd*, and a little greater than *ab*, *aa* = ca. $1\frac{1}{2}ab$; $dd = \frac{3}{5}$–$\frac{2}{3}$ of circumference. Dorsal pores from 10/11. Clitellum less marked ventrally, xiii–xvii (= 5). Male pores on thick transversely oval papillæ, the centres of which are a little lateral to *b*. Female pores in front of *a* of xiv, each surrounded by a whitish area. Spermathecal pores eye-shaped, with centres in *c*. Genital markings as paired transversely oval cushions, between and extending outwards and inwards beyond *a* and *b*; most constant on 15/16, usually on 19/20 and 20/21, sometimes on 18/19, and unilaterally on 14/15 and 21/22.

Septa 5/6 and 8/9 very thick, the intermediate septa missing; 9/10 and 10/11 somewhat thickened. Gizzard large, oblique. Calciferous glands as usual. Large funnels in xi, enclosed in a sac which appears to embrace the œsophagus as a ring. Seminal vesicles in xii. Prostates very long, occupying about six segments; duct long, muscular, describing irregular loops, thinner and shorter than the glandular part, but nevertheless about 20 mm. long. Spermathecæ (text-fig. 236) very large; ampulla irregular, sac-like; duct shorter, conical, thicker entally where it is about half as broad as the ampulla, tapering ectally; diverticula as two groups, five or six in each group, each with short stalk opening

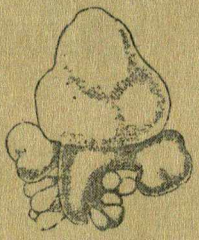

Fig. 236.—*Eutyphœus nepalensis* Mich.; spermatheca; × 5.

into ectal part of duct, most are simple, some divided into two seminal chambers, all small; in addition, at each side a much larger diverticulum, irregular and sac-like, stalked, opening into the ental end of the duct, or lower down amongst the true diverticula (? separated lobes of main pouch, functioning as accessory diverticula). No penial setæ.

*Remarks.* For a somewhat similar condition of an accessory ampulla cf. *Octochætus pachpaharensis.*

*Distribution.* Chitlong, Little Nepal Valley.

15. **Eutyphœus nicholsoni** (*Bedd.*)

1901. *Typhœus nicholsoni*, Beddard, P. Z. S. 1901, i, p. 195, text-figs. 54, 55.
1907. *Eutyphœus khani*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 182, text-fig. 26.
1909. *Eutyphœus khani*, Michaelsen, Mem. Ind. Mus. i, p. 233, pl. xiv, figs. 62, 63, text-fig. 32; *E. provincialis* (laps.), p. 219.
1910. *Eutyphœus nicholsoni*, Michaelsen, Abh. Ver. Hamburg, xix, p. 92.
1914. *Eutyphœus nicholsoni*, Stephenson, Rec. Ind. Mus. x, p. 354.
1916. *Eutyphœus nicholsoni*, Stephenson, Rec. Ind. Mus. xii, p. 342.

Length up to 185 mm.; diameter up to 5·5 mm. Segments 190–225; secondary annulation behind iii; in some preclitellar segments as many as four secondary annuli, behind clitellum three. Colour dorsally brownish to violet-grey, ventrally yellowish

grey. Prostomium combined pro- and tanylobous. Dorsal pores apparently begin in front of clitellum. Setæ all ventral; $ab : bc : cd = 3 : 5 : 4$ behind clitellum; $aa$ less than $bc$ in front of, greater behind clitellum; setæ present on clitellum. Clitellum $\frac{1}{3}$xiii or all xiii to xvii ($=4\frac{1}{3}$ to 5). Male pores near together, surrounded by a common ridge, in $a$ or even closer. Female pore single, on left side in front of seta $a$ of xiv. Spermathecal pores in $a$. Genital papillæ circular or slightly oval, in 15/16, close together, surrounded by a common wall or groove, and separated from each other in the middle line by a groove; occupying most of the space between setal zones of xv and xvi, and laterally extending beyond the line of $b$.



Fig. 237.—*Eutyphœus nicholsoni* (Bedd.); spermatheca; × 10.



Fig. 238.—*Eutyphœus nicholsoni* (Bedd.); distal end of penial seta; × 225.

Septa 4/5 and 8/9–10/11 very strong; 5/6–7/8 absent. Calciferous glands and vascular system as usual in metandric species. Intestine begins in xv; intestinal pouches five pairs, beginning about lxxxiv. Testis sac common to the organs of the two sides. Seminal vesicles long, extending back to xiv, flattened, the margins somewhat lobulated. Prostates tightly coiled; duct muscular, in an S-like curve, of fair length, much thinner than the glandular part. Spermathecal ampulla broad and short, somewhat lobed, the lobes showing a number of small lobular protuberances; duct rather long (longer than height of ampulla), half as thick as ampulla, narrower ectally; diverticulum fan-shaped, on outer side of duct, or double, each broad, with 3–5 seminal chambers.

Penial setæ (text-fig. 238) about 4 mm. long, 20 $\mu$ thick, nearly straight; tip rather blunt; ornamentation of sparse indistinct triangular teeth (not always present).

*Remarks.* A variable species; for example, I found that the papillæ on 15/16 may or may not be surrounded by a wall, and that the male slits may be united in a single one. The penial setæ, according to Michaelsen, may be shorter and thinner than given above; the tip appears often to be sharply bent, almost looped (but it is common in the genus to find the tip soft and bent or deformed). I examined the female pores, and found the left present alone in nine, a large left with a small right pore in two, and no pores distinguishable in one.

*Distribution.* Saharanpur, Lucknow, Bara Banki, and Basti Dist., United Provinces; Rajmahal and Calcutta, Bengal.

### 16. Eutyphœus orientalis (*Bedd.*).

1883. *Typhœus orientalis*, Beddard, Ann. Mag. N. H. (5) xii, p. 219, pl. viii, figs. 1, 2, 4, 9–12.
1888. *Typhœus orientalis*, Beddard, Quart. J. Mic. Sci. xxix, p. 117, pl. xiii, fig. 2.
1895. *Typhœus orientalis*, Beddard, Monog. p. 473.
1898. *Typhœus orientalis*, Fedarb, P. Z. S. 1898, p. 445.
1900. *Eutyphœus orientalis*, Michaelsen, Tier. x, p. 322.
1901. *Typhœus orientalis*, Beddard, P. Z. S. 1901, i, p. 205.
1922. *Eutyphœus orientalis*, Stephenson, Rec. Ind. Mus. xxiv, p. 437, text-fig. 3.

Length 158–250 mm.; diameter 5–8 mm. Segments 192. Dorsal pores present behind clitellum. Setæ all ventral. Clitellum includes xiv and a small part of xiii to xvii (=more than 4). The male area, on xvii, presents a pair of bracket-shaped grooves ([]), each overhung on its outer side by a thickened ridge; male pores in the posterior corner of each bracket, a little outside *b*. Spermathecal pores slit-like, between *b* and *c*, but nearer *c*, the outer end of the slit reaching the line of *c*. Three pairs of genital papillæ, intersegmental, in front of the male pores, transversely oval, depressed in the centre; another pair in 18/19, sometimes papillæ in 19/20 and 13/14; papillæ in line with *ab*.

Five glands, increasing in size backwards, on dorsal surface of intestine towards end of middle third of body, some or all bilobed (*i. e.*, one lobe on each side of the middle line). Seminal vesicles extend back to xv. Prostates as large coiled tubes; ducts thinner. Spermathecal ampulla an ovoid sac, with crenate margins; duct from under surface of ampulla, short, stout, muscular; two diverticula, one on each side, each with one, two, or three seminal chambers, join the main organ where ampulla passes into duct. Penial setæ 2·5 mm. long, 26 $\mu$ thick in middle, shaft almost straight; curved, bluntly pointed and flattened tip; ornamentation of closely set oblique markings along the borders of the distal end.

*Remarks.* The original description states that septa 5/6 and 6/7 are thickened; this may be a mistake for 4/5 and 5/6. The oblique ridges on the penial setæ are described by Beddard as "chevron-shaped ridges."

*Distribution.* Dehra Dun; Calcutta.

### 17. Eutyphœus paivai *Mich.*

1907. *Eutyphœus paivai*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 178, text-fig. 23.
1909. *Eutyphœus paivai*, Michaelsen, Mem. Ind. Mus i, p. 228, pl. xiv, figs. 38, 39, text-fig. 29.

Length 195 mm.; maximum diameter 5 mm. Segments ca. 220. Colour violet-brown dorsally, with darker middorsal stripe; greyish laterally and ventrally. Prostomium tanylobous, borders of tongue parallel. Dorsal pores inconspicuous. Setæ all ventral; $aa : ab : bc : cd = 3 : 2 : 3 : 2\text{–}2\frac{1}{4}$; *dd* greater than half of circumference. Clitellum $\frac{1}{3}$xiii–xvii ($= 4\frac{1}{3}$); ring-shaped, but less marked ventrally, and absent ventrally in xvii. Male pores in hollows, about in *b*; surrounding parts of body-wall tumid.



Fig. 239.—*Eutyphœus paivai* Mich.; spermatheca; × 5.

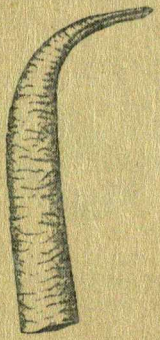

Fig. 240.—*Eutyphœus paivai* Mich.; distal end of penial seta; × 250.

Spermathecal pores as slits between *b* and *c*, nearer to *b*; tumid patches in front and behind. Genital markings as paired transversely oval areas, in and slightly transgressing *ab*, on 15/16, 16/17, and 18/19–22/23, seven pairs in all.

Septa, calciferous glands and anterior male organs as usual in metandric species. Gizzard large. Intestine begins in xv. Seminal vesicles lobate, extending back to xvi. Prostates large, occupying segments xvii–xxi; duct thin, relatively long, describing several loops. Spermathecal ampulla irregularly sac-shaped, constricted (? constantly) in front of the middle, thicker behind; duct broad and short, from the under surface; diverticula three or four, in a single group, each irregularly sausage-shaped or stump-like (text-fig. 239). Penial setæ (text-fig. 240) ca. 4 mm.

long and 32 $\mu$ thick, scarcely bent, scarcely tapering distally; tip bent more strongly, flattened but not broadened; distal third of seta except extreme tip with densely crowded irregular transverse rows of fine teeth.

*Distribution.* Pusa, Bihar.

18. **Eutyphœus pharpingianus** *Mich.*

1907. *Eutyphœus pharpingianus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 177, text-fig. 22.
1909. *Eutyphœus pharpingianus*, Michaelsen, Mem. Ind. Mus. i, p. 226, pl. xiv, figs. 56, 57, text-fig. 28.

Length 130 mm.; diameter 4–4½ mm. Segments 118. Colour grey. Prostomium indistinctly tanylobous, small, retracted into buccal cavity. Dorsal pores from 11/12. Setæ moderately large,

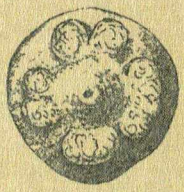

Fig. 241.—*Eutyphœus pharpingianus* Mich.; spermatheca; × 15.



Fig. 242.—*Eutyphœus pharpingianus* Mich.; distal end of penial seta; × 225.

the ventral paired, the lateral separated; $cd=bc=1\frac{1}{2}ab=\frac{4}{5}$–$\frac{3}{4}aa$; $dd=\frac{5}{6}$ of circumference. Clitellum xiii–xvii (= 5); somewhat less distinct ventrally between the lines of setæ *a*. Male pores on nearly circular papillæ, about in *b*. Female pores in front of *a* of xiv. Spermathecal pores in *b*. Genital markings as four pairs of transverse slits or narrow areas, in *ab*, on hinder parts of xiii–xvi or in furrows 13/14–16/17.

Septa and calciferous glands as usual in metandric species. Gizzard large. Funnels in xi, perhaps enclosed in a common

testis sac. Seminal vesicles extending very far back, to xxxiii in the single specimen, broader and lobed in their anterior part, constricted by the septa. Prostates with very long and convoluted glandular part, occupying about four segments; duct thinner, relatively long, describing two loops, muscular. Spermathecal ampulla nearly globular; duct indistinct, very short, about half as broad as ampulla; diverticula as an interrupted circle of seminal chambers round base of ampulla in groups of twos, threes, or fours, or single chambers (text-fig. 241). Penial setæ (text-fig. 242) ca. $1\frac{2}{3}$ mm. long and 26 $\mu$ thick, bent only in the distal part, scarcely tapering, tip simple and blunt; ornamentation beginning some distance above extreme tip, of sparse small irregularly toothed ridges or rows of short teeth.

*Distribution*. Pharping, near Katmandu, Nepal Valley.

### 19. Eutyphœus quadripapillatus *Mich.*

1907. *Eutyphœus quadripapillatus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 175, text-fig. 19.
1909. *Eutyphœus quadripapillatus*, Michaelsen, Mem. Ind. Mus. i, p. 221, pl. xiv, fig. 55, text-fig. 25.
1910. *Eutyphœus quadripapillatus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 90.

Length 60–70 mm.; maximum diameter $3\frac{3}{4}$ mm. Segments 120–155. Colour in general yellowish green, with a light rose tint anteriorly. Dorsal pores from 11/12. Setæ all ventral; in



Fig. 243.—*Eutyphœus quadripapillatus* Mich.; spermatheca; × 8.

general $aa : ab : bc : cd = 4 : 2 : 4 : 3$ in middle of body; $dd$ = ca. $\frac{3}{5}$ of circumference. Clitellum indistinctly saddle-shaped, at least in the hinder part; xiii or $\frac{2}{3}$xiii-xvii (= $4\frac{2}{3}$ or 5). Male pores on prominent transversely oval papillæ, the papillæ in *ab* and extending somewhat outside *b*, their centre a little internal to *b*. Female pores just in front of setæ *a* of xiv. Spermathecal pores on small transversely oval papillæ between *a* and *b*, somewhat nearer to *b*. Genital markings as two pairs of transversely oval papillæ or areas on 13/14 and 14/15 about in *b*.

Septum 4/5 strong, 5/6 very strong, 6/7 and 7/8 missing, the following septa as far as 11/12 scarcely strengthened, except 9/10, which is moderately strong. Gizzard large. Calciferous glands as usual in the genus. Intestine begins in xv. Testes and funnels in x and xi, apparently free; those of x much smaller than those of xi, but by no means vestigial. Seminal vesicles in ix and xii, the anterior pair confined to ix, the posterior extending

back as far as xxx; both pairs much incised. Prostates with long, coiled and adpressed glandular part, occupying about three segments; duct thin, somewhat bent; sperm-ducts of one side unite towards their ectal end, pass the end of the prostatic duct on its outer side, and turn round to open into the same pore from behind. Spermatheca (text-fig. 243) with nearly circular and depressed ampulla; duct short and conical; about ten stump-like diverticula of different sizes, sometimes united two together at their bases, the whole forming a rosette round the duct, which may be interrupted more or less at two points, the rosette being then divided into two groups; *in situ* the diverticula are nearly hidden. No penial setæ.

*Distribution.* Sirsiah, Bihar; Saraghat and Calcutta, Bengal.

20. **Eutyphœus scutarius** *Mich.*

1907. *Eutyphœus scutarius*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 186, text-fig. 29.
1909. *Eutyphœus scutarius*, Michaelsen, Mem. Ind. Mus. i, p. 240, pl. xiv, figs. 51–53, text-fig. 35.

Length 140–180 mm.; maximum diameter 5 mm. Segments ca. 290. Colour greyish with violet tints at the anterior end. Prostomium indistinctly epilobous (?). Dorsal pores from 11/12. Setæ all ventral, paired, but not closely; behind clitellum $aa : ab : bc : cd = 3 : 1 : 3 : 2$; in front of clitellum $ab$ larger ($= 3 : 2 : 3 : 2$); at posterior end $cd$ nearly as large as $bc$, but arrangement somewhat irregular; $dd$ greater than half of circumference. Clitellum ring-shaped, ½xiii–xvii ($= 4½$). Male pores a little lateral to $b$, each a small aperture surrounded by a ring-shaped wall. A median ventral male area of hexagonal form, including ½xvi–½xviii and extending laterally nearly to $c$, the anterior and lateral borders often marked by a wall; male pores in the lateral angles of the area; the ring-shaped walls of the pores connected by a transverse wall, the space between the transverse wall and the anterior wall of the area often depressed, so also sometimes that between the transverse wall and the posterior border of the area. A median ventral cushion just in front of male area on 15/16, transversely oval or hexagonal, extending from middle of xv to middle of xvi, and laterally reaching to midway between $b$ and $c$; the cushion bordered by either a small wall or ridge, or by a furrow, according to the stage of maturity. Female pores just in front of and perhaps rather internal to setæ $a$ of xiv. Spermathecal pores in 7/8 between $b$ and $c$.

Anterior septa as usual, except that 5/6 is extremely strong, almost as thick as the body-wall. Gizzard large; calciferous glands as usual. Intestine begins in xv. Funnels in a common testis sac in xi. Seminal vesicles extend back as far as xv. Prostates with very long and much coiled glandular part, not forming a compact mass, reaching back to xxiv; duct thinner, relatively long, describing one or two large loops; sperm-ducts pass round

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outer side of end of prostatic ducts and bend forwards to open with them in a common pore. Spermathecal ampulla irregular, sac-like; duct short and narrow, arising from the under surface of ampulla about the middle of its length; diverticula two, opposite, simple or compound, hidden in the natural position (text-fig. 244). Penial setæ (text-fig. 245) ca. 2 mm. long, proximally



Fig. 244.—*Eutyphœus scutarius* Mich.; spermatheca; × 4.

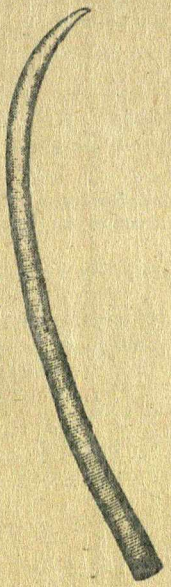

Fig. 245.—*Eutyphœus scutarius* Mich.; penial seta; × 45.

ca. 95 $\mu$ thick, tapering very little, slightly bent in proximal half, more strongly bent distally; distal end simple, often irregular, apparently corrugated, fibrous; distal half of seta with densely crowded irregular transverse rows of fine teeth, not easy to detect on account of structure of seta.

*Distribution.* Comillah, Chittagong District.

21. **Eutyphœus turaensis** *Steph.*

1920. *Eutyphœus turaensis*, Stephenson, Mem. Ind. Mus. vii, p. 244, pl. xi, figs. 48, 49.

Length 100 mm.; maximum diameter 3·5 mm. Segments 171; secondary annulation in v-xi. Unpigmented, no difference between dorsal and ventral surfaces. Prostomium small, tanylobous. Dorsal pores from 11/12. Setæ enlarged on iii–vi, scarcely visible on ix and x; anteriorly $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{3}{4}cd$; behind clitellum $ab = \frac{1}{4}aa = \frac{2}{5}bc = \frac{2}{3}cd$; in middle of body $ab = \frac{1}{3}aa = \frac{1}{2}bc = \frac{2}{3}cd$;

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*dd* = nearly $\frac{2}{3}$ of circumference. Clitellum very slightly marked, ? xv–xvii. Male pores in a pair of narrow transverse depressions, which extend from inside *a* to outside *b*, the pores in *b*. Spermathecal pores in 7/8 in *b*. Faint genital markings on 14/15, 15/16,



Fig. 246.—*Eutyphœus turaensis* Steph.; spermatheca seen from above; the sac is attached to the body-wall by the middle of its under surface.

and 16/17, as slightly pigmented spots surrounded by circular grooves.

Septa and calciferous glands as usual in metandric species. Gizzard barrel-shaped. Intestine begins in xv. Dorsal vessel

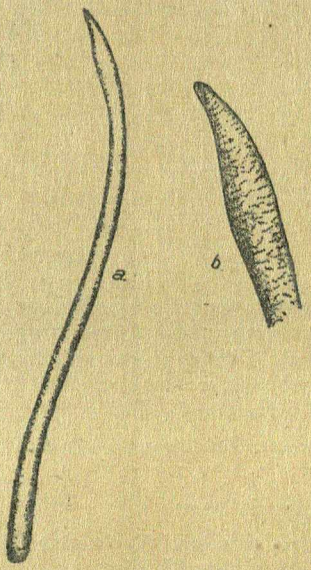


Fig. 247.—*Eutyphœus turaensis* Steph.; penial setæ; *a*, as seen as a whole, × 37; *b*, tip more highly magnified, × ca. 180.

ends at anterior end of gizzard (not posterior end, as usual in metandric species). Testis sacs in xi, separate. Seminal vesicles large, indented, extending back to the level of 14/15 by bulging back the septa. Prostates small, in xviii–xix, coils closely packed; duct scarcely narrower than glandular part, undulating, soft, not

shining. Spermathecal ampulla as an elongated sac attached to body-wall by a portion of the under surface; no distinct duct; diverticula two, one on each side, attached to base of sac by a short and relatively stout stalk, each lobulated, with three or four seminal chambers (text-fig. 246). Penial setæ (text-fig. 247) up to 1·5 mm. long, 35 $\mu$ thick, slightly curved in the distal half; tip bluntly pointed and rather claw-like; ornamentation as very fine dot-like markings over distal eighth or tenth of shaft, including tip.

*Remarks.* Allied to *E. chittayongianus*, the internal anatomy being strikingly similar; the genital markings, however, are just on those grooves where they do not appear in that species.

*Distribution.* Garo Hills, Assam.

## 22. Eutyphœus waltoni *Mich.*

1907. *Eutyphœus waltoni* + *E. bengalensis*, Michaelsen, Mt. Mus. Hamburg, xxiv, pp. 179, 183, text-fig. 24.
1909. *Eutyphœus waltoni* + *E. bengalensis*, Michaelsen, Mem. Ind. Mus. i, pp. 229, 235, pl. xiv, figs. 45–48, text-fig. 30.
1910. *Eutyphœus waltoni*, Michaelsen, Abh. Ver. Hamburg, xix, p. 91.
1914. *Eutyphœus waltoni*, Stephenson, Rec. Ind. Mus. x, p. 352.
1916. *Eutyphœus waltoni*, Stephenson, Rec. Ind. Mus. xii, p. 342.
1917. *Eutyphœus waltoni*, Stephenson, Rec. Ind. Mus. xiii, p. 408.
1919. *Eutyphœus waltoni*, Stephenson and Haru Ram, Tr. Roy. Soc. Edin. lii, p. 447, pl. figs. 7, 8.
1919. *Eutyphœus waltoni*, Stephenson and Prashad, Tr. Roy. Soc. Edin. lii, p. 465, pl. figs. 8–10.
1920. *Eutyphœus waltoni*, Stephenson, Mem. Ind. Mus. vii, p. 243.
1922. *Eutyphœus waltoni*, Stephenson, Rec. Ind. Mus. xxiv, p. 438.

Length 90–230 mm.; maximum diameter 4½–6½ mm. Segments 190–210. Colour brownish to violet-grey dorsally, with middorsal stripe behind clitellum; laterally and ventrally yellowish grey. Prostomium tanylobous, sides of tongue parallel. Dorsal pores from 12/13 or 11/12. Setæ rather small, paired but not closely; behind clitellum $ab = \frac{2}{5}aa = \frac{1}{2}bc = \frac{3}{4}cd$; in front of clitellum and at hinder end setæ nearly separated; all ventral, $dd$=ca. $\frac{2}{3}$ of circumference. Clitellum ring-shaped, but thinner ventrally; ½xiii–xvii (= 4½). Male pores lateral to if not in line with *b*, in deep slits or grooves which extend between and rather transgress the lines *a* and *b*. Female pores in front of and a little lateral to *a*. Spermathecal pores in 7/8, in *c*, in the centre of eye-shaped areas. Genital markings as transversely oval areas or glandular slits between the lines of the ventral setal couples, somewhat transgressing these limits; nearly constant on 15/16 and 18/19, often on 14/15 and 16/17, rarely on 19/20 and 20/21; sometimes a pair of organs of a rather different appearance—eye-shaped papillæ—on 9/10.

Septa, calciferous glands, and vascular system as usual in metandric species. Gizzard large. Intestine begins in xiv (? xv).

GSL



Intestinal cæca about the middle of the body. Funnels in xi, enclosed in a common testis sac. Seminal vesicles in xii. Prostates very long, occupying about three segments; duct muscular, thinner and much shorter than the glandular part, about 6 mm. long. Spermathecal ampulla thick, sac-like; duct thin, about half as long as ampulla; diverticula two, abreast, not opposite, each of about four seminal chambers arranged in a fan-like manner, apposed to base of ampulla, but the attachment is to the duct (text-fig. 248). Penial setæ (text-fig. 249) up to 4·7 mm. long,



Fig. 248.—*Eutyphœus waltoni* Mich.; spermatheca; × 5.

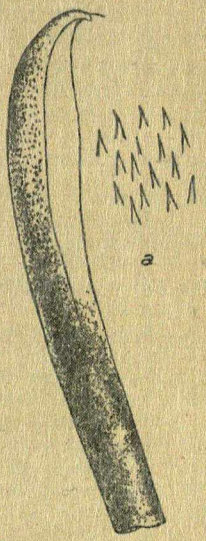


Fig. 249.—*Eutyphœus waltoni* Mich.; distal end of penial seta, × 400; *a*, ornamentation, × 3000.

16 $\mu$ thick, curved to form about a quarter of a circle; distal end curved somewhat more strongly, broadened a little and hollowed on the concave side, and thus spoon-like, with a somewhat hooked tip; ornamentation of fine hair-like spines on convex side of distal end, irregularly but rather densely distributed (may not be identifiable as distinct spines, even with the oil immersion lens).

*Remarks.* This species produces penial setæ early, before the clitellum and genital markings appear; hence the description of *E. bengalensis* as a separate species (93).

Stephenson and Haru Ram have studied the prostate (92), and Stephenson and Prashad the calciferous glands (91).

*Distribution.* Hoshiarpur District, Delhi (Punjab); Dehra Dun, Lucknow, Agra, Mainpuri, Fyzabad (U.P.); Pusa, Siripur (Bihar); Saraghat, Rajmehal, Calcutta (Bengal); Baroda, Ahmedabad, Navli (W. India); Gwalior (Central India).

GSL



## 6. Genus ERYTHRÆODRILUS *Steph.*

1915. *Erythræodrilus*, Stephenson, Mem. Ind. Mus. vi, p. 100.
1917. *Hoplochætella* (part.) + *Erythræodrilus*, Stephenson, Rec. Ind. Mus. xiii, pp. 354, 359.
1920. *Hoplochætella* (part.) + *Erythræodrilus*, Stephenson, Mem. Ind. Mus. vii, p. 227.
1921. *Erythræodrilus*, Michaelsen, Mt. Mus. Hamburg, xxxviii, pp. 35, 38.

Setal arrangement perichætine. One gizzard in one simple segment. Four pairs of calciferous glands in x–xiii. Nephridial system mixed mega- and micronephric, the micronephridia occurring throughout the body, the meganephridia from about xx onwards. Testes and funnels free or in testis sacs; genital apparatus various, from an impure acanthodriline to an incompletely microscolecine condition.

I follow Michaelsen (**99**) in uniting the two genera *Hoplochætella* (as conceived by me, **86**) and *Erythræodrilus*. I now agree with Michaelsen that Bourne's *Perichæta stuarti*, the type of the genus *Hoplochætella*, is unrecognizable, but that it probably had no calciferous glands, and so did not belong to the present genus and cannot be classified along with the species which I described under the name *Hoplochætella*. The single species which I formerly placed in the genus *Erythræodrilus* (*E. kinneari*) differs from those I called *Hoplochætella* in having testis sacs (found however in *Hoplochætella anomala*), in having three pairs of seminal vesicles (also found in *H. anomala*), and in having only the anterior pair of prostates. It is thus a later evolved species, and *H. anomala* is possibly its actual ancestor.

The genus is to be derived from *Howascolex*, as previously explained, to which it is also adjacent geographically. It has given rise to no descendants, being itself as yet in process of evolution, and showing in its several species several stages of the microscolecine reduction.

*Distribution.* Western India, including Bombay and neighbourhood, Portuguese India, Castle Rock in N. Kanara District, and Belgaum.

*Key to the species of the genus* Erythræodrilus.

| | |
|---|---|
| 1. One pair of prostates ..... | *E. kinneari.* |
| Two pairs of prostates ..... | 2. |
| 2. Spermathecal diverticula few, 2–4 ..... | 3. |
| Spermathecal diverticula many, 9–20 .... | 5. |
| 3. Testis sacs present ..... | *E. anomalus.* |
| Testes and funnels free ..... | 4. |
| 4. Genital markings as two papillæ, each surrounded by a groove, over 16/17 and 19/20 ..... | *E. kempi* typ. |
| Genital markings as two saucer-like depressions over 16/17 and 19/20 ..... | *E. kempi* var. *bifoveatus.* |

GSL



5. Spermathecal diverticula in two circles .. *E. inornatus.*
   Spermathecal diverticula in a single circle. 6.
6. Spermathecal diverticula 15–20 in number. *E. suctorius* typ.
   Spermathecal diverticula 9–12 in number.. *E. suctorius* var. *affinis.*

I have somewhat reduced the number of species, in which, as I now think, the variable genital markings were previously accorded undue weight.

### 1. Erythræodrilus anomalus (*Steph.*).

1920. *Hoplochætella anomala*, Stephenson, Mem. Ind. Mus. vii, p. 223, pl. x, figs. 25–29.

Length ca. 85 mm.; diameter 3 mm. Segments ca. 100. Colour pale, unpigmented or almost so. Prostomium epilobous $\frac{1}{3}$, tongue broad, not cut off behind. Dorsal pores from 4/5. Setal rings almost closed ventrally, dorsally the gap=4*yz* in front of the clitellum, 3*yz* behind it, 2*yz* in middle of body; setal intervals decrease somewhat from the midventral line outwards, so that *aa*>*ab*>*bc*>*cd*; numbers 36–44/viii, 40–46/xii, and ca. 40 in middle of body. Clitellum $\frac{1}{2}$xiii–$\frac{1}{2}$xvi (=3). On male area two pairs of crater-like depressions, with thickened and rounded

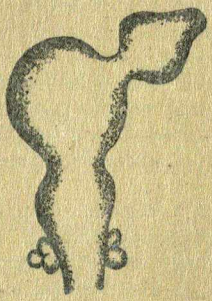

Fig. 250.—*Erythræodrilus anomalus* (Steph.); spermatheca.



Fig. 251.—*Erythræodrilus anomalus* (Steph.); tip of copulatory seta.

margins, rather oval in a transverse direction, on xvii and xix, longitudinally taking up the extent of the segment, transversely extending from *b* to *h*; the two depressions of a pair united by a transverse thickening; prostatic pores in the inner portions of the depressions, between *c* and *d*. There may be similar depressions, one or two, on xviii also. Female pore single, in front of the setal zone of xiv. Spermathecal pores two pairs, on small papillæ on viii and ix, in line with *c*, about one-fifth of the circumference apart, the pores of viii in front of the setal zone, those of ix in it. The setæ on the ventral surface of viii or ix may be displaced forwards or backwards.

Septa 11/12 and 12/13 perhaps somewhat thickened. Gizzard large, ovoid, firm, in vii. Calciferous glands in x–xiii, small, ovoid, set off from the œsophagus, those in x and xi within the testis sacs.

Intestine begins in xvi. Last heart in xii; no large vessel in xiii, but in xiv a pair of large vessels, given off from the dorsal vessel, perhaps distributed to the alimentary canal. Meganephridia from xx. Testis sacs in x and xi, enclosing alimentary canal and dorsal vessel, and in x also a pair of seminal vesicles. Seminal vesicles in ix, x, and xii. Prostates two pairs, the anterior occupying xvii–xviii, the posterior xix–xxi; ducts stouter than the glands, shining, rather short, straight, thinner at the ental end. The vasa deferentia of the same side pass backwards side by side, one ending near the termination of the anterior prostate, the other near that of the posterior. Small ovisacs in xiv. Two pairs of spermathecæ (text-fig. 250); the ampulla an irregular sac; duct stout, nearly as long as ampulla, thicker above, contracted and shiny below, set off from ampulla by a constriction; diverticula two, opposite, on the duct below the upper dilated part, sessile, each consisting of a few rounded seminal chambers. Clusters of finger-shaped accessory glands, 3–5 in each group, near the spermathecal duct. Copulatory setæ (text-fig. 251) associated with the accessory spermathecal glands; length 0·61 mm., diameter 22 $\mu$, almost straight, with a slight proximal curve, tapering and bluntly pointed distally; ornamentation as a few very fine oblique lines or semicircular markings near the tip.

*Remarks.* Differs from the other species of the genus in the manner of ending of the vasa deferentia, and more primitive in the greater separation of the spermathecal and of the prostatic pores of the same side. The presence of testis sacs may or may not be primitive. The species is similar to *E. kinneari* in having testis sacs, and in having the same number of seminal vesicles in the same positions, and may be the direct ancestor of the latter.

*Distribution.* Belgaum, Bombay Presidency.

2. **Erythræodrilus inornatus** (*Steph.*).

1917. *Hoplochætella inornata*, Stephenson, Rec. Ind. Mus. xiii, p. 395, pl. xvii, fig. 17.

Length 101 mm.; maximum diameter 6 mm. Segments 79. Colour light brown dorsally, pale ventrally. Prostomium epilobous (or perhaps may be tanylobous). Dorsal pores from 6/7. Setal rings closed dorsally, and almost so ventrally; setæ of viii–xii very small; numbers 84/v, 80/ix, ca. 84/xii, 85/xx, and 91 in middle of body. Clitellum ½xiii–xvi (= 3½), brown and markedly constricted. Prostatic pores two pairs, on xvii and xix, at the hinder and anterior borders respectively; small pits, fairly close together, broadly oval in outline, with distinct lip. Female pore as in *suctorius*. Spermathecal pores represented by two pairs of transversely oval papillæ on viii, between the setal zone and the anterior, and the setal zone and the posterior, limit of the segment respectively, not far from the middle line. Setæ of viii absent ventrally; a few dark dots on the posterior spermathecal papillæ may be displaced setæ.

Septa as in *suctorius*. A barrel-shaped gizzard in vi. Calciferous glands in x–xiii, small in the two anterior, large in the two posterior segments, kidney-shaped and attached by the hilus. Intestine begins in xvi; lymph-glands as in *suctorius*; a large, probably lymphoid mass on the œsophagus in xv. Last heart in xiii; vessels in xiv as in *suctorius*. Nephridia as in *kempi*. Anterior male organs disposed as in *suctorius*; anterior seminal vesicles very conspicuous, larger than the posterior. Prostates large, the anterior extending back to xxiii, the posterior to xxviii; ectal portion as a thin coiled duct, becoming thicker towards its end. Vasa deferentia separate to their ending, both end in connection with the termination of the anterior prostatic duct. Apparently a small ovisac in xiv. Spermathecal ampulla an irregular sac, narrower below, and continued into the duct with

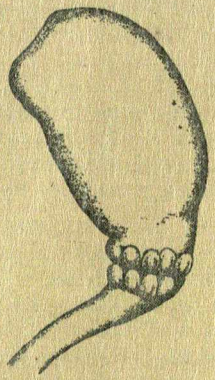

Fig. 252.—*Erythræodrilus inornatus* (Steph.); spermatheca.

no sharp demarcation; duct about half as long as ampulla, narrower towards ectal end; a double ring of small diverticula, about 20 in all, round junction of duct and ampulla (text-fig. 252). Accessory glands in region of prostatic apertures, three pairs, in xvii, xviii, and xix; those in xviii the largest, taking up whole length of segment; stalks short and stout, those of the glands in xvii and xix passing through the septa to join those of the glands in xviii. Accessory spermathecal glands in two groups of five each, each group between the ends of the spermathecæ of the same side, about the middle of the length of viii.

*Distribution.* Talewadi, near Castle Rock, W. India.

### 3. Erythræodrilus kempi (*Steph.*).

1917. *Hoplochætella kempi*, Stephenson, Rec. Ind. Mus. xiii, p. 392, pl. xvii, figs. 15, 16.

Length up to 103 mm.; diameter 4·5 mm. Segments 106. Colour rich brown dorsally with darker median stripe, pale

ventrally. Prostomium variable, epilobous $\frac{2}{5}$ to $\frac{4}{5}$, broad or narrow. Dorsal pores from 6/7. Setal rings with dorsal and ventral gaps; $aa=2\frac{1}{2}$ or $2ab$, $zz=2$–$3yz$; setæ on the average closer set ventrally; numbers 52/v, 56/x, 45/xx, and 44 in the middle of the body. Clitellum $\frac{1}{2}$xiii–xvi ($=3\frac{1}{2}$), darker than the rest of the surface. Ventral surface concave over xvii–xix;

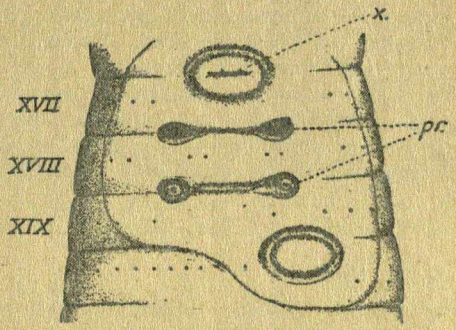


Fig. 253.—*Erythræodrilus kempi* (Steph.); male genital area; *x.*, papilla surrounded by groove; *pr.*, prostatic apertures.

prostatic pores in transversely oval pits in 17/18 and 18/19. Genital markings (text-fig. 253) as large, broadly oval papillæ, each surrounded by a groove; one over 16/17 midventrally or on the right side, and one over 19/20 and the anterior part of xx, on the left side; or only the posterior may be present. Female pore as

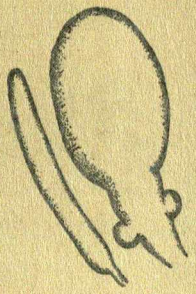

Fig. 254.—*Erythræodrilus kempi* (Steph.); spermatheca, represented with an accessory gland alongside.

in *suctorius*. Spermathecal pores two pairs, on viii, on papillæ; actual pores present apparently only at copulation and oviposition (so, too, in some or all the other species of the genus); the anterior pair in front of the setal zone, the posterior just in front of 8/9; both pairs rather near the middle line. Minute papillæ bearing setæ on vii and ix, usually in the setal zone, not displaced; a few displaced setæ apparently on the anterior pair of spermathecal papillæ themselves.

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Septa as in *suctorius*. Gizzard of moderate size, in vi. Calciferous glands large, stalked, in xii and xiii; smaller and more deeply placed in x and xi. Intestine begins in xvi; lymph glands as in *suctorius*. Last heart in xiii; a pair of commissures in xiv, as in *suctorius*. Meganephridia first plainly visible in xx; behind this micronephridia in a transverse band, though not in a single row. Anterior male organs as in *suctorius*; prostates also much as in that species. Vas deferens ends by entering body-wall just behind and external to prostatic duct. Spermathecal ampulla ovoid; duct only slightly set off, narrowing to its termination, rather shorter than the ampulla; diverticula two to four, about the middle of the length of the duct (text-fig. 254). Accessory glands numerous and conspicuous on inside of body-wall in spermathecal region, each elongated and cylindrical, with short narrow stalk.

*Distribution.* Talewadi, near Castle Rock, W. India.

*a.* var. **bifoveatus** (*Steph.*).

1917. *Hoplochætella bifoveata*, Stephenson, Rec. Ind. Mus. xiii, p. 398, pl. xvii, fig. 18.

1922. *Erythræodrilus kempi* var. *bifoveatus*, Stephenson, Rec. Ind. Mus. xxiv, p. 437.

As for type form, with the following exceptions:—

Colour light brown. Prostomium epilobous ½, broad. Dorsal pores from 5/6. Numbers of setæ 49/v, 62/x, 60/xii, ca. 50/xxii. Clitellar region much swollen, xvii and part of xviii also somewhat modified. Genital markings (text-fig. 255) as two large shallow saucer-like depressed areas over 16/17 and 19/20, in transverse

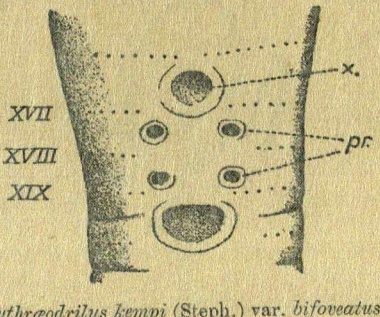


Fig. 255.—*Erythræodrilus kempi* (Steph.) var. *bifoveatus*; male genital field; *x.*, depression; *pr.*, prostatic pores.

extent each equal to the interval between the prostatic pores. Setæ absent from viii in midventral region; displaced setæ on all the papillæ of the spermathecal pores. An additional pair of papillæ on ix, in line with papillæ of spermathecal pores, with displaced setæ on them. Small accessory glands in neighbourhood of prostatic apertures, in front of and behind the terminations of each of the ducts.

*Distribution.* Talewadi, near Castle Rock, W. India; Bombay.

4. **Erythræodrilus kinneari** *Steph.*

1915. *Erythræodrilus kinneari*, Stephenson, Mem. Ind. Mus. vi, p. 100, pl. vii, fig. viii.
1917. *Erythræodrilus kinneari*, Stephenson, Rec. Ind. Mus. xiii, p. 402, pl. xvii, fig. 21.

Length 40–120 mm.; maximum diameter 2–3½ mm. Segments 64–112. Colour brown. Prostomium apparently prolobous. Dorsal pores from 3/4. Setæ small; $aa=1\frac{1}{2}ab$, $zz=2$–$3yz$; numbers 46/vi, ca. 53/ix, 43/xiv, 40/xix (or smaller numbers, 34–36). Clitellum ½xiii–⅔xvi (=3⅓); dorsal pores absent. Male pores on xvii, behind the setal ring, about in *cd*, ¼–⅐ of circumference apart, on whitish papillæ. A rectangular glandular area may be present ventrally on xvii, within which the pores are included. Female pore single, in front of setal zone of xiv. Spermathecal

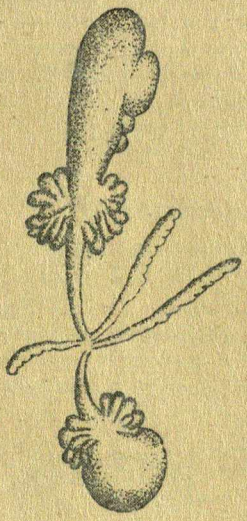

Fig. 256.—*Erythræodrilus kinneari* Steph.; spermathecæ of one side, with diverticula and spermathecal glands; the spermathecæ almost meet at their ectal ends on the body-wall in segment viii.

pores two pairs, those of each side nearly confluent at the level of the setal ring of viii, in or near *d*; or the anterior pair may end just in front of groove 7/8, or in the groove. Genital markings not constant, and may be absent: (1) a pair of small rounded papillæ on xviii behind the setal ring, very slightly internal to the position of the male pores; (2) a pair of oval patches with whitish periphery and dark centre, on vii, near the posterior border of the segment, its centre in line with *e*; (3) eye-like markings in 16/17 just internal to the line of the male papillæ.

Septa all present from 4/5, all thin. Gizzard ovoid, in vi. Calciferous glands four pairs, in x–xiii, those in x and xi smaller;

or three pairs in x–xii, with no marked difference in size. Intestine begins in xv or xvi. Last heart in xii or xiii; in xiv a vascular commissure like that in *suctorius*. Meganephridia begin in xx or xxi; micronephridia throughout the body, especially numerous on inner side of body-wall in clitellar region, and in iv and v in the form of conspicuous tufts at hinder end of pharynx. Testes and funnels in testis sacs in x and xi; the sacs of xi contain also the hearts, extending upwards towards the dorsal surface. Seminal vesicles three pairs, in ix, x, and xii. Prostates extending back several segments, to xix or xxi, thrown into a series of loops; duct thinner than glandular part. Two pairs spermathecæ (text-fig. 256); ampulla large, pear-shaped, continued into duct at its narrow end; duct about as long as ampulla, not set off; diverticula in two considerable clusters at base of ampulla, or two diverticula, each subdivided. Ducts of spermathecæ of the same side converge, backwards and forwards, and may almost meet at the middle of viii. Accessory glands (text-fig. 256), one, two or three, on each side, opening near spermathecæ, narrow, finger-like, stalked, the longest about half as long as a spermatheca.

*Distribution.* Castle Rock, W. India.

### 5. Erythræodrilus suctorius (*Steph.*).

1917. *Hoplochætella suctoria*, Stephenson, Rec. Ind. Mus. xiii, p. 388, pl. xvi, fig. 12, pl. xvii, figs. 13, 14.

Length 140 mm.; diameter 6 mm. Segments 145. Colour light brown dorsally, with darker median stripe; pale ventrally. Prostomium epilobous $\frac{2}{3}$, tongue not closed behind. Dorsal pores from 4/5. Setal rings with small dorsal and ventral gaps;

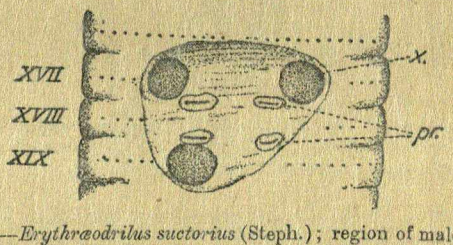


Fig. 257.—*Erythræodrilus suctorius* (Steph.); region of male pores; *x.*, suckerlike depression; *pr.*, prostatic apertures.

setæ of iii–viii enlarged; setæ more closely set ventrally; numbers 66/v, 66/ix, 63/xii, 60/xxi, and 58 behind middle of body. Clitellum not distinguishable. Male field (text-fig. 257) over xvii–xix, sunken, triangular with base anterior; containing the prostatic pores, in 17/18 and 18/19, transverse almost linear pits, fairly close together; and also three sucker-like circular or oval clean-cut depressions, a pair on xvii and a single one on xix, which latter

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may be in the middle line or not; or there may be a single depression on xvii and a pair on xix, in which case the triangle is reversed, the base being posterior. Female pore midventral on xiv, in front of the setal zone. Spermathecal pores (text-fig. 258) two pairs, transverse slits, their inner ends not far from the

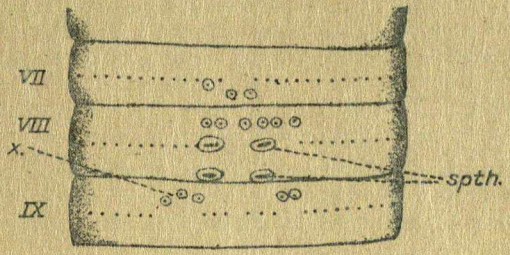


Fig. 258.—*Erythræodrilus suctorius* (Steph.); region of spermathecal apertures *x.*, group of displaced setæ; *spth.*, spermathecal apertures.

middle line, on viii, the anterior in the line of the setæ, the hinder just in front of groove 8/9. In the spermathecal region, on vii, viii, and ix, a number of minute papillæ, each with a black dot in its centre which is a displaced seta; these papillæ may be in front of, or less often behind, the setal zone; there are gaps in the regular line of setæ corresponding to the displaced setæ (text-fig. 258).

Septum 4/5 thin, 5/6–7/8 very thin indeed, 8/9 scarcely thickened; ix is a wide segment, 9/10, 10/11, and 11/12 are united together peripherally, giving the appearance of a single hugely thickened septum; 12/13 somewhat thickened. Gizzard in vi, large and subspherical. Calciferous glands in x–xiii, kidney-shaped,



Fig. 259.—*Erythræodrilus suctorius* (Steph.); spermatheca.

well set off, the two posterior pairs larger than the others. Lymph-glands similar to those of *Pheretima* over the intestine. Last heart in xiii; a pair of commissures, smaller than the hearts, in xiv. Micronephridia behind the genital region arranged in a transverse row; meganephridia from about xii backwards, but large and conspicuous from xx. Testes and funnels free in x and

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xi (between the fused septa, *v. ant.*). Seminal vesicles two pairs, slightly lobed, in ix and xii. Prostates two pairs, each a long looped tube longitudinally disposed, ending in a fusiform duct; the anterior occupying xvii–xxi, the posterior xix–xxv. Vas deferens joins the end of the ducts of the anterior pair. Spermathecæ (text-fig. 259) two pairs; ampulla sac-like, broadly ovoid; duct broad and short, not set off from ampulla; diverticula numerous, 15–20, in a circle round lower part of ampulla; ducts of anterior pair run back under peritoneal layer of body-wall before ending. Accessory glands near spermathecal apertures, projecting into body-cavity, club-shaped, about 1 mm. in length.

*Remarks.* The displaced setæ of the spermathecal region are rather longer and slenderer than the normal setæ of the region, with sharper tip and no distinct nodulus, and with well-marked sculpturings.

*Distribution.* Sanvordem, Portuguese India.

*a.* var. **affinis** (*Steph.*).

1917. *Hoplochætella affinis*, Stephenson, Rec. Ind. Mus. xiii, p. 399, pl. xvii, figs. 19, 20.

As for the type form, except as follows:—

Dorsal pores from 4/5 or 5/6. Setal rings with irregular and moderately large dorsal break, 4–5*yz* or less behind clitellum, 2–3*yz*

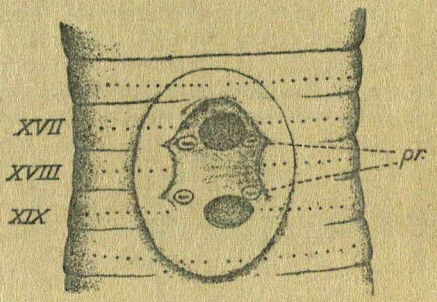


Fig. 260.—*Erythræodrilus suctorius* (Steph.) var. *affinis*; male genital region; *pr.*, prostatic apertures.

or less anteriorly and posteriorly; ventral break small and more regular; there may or may not be a tendency to coupling of the dorsal setæ; numbers 72/v, 80/ix, 74/xii, 65/xix, and 60 in the middle of the body. Clitellum indistinct, xiii–xvi or ½xiii–½xvi (= 3 or 4). Male area (text-fig. 260) saucer-like, depressed, oval with long axis longitudinal, with thickened lip, extending over xvii–xix (without the lip). Prostatic apertures on xvii and xix, near the posterior and anterior borders of the segments respectively. Two transversely oval dark slightly sunken patches, mid-ventral or almost so, on xvii and xix, the anterior between the

anterior prostatic pores, the posterior rather behind the posterior pores; or these patches may be represented by sunken flat papillæ, each surrounded by a groove, on 16/17 and 19/20 respectively. The anterior pair of papillæ of the spermathecal pores in front of the setal ring.

Anterior seminal vesicles very large and irregular in shape; posterior of moderate size. Prostatic ducts fine, much coiled, of some length, widening into a fusiform shining dilatation at the end. Spermathecal diverticula 9–12 in number, in an incomplete circle.

*Distribution.* Mormugao Bay, Portuguese India.

## Genus **HOPLOCHÆTELLA** *Mich.* gen. inquir.

1886. *Perichæta* (part.), Bourne, P. Z. S. 1886, p. 667.
1890. *Hoplochæta*, Beddard, P. Z. S. 1890, p. 57.
1895. *Hoplochæta*, Beddard, Monog. p. 368.
1900. *Hoplochætella*, Michaelsen, Tier. x, p. 321.
1909. *Hoplochætella* (part.), Michaelsen, Mem. Ind. Mus. i, p. 202.
1917. *Hoplochætella* (part.), Stephenson, Rec. Ind. Mus. xiii, p. 354.
1921. *Hoplochætella*, Michaelsen, Mt. Mus. Hamburg, xxxviii, pp. 34, 38.

Setal arrangement perichætine. One œsophageal gizzard. Calciferous glands? Excretory system? Sexual apparatus acanthodriline.

The genus was founded by Beddard for Bourne's *Perichæta stuarti*, shortly and somewhat enigmatically described in 1886; but Beddard withdrew the name again in 1895, apparently in the belief that we do not know enough about the worm to justify our assigning it to a definite genus. The name *Hoplochæta* given to it by Beddard being preoccupied was altered to *Hoplochætella* by Michaelsen in 1900, and Bourne's data were accepted and supplemented by a perhaps rather too venturesome assumption regarding the nephridia, concerning which Bourne had given no information; supposing these to be micronephridial, Michaelsen in 1909 united with *Hoplochætella* some species of New Zealand *Plagiochæta*.

In 1917 I identified generically several new species of Indian worms with *Hoplochætella*, and gave reasons for filling in the gaps of our knowledge of the type form *Perichæta stuarti* in a different way from that adopted by Michaelsen; I believed that the species of *Plagiochæta* have no close connection with *Hoplochætella*. More recently still, Michaelsen has expressed the opinion that Bourne would have mentioned calciferous glands if they had been present, at any rate if well marked (since he records a series of dorso-lateral swellings on the anterior part of the intestine), and hence that this worm is not, as I had thought, closely related to my species of *Erythræodrilus* which I first described under the

name *Hoplochætella*; he thinks it may be a *Howascolex*, in which the perichætine arrangement of the setæ, beginning in some Indian species, has attained completeness.

*Distribution.* Yercaud, near Salem, S. India.

1. **Hoplochætella stuarti** (*A. G. Bourne*).

1886. *Perichæta stuarti*, Bourne, P. Z. S. 1886, p. 667.
1889. *Perichæta stuarti*, Bourne, J. Asiatic Soc. Bengal, lviii, p. 110.
1890. *Hoplochæta stuarti*, Beddard, P. Z. S. 1890, p. 57.
1895. *Hoplochæta stuarti*, Beddard, Monog. p. 368.
1900. *Hoplochætella stuarti*, Michaelsen, Tier. x, p. 322.
1917. *Hoplochætella stuarti*, Stephenson, Rec. Ind. Mus. xiii, p. 354.
1921. *Hoplochætella stuarti*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 34.

Length 141 mm.; diameter 4·5 mm. Segments 111. Setæ in rings with small dorsal and ventral breaks, ca. 52 per segment; present on clitellum. Clitellum well marked, xiv–xvi (= 3). Prostatic pores two pairs, on xvii and xix, all contained in a whitish slightly depressed area, the male field, which extends over the greater portions of xvii and xix, and over the whole of xviii. Female pore single, on the anterior part of xiv. No special setæ in xviii; copulatory setæ on the anterior part of viii, a group on each side, on papillæ.

In xxiii–xxvi (?) four pairs of dorso-latèrally situated intestinal diverticula. Prostates two pairs, large, coiled, each extending back through eight or nine segments. Spermathecæ two pairs, in vii and viii; diverticula as a frill of seminal chambers round the base of the ampulla.

*Remarks.* The description dates from a good many years back, and it was impossible to foresee at that time what characters would ultimately be of systematic importance; consequently it is very defective. The original is probably wrong in placing the gizzard in segment x. The question as to how much we really know about this worm is discussed by me in my paper of 1917, and by Michaelsen in his of 1921.

Bourne says that the worm is exceedingly common; when opportunity offers it should certainly be sought for, and subjected to a complete examination.

*Distribution.* Yercaud, near Salem, S. India; in dry ground, often under large stones.

## Subfamily DIPLOCARDIINÆ.

1900. Diplocardiinæ+Trigastrinæ (part.), Michaelsen, Tier. x, pp. 324, 330.
1903. Diplocardiinæ+Trigastrinæ (part.), Michaelsen, Geog. Verbr. Olig. p. 106.
1909. Diplocardiinæ+Trigastrinæ (part.), Michaelsen, Mem. Ind. Mus. i, p. 123.
1910. Diplocardiinæ+Trigastrinæ (part.), Michaelsen, Abh. Ver. Hamburg, xix, p. 26.

1915. Diplocardiinæ + Trigastrinæ (part.), Michaelsen, Zweit. deutsch. Zent.-Afr. Exp. I, p. 186.
1921. Trigastrinæ, Stephenson, P. Z. S. 1921, p. 111.
1921. Diplocardiinæ, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 54.

Setal arrangement lumbricine. Two œsophageal gizzards, seldom united into one large one taking up more than one segment (in this case three pairs of large calciferous glands in xv–xvii).

A number of the forms included in the present subfamily were first put together by Michaelsen in 1895 as Benhamiacea (Verh. Naturw. Ver. Hamburg, (3) ii, p. 23), and later as Benhamini (1897, same journal (3) iv, p. 25). The name of this group appears as Trigastrinæ in the Tierreich volume.

In 1921 I proposed to reduce the content of this group by abstracting the genus *Eudichogaster*, which I placed in the Octochætinæ; the group came therefore to consist of *Trigaster*, *Dichogaster*, and the new genus *Monogaster*, established by Michaelsen for (at present) a single species, which is essentially a *Dichogaster* in which the two gizzards have fused into one. Since this group was only a small one, and since the genus from which it takes its origin, *Diplocardia*, was associated with only one other, *Zapotecia*, in the subfamily Diplocardiinæ, it seemed more convenient to unite the two subfamilies into one. The name of the combined group should doubtless be Diplocardiinæ, as Michaelsen has it, not Trigastrinæ, as written by me.

*Distribution.* The Diplocardiinæ of India are confined to the genus *Dichogaster*, which occurs scattered over the W. coast, in the extreme south, in Ceylon, in the region of the Ganges delta, and far inland only in E. Rajputana and Darjiling District. The only possibly endemic species are *D. travancorensis* and *D. curgensis*, and these must be considered as doubtful. Outside India the genus is endemic in Tropical Africa, the W. Indies, and Central America; but numerous species are found in the Malay Archipelago and Polynesia, which may not be endemic.

Of the other genera *Diplocardia* and *Zapotecia* are North American, *Trigaster* West Indian and Mexican, and *Monogaster* West African.

In the main line of descent of the Diplocardiinæ from the "original Acanthodriline," the first stage is reached in the genus *Diplocardia*, in which the gizzard is doubled; the next stage is represented by *Trigaster*, where, in addition to the previous change, the excretory system has become micronephric; the next stage is that of *Dichogaster*, where calciferous glands have been developed in segments xv–xvii; lastly, in *Monogaster* the two gizzards have fused into one again, while for the rest the anatomy is as in *Dichogaster*. The geographical argument also supports the above phyletic arrangement of the genera (*cf.* Stephenson, 95).

## 1. Genus **DICHOGASTER** *Bedd.*

1900. *Dichogaster*, Michaelsen, Tier. x, p. 334.
1921. *Dichogaster*, Stephenson, P.Z.S. 1921, p. 110.

Setæ paired, all ventrally situated; *cd* approximately equal to *ab*. Prostatic pores one to three pairs, on xvii, or xix, or xvii and xix, or on xvii, xviii and xix, in *ab* or medial from *a*. Spermathecal pores one or two pairs, in 7/8 and 8/9 or one of these. Two gizzards in front of the testis segments. Usually three, seldom two pairs of calciferous glands behind the ovarian segment, usually in xv–xvii, rarely xiv–xvi. Micronephridial.

The *Distribution* is given in the account of the subfamily.

The synonymy of the genus may be gathered from Michaelsen's Tierreich volume. It now includes the majority of the species formerly described as *Benhamia*. Essentially it embraces forms which are derived from the original Acanthodriline in having a double gizzard (the Diplocardia stage), micronephridia (the Trigaster stage), and calciferous glands behind the ovarian segment. The male organs may retain the acanthodriline condition (prostates opening on xvii and xix, vasa deferentia on xviii), or reduction may have taken place (disappearance of one pair of prostates, union of the ending of the vasa deferentia with the remaining prostatic orifices); the spermathecæ may remain as two pairs, or may be reduced to one pair along with the reduction of the prostates. (In one curious form there are three prostates, the vasa deferentia open on xvii, and the spermathecæ have been reduced to one pair.)

All the Indian and many of the other species of the genus are small worms, the dissection of which is often difficult, since they go down to a diameter of 1 mm. or so. Their small size helps to explain how it is that they are so frequently introduced into localities so far removed from their homes.

If the investigator feels inclined to resort to section-cutting instead of dissection, he should remember (1) that a single specimen may be quite spoilt in the cutting if there should be, as not infrequently, a quantity of earth in the anterior part of the alimentary canal; (2) that the penial setæ are among the best means for the discrimination of species, and that these are destroyed by section-cutting; (3) that the relations and shape of such things as the spermathecal diverticula, on which also much may hang, are better appreciated in a dissection than in a series of sections.

*Key to the Indian species of the genus* Dichogaster.

| | | |
|---|---|---|
| 1. | One pair of prostates | 2. |
| | Two pairs of prostates | 3. |
| 2. | Tip of penial setæ bent at a right angle | *D. crawi.* |
| | Tip of penial setæ not bent at a right angle | *D. saliens.* |

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| | | |
|---|---|---|
| 3. | All penial setæ of the same form..... | 4. |
| | Penial setæ of two or more forms ..... | 7. |
| 4. | Spermathecal diverticulum simple, or with seminal chambers massed together | 5. |
| | Spermathecal diverticulum with two separate seminal chambers ..... | *D. parva.* |
| 5. | Penial setæ ending in a small knob .... | *D. affinis.* |
| | Penial setæ not ending in a small knob-like thickening ..... | 6. |
| 6. | Spermathecal diverticulum arises from middle of length of duct ..... | *D. travancorensis.* |
| | Spermathecal diverticulum arises from ental end of duct..... | *D. curgensis.* |
| 7. | Spermathecal diverticula two, sessile.... | *D. bolaui* var. *malabarica.* |
| | Spermathecal diverticulum single ..... | 8. |
| 8. | One variety of the penial setæ is knobbed at the end ..... | *D. modigliani.* |
| | None of the penial setæ knobbed at the end. | 9. |
| 9. | Clitellum ring-shaped; gizzards in v and vi ..... | *D. malayana.* |
| | Clitellum saddle-shaped; gizzards in vii and viii ..... | *D. bolaui.* |

The prostates have been investigated by Stephenson and Haru Ram in *D. affinis* and *D. malayana* (92).

Certain species show a beginning of the condition found in the genus *Monogaster*, where the two gizzards are united into one. Thus in *D. malayana* the gizzards, in v and vi, are not well separated; in *D. bolaui* var. *malabarica* the alimentary tube is scarcely constricted between the two. No doubt other species would show various grades of the same condition if examined,—those species, at least, where the septum which should intervene between the two gizzards is wanting.

### 1. Dichogaster affinis (*Mich.*).

1903. *Dichogaster affinis*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 16.
1904. *Dichogaster affinis*, Michaelsen, Mt. Mus. Hamburg, xxi, p. 127.
1910. *Dichogaster affinis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 98.
1913. *Dichogaster affinis*, Stephenson, Spol. Zeyl. viii, p. 273.
1916. *Dichogaster affinis*, Stephenson, Rec. Ind. Mus. xii, p. 338.
1919. *Dichogaster affinis*, Stephenson and Haru Ram, Tr. Roy. Soc. Edin. lii, p. 451.
1920. *Dichogaster affinis*, Stephenson, Mem. Ind. Mus. vii, p. 258.

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1895. *Benhamia affinis*, Beddard, Monog. p. 567.
1900. *Dichogaster affinis*, Michaelsen, Tier. x, p. 345.

Length 30–32 mm.; diameter 1·2–1·5 mm. Segments ca. 140. Colourless. Prostomium epilobous. Dorsal pores from 5/6. Setæ closely paired; $aa = bc$, $dd$ = two-thirds of circumference. Clitellum saddle-shaped, xiii or xiv–xxi or xxii (= 8–10). Prostatic pores two pairs, on xvii and xix, in *ab*; seminal grooves

almost straight, each included by a whitish wall, which also includes the prostatic pores. Spermathecal pores two pairs, in *a*. One to three midventral papillæ, seldom wanting, eye-shaped, on 7/8–9/10, or 8/9 and 9/10, or one of the latter.

Septa 9/10–12/13 strongly, 8/9 and 13/14 more slightly thickened. Gizzards in vi and vii. Calciferous glands three pairs, kidney-shaped, in xv–xvii, the most anterior the smallest. Micronephridia in three or four longitudinal rows on each side. Testes and funnels two pairs, free. Seminal vesicles in x, xi, and xii. Prostates straight. Spermathecæ with very thick, fairly long duct, which bears immediately below its middle a small club-shaped diverticulum. Penial setæ thin, 0·3 mm. long, gently undulating, with knob-like distal end.

*Remarks.* The genital "papillæ" were scarcely such in some specimens I examined; each was an inconspicuous circular area, with a smaller circular marking in its centre. In one specimen I also found a small area similar to these between and behind the posterior prostatic apertures.

The specimen from Ceylon that I examined was found in rotten wood. It possessed one segment less than normal in the anterior part of the body, and the organs therefore appeared one segment further forwards than usual; possibly the first segment may have been retracted.

*Distribution.* Bombay and Baroda, in Western India; Shasthancottah and Trivandrum, Travancore; Peradeniya and Anuradhapura, Ceylon. Outside India it is known from E. Africa, Mozambique, Madagascar, the Comoro Is., Siam, Cape Verde Is., and Colombia.

2. **Dichogaster bolaui** (*Mich.*).

1900. *Dichogaster bolaui*, Michaelsen, Tier. x, p. 340.
1903. *Dichogaster bolaui*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 16.
1910. *Dichogaster bolaui* Michaelsen, Abh. Ver. Hamburg, xix, p. 98.
1916. *Dichogaster bolaui* subsp. *palmicola*, Stephenson, Rec. Ind. Mus. xii, p. 348.
1917. *Dichogaster bolaui*, Stephenson, Rec. Ind. Mus. xiii, p. 413.
1920. *Dichogaster bolaui*, Stephenson, Mem. Ind. Mus. vii, p. 257.

Length 20–40 mm.; diameter $1\frac{1}{3}$–$1\frac{1}{2}$ mm. Segments 78–97. Unpigmented. Prostomium proepilobous. Dorsal pores from 5/6. Setæ in general closely, towards the hinder end more widely paired; *dd* anteriorly $=\frac{2}{3}$ of circumference, in the hinder part little more than half the circumference. Clitellum saddle-shaped, xiii or xiv–xviii, xix or xx (= 5–8). Prostatic pores on xvii and xix; seminal grooves straight, bordered by flat walls. Female pore single, on a papilla. Spermathecal pores two pairs.

Gizzards in vii and viii. Calciferous glands three pairs, oval, in xv–xvii. Micronephridia in three or four longitudinal rows on

each side. Two pairs testes and funnels. One pair vestigial seminal vesicles in xi. Prostates almost straight. Spermathecal ampulla sac-like; duct thick, faintly set off; diverticulum small, club-shaped, joining the middle of the duct. Penial setæ of two forms: (i) 0·32 mm. long, 5 $\mu$ thick, with about eight sharp short teeth on the concave side of the distal end, tip slightly hooked; (ii) 0·27 mm. long, 5 $\mu$ thick, with slightly thickened distal end, which is broadened in the form of a spatula and hollowed (often apparently scalpel-shaped).

*Distribution.* Peradeniya (Ceylon); Ernakulam (Cochin), and Trivandrum (Travancore), in S. India; Rangamati, Sibpur, and Calcutta (Bengal); Junagarh (Kathiawar), Bombay, Bassein Rd., Baroda, in Western India; Bayana (E. Rajputana). It has a wide distribution outside India, including tropical Africa, N., Central, and S. America, and the W. Indies.

*a.* var. **malabarica** *Steph.*

1920. *Dichogaster bolaui* var. *malabaricus*, Stephenson, Mem. Ind. Mus. vii, p. 257.

Length 20–40 mm.; diameter 2¼ mm. Segments 86. Colour buff, unpigmented except for a dark middorsal stripe. Prostomium prolobous. Dorsal pores in 5/6, then absent till 11/12 which is vestigial, well marked from 12/13 onwards. In general $ab = \frac{1}{4}aa = \frac{1}{4}bc = cd$; in front of the clitellum the pairs are closer together, so that *dd*, which behind is about ⅓ of the circumference, increases. Clitellum xiii-xx (= 8); dorsally extends over part of xxi also; ring-shaped over xiii, thinned ventrally over xiv–xvi, thenceforward interrupted ventrally. Seminal grooves run in the interval between the lines *a* and *b*, are straight, and bordered by whitish thickened lips, the inner lips being almost contiguous in the middle line. Spermathecal pores ? Ventral surface of viii and perhaps of ix slightly thickened, and setæ rather irregular.

Septum 4/5 slightly strengthened, 5/6 and 6/7 perhaps absent, 7/8 thin, 8/9 and 9/10 perhaps slightly thickened. Gizzards in vii and viii. Calciferous glands in xv, xvi, and xvii, kidney-shaped. Intestine begins in xviii. Last hearts in xii. Testes and funnels in xi. Seminal vesicles small, racemose, in xii. Small ovisacs in xiv. Prostates and the two kinds of penial setæ as for type form. Spermathecæ with two small sessile diverticula attached about the middle of the duct.

*Remarks.* The chief distinctions from the type are the two spermathecal diverticula, the clitellum (which is not saddle-shaped throughout), and the anterior male organs (which, however, may not have been fully developed in the specimens I had for examination).

*Distribution.* Bombay.

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### 3. Dichogaster crawi *Eisen.*

1920. *Dichogaster crawi*, Stephenson, Mem. Ind. Mus. vii, p. 258.

1900. *Dichogaster crawi*, Eisen, P. Calif. Ac. (3) ii, p. 228, pl. x, figs. 82–94.
1900. *Dichogaster crawi*, Michaelsen, Tier. x, p. 346.
1913. *Dichogaster crawi*, Michaelsen, Ann. Natal Mus. ii, p. 418.
1916. *Dichogaster crawi*, Michaelsen, Ark. f. Zool. x, p. 19.

Length 40 mm.; diameter ca. 1·5 mm. Segments 120. Prostomium (pro-?) epilobous; segment i very short. Setæ closely paired; the median ventral interval *aa* contracted in the region of the prostatic pores, and less obviously also in the region of the spermathecal pores; *dd* greater than half the circumference; all setæ with four or more slight notches or spines near the apex. Dorsal pores from 3/4. Clitellum ring-shaped, less developed ventrally, $\frac{1}{2}$xiii–$\frac{1}{2}$xx (=7). Prostatic pores one pair, on papillæ on xvii, in *ab*, contained in a narrow median sunken area on xvi–$\frac{3}{4}$xviii, the area broader on xvii; openings of vasa deferentia close to the prostatic pores; in some specimens the pores are borne on a transverse oval elevation on xvii, and occasionally there is a similar elevation on xix. Spermathecal pores two pairs, in *ab*.

Septa 4/5 and 10/11–13/14 thickened slightly, 6/7–9/10 wanting, 11/12 and 12/13 double (abnormality?). Gizzards in vii and viii. Calciferous glands three pairs, in xv–xvii, discharging by a common duct on each side in xvi. Last hearts in xii. Micronephridia in four longitudinal rows on each side. Two pairs racemose seminal vesicles in xi and xii. Prostates confined to xvii, with long duct; ectal end of vas deferens as thick as prostatic duct. Spermathecal ampulla short and broad, with sharply demarcated duct which bulges all round below the ampulla, the part not included in the body-wall being about as long though not quite as broad as the ampulla; diverticulum with globular seminal chamber, hanging down, entering ental end of duct; sometimes two diverticula. Penial setæ 0·4-0·6 mm. long, thin, slightly bowed, distal end undulating, hair-like, with small terminal knob, bent at a right angle; the wavy outline is due to a series of ridges on each side, corresponding to grooves on the opposite side, the two series of ridges alternating.

*Distribution.* Pashok, Darjiling District. Outside India it has been found between the roots of greenhouse plants in California (the original discovery), where in one of the places (San Francisco) it was supposed, probably erroneously, to have been introduced from Hawaii; N.W. Australia; Natal (Pietermaritzburg).

### 4. Dichogaster curgensis *Mich.*

1921. *Dichogaster curgensis*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 54, text-fig. 6.

Length 65–75 mm.; maximum diameter ca. 2 mm. Segments 90–110. Colour an even grey, unpigmented. Prostomium

epilobous ca. $\frac{2}{5}$. Dorsal pores from 11/12 (perhaps more anteriorly). Setæ fine, closely paired; $aa=bc$; $dd=\frac{3}{4}$ circumference. Clitellum xiii–xx (= 8); may also include xii dorsally; ring-shaped, but less marked ventrally; when incompletely developed appears saddle-shaped; setæ *ab* of xvii, xviii, and xix absent. Male field depressed; prostatic pores on xvii, and xix, in line with *ab*; the seminal groove somewhat bowed inwards. Female pores in the position of setæ *a* on xiv. Spermathecal pores not obvious, two pairs, in 7/8 and 8/9, in line with *a*.

Septa 6/7–12/13 (?13/14) slightly thickened. Gizzards in vi and vii. Calciferous glands three pairs, in xv, xvi, and xvii; of approximately equal size, almost smooth. A moderately broad typhlosole. Funnels free in x and xi. Seminal vesicles? Prostates two pairs, confined to xvii and xix, the glandular portion simple, irregularly spindle-shaped; the duct short and thin. Spermathecal ampulla short and thick, passing into the duct, which is three times as long as ampulla, narrowing in its middle and ectal portions; diverticulum small, with three or four seminal chambers, with short and thin stalk entering the ental end of duct, the whole as long as the duct is thick. Penial setæ slender, 1 mm. long, 9 $\mu$ thick proximally, tapering gradually to a fine point; moderately bowed; distal portion undulating, whip-like, marked by a double series of scars, the proximal border of each of which is formed by a relatively broad but only slightly projecting tooth.

*Remarks.* Michaelsen considers this form to be perhaps identical with Fedarb's *Benhamia travancorensis*; and it does in fact seem probable that some of the apparent differences between the two are due to faulty description by the earlier author (*e.g.*, the position of the gizzards). The spermathecæ, however, seem to be of a different form, and the position of the calciferous glands and of the last heart may also be really different in the two.

*Distribution.* Moonad and Bhagamanola, Coorg.

### 5. Dichogaster malayana (*Horst*).

1916. *Dichogaster malayana*, Stephenson, Rec. Ind. Mus. xii, p. 346, pl. xxxiii, figs. 35, 36.
1919. *Dichogaster malayana*, Stephenson and Haru Ram, Tr. Roy. Soc. Edin. lii, p. 451, pl. fig. 9.

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1895. *Benhamia malayana*, Beddard, Monog. p. 569.
1900. *Dichogaster malayana*, Michaelsen, Tier. x, p. 341.

Length 20–30 mm.; maximum diameter 1·5 mm. Segments 92–95. Colour grey; clitellum darker. Prostomium with posterior projecting angle; segment i partly divided midventrally by a groove leading back from the border of the mouth. Dorsal pores from 5/6 or 6/7. Setæ closely paired, all ventral; $aa=bc=3ab=3cd$. Clitellum xiii–xx (= 8); brown in colour, but lighter along a midventral strip (perhaps thinner here); sharply marked off by

GSL



a constriction at both ends. Prostatic pores on xvii and xix, between *a* and *b* (or ? in *a*); seminal grooves with slightly wavy course; indications of faint transverse grooves between the two pores of the same segment. Spermathecal pores in 7/8 and 8/9, in *ab*.

Septum 4/5 the first, 7/8 the next; 10/11–12/13 slightly thickened. Gizzards in v and vi, not well separated, no septum attached between them. Calciferous glands in xv–xvii, all about the same size. Micronephridia in three or four longitudinal rows on each side, the ventralmost row the smallest; sometimes a fifth row of small nephridia ventral to the others; behind the clitellar region the nephridia have the form of flattened plates, in the clitellar region are more like the usual twisted tubes. Testes and

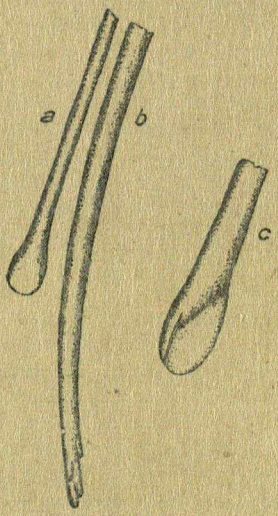


Fig. 261.—*Dichogaster malayana* (Horst); penial setæ; *a*, *b*, the two types numbered 1 and 3 in text; *c* (2 in text) resembles *a* except that the thin expansion is one-sided.

funnels free in x and xi. Seminal vesicles in x and xi, sometimes in xii also. Prostates in xvii and xix, vertically placed in the segments. Spermathecal ampulla small and ovoid, constricted from the duct; duct equal in size to the ampulla, pear-shaped, gradually narrowing ectally; diverticulum (apparently not always present) small, tag-like, at middle of length of duct on its anterior face. Penial setæ (text-fig. 261) of several types: (1) slender, 3·5 $\mu$ thick, shaft straight, distal end flattened and oar-like, 6 $\mu$ across; (2) 0·28 mm. long, 4 $\mu$ thick, like the last, but the terminal expansion one-sided; (3) stouter, 7 $\mu$ thick, distal portion gently curved, distal end with a few blunt projections on its sides and on the concavity of the curve; (4) a mixed type, with the tip

of the second and the stout shaft of the third type, with a gentle almost even curve, the length across the curve 0·3 mm., and thickness at the middle 6 $\mu$.

*Distribution.* Neyyatinkara, Travancore. Outside India has been recorded from numerous localities in the Malay Archipelago.

### 6. Dichogaster modiglianii (*Rosa*).

1910. *Dichogaster modiglianii*, Michaelsen, Abh. Ver. Hamburg, xix, p. 98.

1900. *Dichogaster modiglianii*, Michaelsen, Tier. x, p. 346.

Length 22 mm.; diameter 2 mm. Colour dark grey. Segments 76. Prostomium proepilobous; segment i almost divided by a dorsal median groove. Dorsal pores from 4/5. Setæ paired, all ventral; $aa=bc$. Clitellum xiii–xx (=8); only ring-shaped on xiii. Prostatic pores on xvii and xix; seminal grooves straight. Spermathecal pores two pairs.

Micronephridia in four longitudinal rows on each side behind clitellum. Spermathecal ampulla pear-shaped; duct twice as long as and somewhat thicker than ampulla; diverticulum small, of an elongated pear-shape, hanging down, attached to ental part of duct. Penial setæ of two kinds: (i) distal end slightly bent, with slightly thickened tip, with scale-like elevations situated above slight constrictions; (ii) smooth, distal end slightly bent, thread-like, with slightly thickened tip in the form of a knob.

*Distribution.* Calcutta (at the base of a leaf on the stem of a sago-palm). Outside India is known from Sumatra and New Britain (Neu Pommern).

### 7. Dichogaster parva (*Mich.*).

1903. *Dichogaster parva*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 15.

1895. *Benhamia parva*, Beddard, Monog. p. 571.
1900. *Dichogaster parva*, Michaelsen, Tier. x, p. 356.

Length 32 mm.; diameter 2 mm. Reddish in colour. Dorsal pores from 5/6 or still further forwards. Setæ closely paired, all ventral; $aa=bc$, $dd=\frac{5}{7}$ of circumference. Clitellum swollen, ring-shaped but less developed ventrally, $\frac{1}{2}$xii or xiii–xx (= 8 or $8\frac{1}{2}$). Prostatic pores two pairs, on xvii and xix, in *ab*; seminal grooves straight, bordered by fairly broad walls which at the ends surround the prostatic pores. Spermathecal pores two pairs in *ab*.

Calciferous glands three pairs, xv–xvii, narrowly bean-shaped, with several marked indentations on the convex side. Prostatic duct twice kinked. Spermathecal ampulla pear-shaped; duct short and thick; diverticulum short, tubular, ending entally in two seminal chambers which are separate from each other and spherical in shape, close together; diverticulum joins ental portion of duct. Penial setæ 0·75–0·9 mm. long, at proximal end 10 $\mu$

GSL



thick, in the middle 4$\mu$, and the distal end still thinner; the narrow distal end showing irregularly alternating obtuse feeble bends; ornamentation of longitudinal scars, a small rounded projection at the proximal end of each.

*Distribution.* Peradeniya, Ceylon. The original find was in Central Africa.

8. **Dichogaster saliens** (*Bedd.*).

1903. *Dichogaster saliens*, Michaelsen, Sb. Böhm. Ges. Prag, xl. p. 13, text-fig. F.

1895. *Microdrilus saliens*, Beddard, Monog. p. 506.
1900. *Dichogaster saliens*, Michaelsen, Tier. x, p. 343.

Length 25–40 mm.; diameter 1·5 mm. Segments 96–120. Unpigmented. Prostomium tanylobous, tongue narrow; groove 1/2 less marked than the other grooves. Setæ rather small, closely paired; $aa=bc$; $dd=\frac{2}{3}$ of circumference. Clitellum saddle-shaped, xiii–xix (= 7). Prostatic pores one pair, in the setal zone of xvii, in *a*, on halfmoon-shaped papillæ, which take up all xvii and the anterior fourth of xviii, their straight sides contiguous in the middle line. Spermathecal pores two pairs, inconspicuous, in 7/8 and 8/9, in *a*. Sometimes a pit, small, transversely situated, in 15/16.

Septa all thin; 10/11–13/14 somewhat thicker than the rest. Gizzards in vii and viii. Calciferous glands kidney-shaped, three pairs, in xv–xvii, with narrow ducts leading into the œsophagus, the anterior pair the smallest. Intestine begins in xviii. Micronephridia four or oftener five on each side behind the clitellum. Funnels in x and xi (apparently in testis sacs?). Seminal vesicles in xi and xii, racemose. Prostates in xvii, the glandular part thick and irregularly bent; duct thinner, fairly well demarcated. A hemispherical elevation internally corresponding to the groove in 15/16. Spermathecal ampulla small, ovoid; duct demarcated, double as long as ampulla, thin; diverticulum joining ental end of duct, narrowly pear-shaped, hanging down, half as long as duct. Penial setæ ca. 0·6 mm. long, 12$\mu$ thick proximally, slightly curved in the shape of a sabre, gradually tapering; distal fourth with wavy course, at each bend a stout, blunt, scale-like tooth; tip drawn out to a fine point, ending in a small knob.

*Distribution.* Peradeniya, Ceylon. Known outside India from several places in the Malay Peninsula and Archipelago (Penang, Singapore, Java).

9. **Dichogaster travancorensis** (*Fedarb*).

1898. *Benhamia travancorensis*, Fedarb, J. Bombay Soc. xi, p. 433, pl. i, figs. 6, 8, 9, 11, 12.
1900. *Dichogaster travancorensis*, Michaelsen, Tier. x, p. 353.

Length 75 mm.; diameter 2 mm. Segments 131. Dorsal pores "commence posteriorly." Setæ in pairs, very close together. Clitellum saddle-shaped, xiv–xxi (= 8).

Septa 9/10–13/14 thickened. Calciferous glands in xiv-xvi, pouch-shaped, the anterior the smallest, somewhat corrugated, with about six equal lobulations. Intestine begins in xvii. Last hearts in xiii. Spermsacs in xi and xii, very minute. Prostates fusiform, prolonged at one end into a narrower duct. Spermathecæ two pairs, with ovoid ampulla, constricted from the duct, which is thick and dilated, equal to the ampulla in length; diverticulum shortly cylindrical, sessile on the duct at the middle of the length of the latter. Penial setæ four times as long as the ordinary, ending in a fine whip-like end frequently bent into a hook.

*Remarks.* The account is unsatisfactory. It is scarcely clear whether the setal pairs are very close together, or the two setæ of a pair, probably the latter. According to the figure the prostates are in xvii and xix, but in the text they are said to be in xviii and xix. The gizzards are said to be in viii and ix; this is very far back. The spermathecæ, according to the figure, discharge at the hinder ends of the two gizzards respectively, *i. e.*, in 8/9 and 9/10, which would be quite abnormal; probably they discharge in 7/8 and 8/9, and the gizzards are in vii and viii. The meaning of the statement regarding the septa—that septa ix to xiv are thickened—may or may not be exactly what I have given above.

Michaelsen's recently described *D. curgensis* is possibly identical with this species.

*Distribution.* Travancore.

## Subfamily OCNERODRILINÆ.

1891. Ocnerodrilidæ, Beddard, Tr. Roy. Soc. Edin. xxxvi, p. 581.
1895. Ocnerodriliacea, Michaelsen, Verh. naturw. Ver. Hamburg, (3) ii, p. 23.
1895. Cryptodrilidæ (part.) + Acanthodrilidæ (part.), Beddard, Monog. pp. 506, 510, 515, 553.
1897. Ocnerodrilini, Michaelsen, Verh. naturw. Ver. Hamburg, (3) iv, p. 25.
1900. Ocnerodrilinæ, Michaelsen, Tier. x. p. 368.
1903. Ocnerodrilinæ, Michaelsen, Geog. Verbr. Olig. p. 118.
1921. Ocnerodrilinæ, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 58.

Setal arrangement lumbricine. Œsophagus in segment ix (rarely ix and x) with paired diverticula or with an unpaired ventral sac (calciferous glands, chyle-sacs). Meganephridial. Prostates tubular, one to three pairs, with single-layered gland epithelium. Sexual apparatus acanthodriline, or in varying degree microscolecine (male pores on xvii or xviii; prostatic pores one to three pairs, on xvii, xviii, and xix; exceptionally male and prostatic pores shifted three segments further back); male pores opening either separately from the prostatic pores (though sometimes close to them) or fused with the anterior pair. Spermathecal pores, when present, in 7/8 or 8/9 or both of these. Genital pores often unpaired, fused in the midventral line.

The recognition of the present group of forms as a special subdivision was first made by Beddard in 1891, when he created a separate family for the genus *Ocnerodrilus*. In his Monograph, however, he gave up this division; but it was adopted by Michaelsen, and has been generally recognized by subsequent writers. The distinguishing character of the group is the presence of a ventral diverticulum, or of a pair of such diverticula, of the alimentary canal in segment ix. Various changes, along the lines we are accustomed to see in other groups, have taken place in the various genera, but the above feature is common to all, and is evidence of their relationship.

Thus the primitive genus *Kerria* only differs from the primitive Acanthodriline in the possession of the subfamily characteristic,—the œsophageal sacs in segment ix,—and in being protandric. *Maheina*, in the Seychelles, is acanthodriline, but metandric, and has two pairs of œsophageal appendages. The genus *Ocnerodrilus* is to be derived from *Kerria* by the reduction of the posterior male organs from the acanthodriline to the microscolecine condition. *Gordiodrilus* comprises a group of species in which reduction of the posterior male organs is taking place in more than one way, but in none of which it is complete; the œsophageal sac is unpaired. In *Curgia* the microscolecine reduction is complete, and there are two unpaired œsophageal sacs, in ix and x; the genus is metandric. *Nannodrilus* retains the incomplete reduction of the posterior male organs, but differs from *Gordiodrilus* in the doubling of the gizzard. In *Nematogenia*, which possesses the two gizzards of *Nannodrilus*, the microscolecine reduction has been completed. *Pygmæodrilus* (which like *Kerria*, *Maheina*, and *Nannodrilus* does not occur in India) differs from the rest of the subfamily in having true diverticula on the spermathecal duct; its origin is uncertain.

*Distribution.* While *Ocnerodrilus* is widely spread throughout India, the other three genera found in India are restricted to the South and Ceylon. Outside India the subfamily is found in the warmer regions of America and Africa—California and Arizona to Central Chile and the Argentine; Egypt and Upper Guinea to Natal; *Maheina* in the Seychelles. Certain forms are peregrine, *e. g.*, two out of the four found in India. A number of species are limnic in habitat.

*Key to the Indian genera of* Ocnerodrilinæ.

| | | |
|---|---|---|
| 1. | Œsophageal sacs in ix and x | *Curgia.* |
| | Œsophageal sacs in ix only | 2. |
| 2. | Male pores on xviii | *Gordiodrilus.* |
| | Male pores on xvii | 3. |
| 3. | Two gizzards in vi and vii | *Nematogenia.* |
| | No gizzard | *Ocnerodrilus.* |

## 1. Genus **CURGIA** *Mich.*

1921. *Curgia* (typ. *C. narayani*), Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 59.

Setæ closely paired. Prostatic pores one pair on xvii. Spermathecal pores one pair in furrow 8/9. An œsophageal gizzard in vii; two unpaired ventral chyle-sacs with narrow tubular central lumen in ix and x. One pair of testes and funnels in xi. Spermathecæ without diverticulum.

The genus has recently been established by Michaelsen for *C. narayani*. It differs from all the previously known species of the subfamily, except *Maheina braueri*, in possessing chyle-sacs in two segments instead of in only one; these sacs agree in structure with those of *Gordiodrilus*, the central lumen being narrow and tubular, and the thick wall being traversed in a longitudinal direction by numerous chyle-canals. The only other point of difference from *Gordiodrilus* is that the male apparatus is in *Curgia* purely microscolecine.

The presence of two or three unpaired œsophageal sacs, of similar structure to those of the Ocnerodrilinæ, in the Eudrilinæ was one of the reasons which caused Michaelsen to derive these latter from the former. The discovery of the genus *Curgia*, with two sacs in segments ix and x, diminishes the distance between the two subfamilies.

*Distribution.* Coorg, S. India.

### 1. Curgia narayani *Mich.*

1921. *Curgia narayani*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 59.

Length ca. 100 mm.; diameter ca. 0·7–0·9 mm. or more; long, thread-like, hinder end gradually tapering. Segments ca. 230. Colour whitish. Prostomium epilobous ½, not cut off behind. Setæ closely paired; *aa*=*bc*, *dd*=half the circumference. Nephridiopores in *ab*. Clitellum ? Male pores (? prostatic pores) as whitish papillæ on xvii in *ab*, apparently close behind the setal zone; setæ *ab* of segment xvii apparently absent. Female pores inconspicuous, anteriorly on xiv in the line *b*. Spermathecal pores one pair, in 8/9 in *b*.

Septa 6/7 and 7/8 somewhat thickened; one or two in front and behind these also slightly thickened. Gizzard cylindrical, in vii. Œsophagus swollen and vascular in viii, ix, and x; chyle-sacs in ix and x, ventral, unpaired, sessile, the axial canal communicating with the œsophageal lumen, and around this "chylus-tubes" and blood-vessels. Intestine beginning in xii; no typhlosole. Last heart in xi. Meganephridial. Testes and funnels free, one pair, in xi. Seminal vesicles, one pair, elongated, simple, and sac-like, occupying xii and xiii. Copulatory bursæ projecting inwards in xvii, and receiving vasa deferentia. Prostates one pair, long, tubular, irregularly undulating and winding; beginning behind in xxii; the duct short, not sharply set off.

Spermathecæ in ix, elongated, tubular, curved and winding; ampulla long; duct shorter, not sharply set off, not much thinner than ampulla; no diverticulum.

*Distribution.* R. Hatti, Madapur, Coorg.

## 2. Genus **GORDIODRILUS** *Bedd.*

1895. *Gordiodrilus*, Beddard, Monog. p. 506.
1900. *Gordiodrilus*, Michaelsen, Tier. x, p. 373.

Vasa deferentia ending on xviii. Prostatic pores one or two pairs; one pair of prostatic pores approximated to the male pores; either the anterior or the posterior or the only pair may be so approximated (in one case fused), so that the prostatic pores are on xvii and xviii, or xviii and xix, or only on xviii; the whole of the pores of the male apparatus may be displaced backwards for three segments. One or no gizzard. A single ventral œsophageal sac in ix. Spermathecæ without diverticula on the duct, often with evaginations at the ectal end of the ampulla.

*Distribution.* Nedumangad, Travancore. Outside India is endemic in Equatorial E. and W. Africa, and in Dominica in the W. Indies.

### 1. Gordiodrilus travancorensis *Mich.*

1910. *Gordiodrilus travancorensis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 98.

Length 32 mm.; maximum diameter $\frac{2}{3}$ mm. Segments 84. Unpigmented, light grey in colour. Prostomium epilobous $\frac{1}{2}$; tongue triangular, pointed behind. Setæ fairly closely paired; *aa* very little greater than *bc*, and on xviii and xix *aa* is much diminished; *dd*=half of circumference. Clitellum saddle-shaped, or at least slightly developed between the lines *aa*, $\frac{1}{4}$xiii–xix (=$6\frac{1}{2}$) (so orig.). Prostatic pores two pairs, on small wart-like papillæ in the situation of the missing setæ *b* of xviii and xix; setæ *a* of these segments well developed, but displaced more medianwards; seminal grooves straight, bounded by low walls. Male pores apparently confluent with the anterior prostatic pores. Female pores in front of setæ *ab* of xiv. Spermathecal pores two pairs, in 7/8 and 8/9, in line with *b*.

Septa 6/7–8/9 much thickened, 5/6 and 9/10 slightly so. No gizzard. A large median diverticulum depends from the œsophagus in ix; this has the usual structure in the genus—a fairly narrow lumen lined by cylindrical epithelium, and a thick wall penetrated by blood-vessels. Intestine begins in xiii. Testes and funnels in x and xi. Seminal vesicles one pair, in xii. Prostates two pairs, ending in xviii and xix, slender, moderately long, irregularly coiled, with short narrow duct. Spermathecal ampulla sac-like; duct narrow, about as long as ampulla.

*Remarks.* This species comes near *G. zanzibaricus*, and also has relations with *G. madagascariensis*; it thus illustrates a faunal relationship between India and East Africa.

*Distribution.* Nedumangad, Travancore.

### 3. Genus **NEMATOGENIA** *Eisen.*

1895. *Ocnerodrilus* (part.), Beddard, Monog. p. 510.
1900. *Nematogenia*, Michaelsen, Tier. x, p. 376.

Male pores on xvii. Prostatic pores one pair, on xvii, fused with the male pores. Spermathecal pores one pair, in or immediately behind 8–9. Two gizzards, in vi and vii. One pair of œsophageal sacs in ix. One pair of testes and funnels free in xi. Spermathecal duct without diverticulum.

*Distribution.* In India found only at Peradeniya in Ceylon; doubtless introduced into the Botanical Gardens there. Outside India the genus is known from the Cameroons and Central America.

#### 1. **Nematogenia panamaensis** (*Eisen*).

1903. *Nematogenia panamaensis*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 16.

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1900. *Nematogenia panamaensis*, Michaelsen, Tier. x, p. 376.

Length 55–75 mm.; diameter 2 mm. Segments 110–120. Dorsal pores from 10/11. Clitellum from ½xiii, ⅓xiii, or xiv to xxi or xxii (= up to 9½); saddle-shaped, with however only a small ventral interval, except on xxii; this deficiency is filled up by a swelling of the surface; setæ *ab* absent on xvii. Prostatic pores as transverse slits on transversely oval papillæ, which are set on a raised cushion-like diamond-shaped median genital area; male pores open on the same papillæ as and close to the prostatic pores. Spermathecal pores anteriorly on ix, in *ab*.

Septum 4/5, the first, thin; 6/7–8/9 moderately strongly thickened, 5/6 and 9/10 less so. Two very small gizzards in vi and vii. Postclitellar nephridia with an investment of cœlomic cells. One pair of free testes and funnels in xi. One pair racemose seminal vesicles in xii; ectal end of vas deferens not thickened. Prostates very long, reaching as far as xxxiii; the duct much shorter but only a little thinner than the glandular part. Spermathecal ampulla ovoid; duct very thin, shorter than ampulla; no diverticulum.

*Distribution.* Peradeniya, Ceylon. Outside India is known from Panama and the Cameroons.

### 4. Genus **OCNERODRILUS** *Eisen.*

1895. *Ocnerodrilus* (part.), Beddard, Monog. p. 510.
1900. *Ocnerodrilus*, Michaelsen, Tier. x, p. 377.

Male pores on xvii; prostatic pores one pair on xvii, fused with the male pores; seldom a second pair on xviii. Spermathecal pores one pair or absent. No gizzard. One pair of œsophageal sacs in ix, of simple constitution. Spermathecæ without diverticulum.

*Distribution.* The single species found in India is widely distributed, from Ceylon in the S. to Mardan in the extreme N., from Bombay in the W. to the Andamans in the E. The genus is endemic in America from California to Paraguay, and in the W. Indies; it has been found in S. Africa (Natal).

The genus may be divided into four subgenera: subgenus *Ocnerodrilus*, with two pairs of testes and funnels, the testes enclosed in testis sacs which are formed around them so as to exclude the funnels, without seminal vesicles, without spermathecæ; *Liodrilus*, with two pairs of free testes and funnels, and one pair of spermathecæ opening in 7/8; *Ilyogenia*, with two pairs of free testes and funnels, and one pair of spermathecæ opening in 8/9; and *Haplodrilus*, with one pair of free testes and funnels, in x, and a pair of spermathecæ opening in 8/9.

#### 1. Ocnerodrilus (Ocnerodrilus) occidentalis *Eisen.*

1910. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Michaelsen, Abh. Ver. Hamburg, xix, p. 100.
1914. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Stephenson, Rec. Ind. Mus. x, p. 361.
1916. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Stephenson, Rec. Ind. Mus. xii, p. 348.
1919. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Stephenson & Haru Ram, Tr. Roy. Soc. Edin. lii, p. 451, pl. fig. 10.
1919. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Stephenson & Prashad, Tr. Roy. Soc. Edin. lii, p. 463, pl. figs. 3, 4.
1920. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Stephenson, Mem. Ind. Mus. vii, p. 258.

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1895. *Ocnerodrilus occidentalis*, Beddard, Monog. p. 512.
1900. *Ocnerodrilus* (*Ocnerodrilus*) *occidentalis*, Michaelsen, Tier. x, p. 377.

Length 15–30 mm. (up to 36 mm. when living and moderately extended); diameter 1 mm. Segments 70. Clitellum ring-shaped, xiii or xiv–xix or xx (= 6–8). Male pores on small papillæ on xvii, immediately lateral to the line of setæ *b*.

Septa 5/6–11/12 thickened, 6/7–9/10 fairly strongly, the others gradually less. Septal glands in v–viii approximately of the same size. Œsophageal sacs with single lumen, imperfectly divided up by folds of the wall which project to a greater or less distance into the cavity. Two pairs testes, enlarged and dissolving into

masses of spermatozoa at their free ends, and surrounded by a peritoneal membrane after the manner of a testis sac. No seminal vesicles apart from these testis sacs. Ectal end of vasa deferentia not thickened. Prostates long and thick, extending through several segments beyond the clitellar region posteriorly. No spermathecæ.

*Remarks.* Eisen established a var. *arizonæ*, with the following characters:—"Septa 5/6–7/8 very slightly, 8/9–11/12 slightly thickened. Septal glands of various sizes, those in viii much smaller than those in front. Prostates small, not extending behind the clitellar region. Length 15–25 mm." Michaelsen does not agree in assigning an independent status to the variety; for example, he finds that the septal glands of segment viii may be only a little smaller than those of the preceding segments, and thus such specimens would be intermediate between the type form and the supposed variety. In this I agree (**75, 93**).

I have given an account of the vascular system (**75**); with Haru Ram, of the development of the prostate (**92**); and with Prashad, of the chyle-sacs (calciferous glands) (**91**). For a comparison of the testis sacs with those of other Oligochæta, see a discussion in Stephenson (**100**).

*Distribution.* Mardan and Rawal Pindi (Punjab); Kotah (Rajputana); Bombay; Andaman Is.; Nedumangad (Travancore); Panadhure (Ceylon). Outside India the species is known from N. America and Africa, including the Cape Verde Is. and Comoro Is. It is thus a widely peregrine species.

## Subfamily EUDRILINÆ.

1895. Eudrilidæ, Beddard, Monog. p. 573.
1900. Eudrilinæ, Michaelsen, Tier. x, p. 387.

Setal arrangement lumbricine. Clitellum beginning with or in front of xv, extending over two to six segments. Male pores and spermathecal pores single or one pair, male pores on xvii or xviii, spermathecal pores on x or further back. Meganephridial. Prostates as "euprostates", not reducible to the acanthodriline type, the vasa deferentia entering the ental end of the gland or some other point in its extent. Female genital apparatus distinguished by a more or less close relation of the spermathecæ to the other female organs—ovaries, oviducts, funnels, and ovisacs—fusion and connection by means of cœlomic tubes and chambers; the lowest grade of this condition consists in the approximation of the spermathecæ to the other organs.

*Distribution.* The group has its home in tropical and subtropical Africa; the one species found in India is widely peregrine.

The present subfamily presents many peculiarities of organisation, which, since there is only one peregrine species in India, cannot be discussed here.

Michaelsen derives the group from the Ocnerodriline branch of the Megascolecid stem (**45**, p. 115).

The subfamily is again divided by Michaelsen into Pareudrilacea and Eudrilacea. For the distinctions between these, *cf.* **45**, p. 116; and for a discussion of the characters of the Eudrilacea, to which the Indian species belongs, **130**, p. 231.

### 1. Genus **EUDRILUS** *E. Perr.*

1895. *Eudrilus*, Beddard, Monog. p. 603.
1900. *Eudrilus*, Michaelsen, Tier. x, p. 401.
1915. *Eudrilus*, Michaelsen, Zweit. deutsch. Zent.-Afr. Exp. I, i, p. 239.

Setæ closely paired. Male pores and spermathecal pores paired, the latter some distance in front of the former. Separate female pores not present (fused with the spermathecal pores). Gizzard in front of 7/8; two unpaired œsophageal sacs in x and xi, one pair of calciferous glands in xii. Holandric. No penial setæ. Sexual organs completely paired. Oviduct (stalk of ovisac) united ectally with the spermathecæ without separate opening to the exterior.

*Distribution.* Equatorial W. Africa. The species which is found in India has been distributed over the whole tropical belt.

#### 1. **Eudrilus eugeniæ** (*Kinb.*).

1897. *Eudrilus eugeniæ*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 41.
1898. *Eudrilus eugeniæ*, Fedarb, J. Bombay Soc. xi, p. 431.
1898. *Eudrilus eugenia* (laps.), Michaelsen, Zool. Jahrb. Syst. xii, p. 144.
1900. *Eudrilus eugeniæ*, Michaelsen, Tier. x, p. 402.
1903. *Eudrilus eugeniæ*, Michaelsen, Sb. Böhm. Ges. Prag, xl, p. 16.
1910. *Eudrilus eugeniæ*, Michaelsen, Abh. Ver. Hamburg, xix, p. 100.

Length 32–140 mm.; diameter 5–8 mm. Segments 145–196. Colour brown and red to dark violet. Prostomium epilobous $\frac{1}{2}$. Setæ lateral and ventral; *aa* somewhat greater than *bc*. Clitellum ventrally somewhat less strongly developed, xiii or xiv–xviii (= 5 or 6). Male pores immediately in front of 17/18, in *ab*. Spermathecal pores fused with the female pores, immediately behind 13/14.

Prostates with markedly set off narrow duct, sharply set off from copulatory sacs; these sacs with Y-shaped appendages. The muscular atrium-like cavity of the spermathecæ with only one proper diverticulum, fairly close to the ental end and opposite the ovisac. Ovisac with long undulating stalk; the tube which leads from the ovarian chamber opens into the ectal end of the spermathecal ampulla.

*Distribution.* Colombo, Peradeniya, Kandy, W. Province, Bentota, Panadhure (all in Ceylon). Fedarb's specimens may have come from Travancore, Poona, or N. Konkan—locality not stated.

## Family LUMBRICIDÆ.

1895. Lumbricidæ + Geoscolicidæ (excl. gen. *Ilyogenia*), Beddard, Monog. pp. 622, 687.
1900. Lumbricidæ + Glossoscolecidæ, Michaelsen, Tier. x, pp. 420, 470.
1917. Lumbricidæ, Michaelsen, Zool. Jahrb. Syst. xli, p. 3.

Asexual reproduction by production of zones of budding and chains of individuals does not occur. Normal setæ S-shaped, usually eight per segment, seldom more. Male pores mostly intra- or anteclitellar. Spermathecal pores never only in 4/5, partly at least further back, if not altogether wanting. Clitellar epidermis never of only one layer of epithelium. Meganephridial; as a rule only one pair, seldom two pairs of nephridia per segment. Testes and funnels in x and xi or one of these; ovaries and funnels in xiii, very seldom a second pair of ovaries in xii. Prostates as a rule wanting (if present—*Kynotus*, *Glyphidrilus*, *Callidrilus*—spermathecal pores in groups of several or of several pairs behind the testis segments).

The union of the two groups Glossoscolecidæ and Lumbricidæ was first carried out by Michaelsen in 1897 (Mt. Mus. Hamburg, xiv, pp. 57, 68), who made them two subfamilies, Geoscolecini and Lumbricini, of the family Lumbricidæ. In the Tierreich volume however he reverted to the old arrangement of the two families; but more recently still he has again united them (1916, *sup.*).

The close connection between the two groups has long been recognized; a full discussion of the relationships between the two, and of the origin of the family and its relations to other families, will be found in the paper just quoted. Since the number of Lumbricidæ (incl. Glossoscolecidæ) in India is so small, and especially since even of these such a small proportion are endemic, the family can scarcely be looked upon as a proper part of the Indian fauna; and it would therefore be out of place to enter on a lengthy discussion of questions of classification, relationships, and origins; this would bring in references to numerous genera which are not found in India, and the whole subject must therefore be studied in Michaelsen's paper. The result of Michaelsen's argument is to establish the Lumbricidæ in the old sense as a subfamily of the Family Lumbricidæ *sensu lato*, and to make it, as the Lumbricinæ, the equivalent of the subfamilies Glossoscolecinæ, Sparganophilinæ, Microchætinæ, Criodrilinæ and Hormogastrinæ.

In Michaelsen's last scheme (*cf.* p. 38) all the above subfamilies are given family rank, so that here the term Lumbricidæ has again the same content as in the Tierreich.

The *Distribution* of the family Lumbricidæ *s. l.* takes in the whole world with the exception of the Australian region and Polynesia. The various subfamilies have however each their own well-defined regions, which are broadly as follows.

The phyletically oldest group, the Glossoscolecinæ, occupies Tropical S. America and the southern part of Central America; the Sparganophilinæ, N. America, with two species in England; the Microchætinæ have a more scattered distribution—the older genera in S. Africa and Madagascar, the aquatic *Callidrilus* and *Glyphidrilus* in Tropical E. Africa, the latter having also spread into India, Further India, and the Malay Archipelago, *Driocrilus* in Tropical S. America and southern Central America, and *Alma* in Tropical W. and Central Africa and Egypt; the Criodrilinæ inhabit a region which extends from England to Palestine (? to India); the Lumbricinæ are endemic in temperate Eurasia and in the eastern part of N. America; and the Hormogastrinæ on both sides of the western Mediterranean.

*Key to the Indian subfamilies of* Lumbricidæ.

| | |
|---|---|
| 1. No obviously developed intestinal gizzard .... | 2. |
| An obvious intestinal gizzard present ..... | LUMBRICINÆ. |
| 2. Genital setæ, if present, are not grooved .... | 3. |
| Genital setæ present, with longitudinal grooves. | CRIODRILINÆ. |
| 3. Spermathecæ at least partly in front of the testis segments, or wanting ..... | GLOSSOSCOLECINÆ. |
| Spermathecæ behind the testis segments; in addition, sometimes other, vestigial, spermathecæ in the region of the testis segments .. | MICROCHÆTINÆ. |

## Subfamily GLOSSOSCOLECINÆ.

1900. Glossoscolecinæ, Michaelsen, Tier. x, p. 420.
1917. Glossoscolecinæ, Michaelsen, Zool. Jahrb. Syst. xli, p. 54.

Genital setæ, if present, not grooved longitudinally. Male pores usually intraclitellar, seldom (*Opisthodrilus*) postclitellar. Spermathecal pores, if not altogether absent, wholly or at any rate partly in front of the testis segments. A single œsophageal gizzard present. Calciferous glands ("chyle sacs") present.

*Distribution.* The subfamily is endemic only in Central and S. America as far as the Argentine, in the Bermudas and W. Indies. The only Indian species is *Pontoscolex corethrurus*, which has been carried all over the Tropics, where it is found on islands or near the coasts.

### 1. Genus **PONTOSCOLEX** *Schmarda.*

1895. *Pontoscolex*, Beddard, Monog. p. 653.
1900. *Pontoscolex*, Michaelsen, Tier. x, p. 424.
1917. *Pontoscolex*, Michaelsen, Zool. Jahrb. Syst. xli, p. 233.

Setæ at the hinder end of the body usually (? always) arranged in quincunx. Male pores and copulatory papillæ in the region of the clitellum. Three pairs of chyle-sacs in vii–ix, of complicated structure, originating dorsally. Nephridia with terminal sphincter.

Sexual apparatus metandric and metagynous; seminal vesicles very long, piercing the successive septa for a long distance.

*Distribution.* For the Indian distribution see under the species. The original home of the genus is Central America.

Michaelsen considers it doubtful whether the quincunx arrangement in the hinder part of the body is a generic character; there are specimens which show the regular arrangement in pairs throughout the body. These however may possibly have been injured, and the regenerated part may have produced setæ with the paired arrangement, similar to that in the anterior part of the body.

1. **Pontoscolex corethrurus** (*Fr. Müll.*).

1897. *Pontoscolex corethrurus*, Michaelsen, Mt. Mus. Hamburg, xiv, p. 247.
1898. *Pontoscolex corethrurus*, Michaelsen, Zool. Jahrb. Syst. xii, p. 144.
1900. *Pontoscolex corethrurus*, Michaelsen, Tier. x, p. 425.
1903. *Pontoscolex corethrurus*, Michaelsen, Sb. Böhm. Ges. Prag, xl. p. 16.
1904. *Pontoscolex corethrurus*, Michaelsen, Mt. Mus. Hamburg, xxi, p. 127.
1909. *Pontoscolex corethrurus*, Michaelsen, Mem. Ind. Mus. i, p. 244.
1910. *Pontoscolex corethrurus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 101.
1913. *Pontoscolex corethrurus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 92.
1915. *Pontoscolex corethrurus*, Stephenson, Mem. Ind. Mus. vi, p. 105.
1916. *Pontoscolex corethrurus*, Stephenson, Rec. Ind. Mus. xii, p. 349.
1917. *Pontoscolex corethrurus*, Michaelsen, Zool. Jahrb. Syst. xli, p. 234.
1920. *Pontoscolex corethrurus*, Stephenson, Mem. Ind. Mus. vii, p. 258.
1921. *Pontoscolex corethrurus*, Michaelsen, Mt. Mus. Hamburg, xxxviii, p. 68.
1922. *Pontoscolex corethrurus*, Stephenson, Rec. Ind. Mus. xxiv, p. 440.

Length 60–120 mm.; diameter 4 mm. Segments 90–212. Unpigmented. Prostomium with segment i retractile. Setæ slightly ornamented, transversely grooved at the tip (ornamentation often worn away); in the anterior part of the body closely paired, and exceptionally so throughout the body; usually from about x or xii onwards the pairing is wider, and in the hinder part of the body the setæ are alternately widely and closely paired, with a quincunx arrangement. Setæ in the hinder part of the body much enlarged, with straight distal end; in the clitellar region more strongly ornamented. Nephridiopores in *c*. Clitellum xv or xvi–xxii or xxiii (= 8 or 9); thickened ridges ("walls") xix–xxii, outside the line of *b*. Male pores on 20/21 or immediately behind this. Spermathecal pores three pairs, in 6/7–8/9, in *c*.

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Septa 5/6 (?), 6/7–10/11 thickened, the first fairly strongly, the last two gradually less. Last heart in xi. Spermathecæ very slenderly club-shaped.

*Remarks.* In a worm probably belonging to this species (there is no other Indian worm which has the quincunx arrangement of the setæ) I found the nephridia of segment ii opening into the pharynx; they would therefore be peptonephridia. According to Beddard these nephridia open on the surface of the body on segment ii, though owing to the great retractility of the anterior end of the body this orifice may come to lie in a temporary buccal cavity.

I found the septum 10/11 thin, and 9/10 absent; there was also some irregularity in the attachment to the parietes.

*Distribution.* Hyderabad, Deccan; Andaman Is.; Bombay, Poona, Ahmedabad (Western India); Adam's Peak, Peradeniya, Kandy, Colombo, Avissavela, W. Haputale, the W. Province (all in Ceylon); Mangalore, Calicut, Tiruvellur, on the Malabar Coast; Shimoga (Mysore); Merkara, Madapur, Dubari (Coorg); Coonoor (Nilgiris); Bonaccord, Chimunga, Shasthancottah, Pallode, Trivandrum, Kerumaadi, Vellany, Neyyatinkara (Travancore).

Outside India the species is circummundane.

## Subfamily MICROCHÆTINÆ.

1900. Microchætinæ + Criodrilinæ (part.), Michaelsen, Tier. x, pp. 447, 463.
1917. Microchætinæ, Michaelsen, Zool. Jahrb. Syst. xli, p. 305.

Normal setæ in eight longitudinal rows. Genital setæ, if present, not longitudinally grooved. Male pores ante- or intra-clitellar. Spermathecal pores mostly altogether behind the testis segments, occasionally vestigial spermathecæ in addition in the region of the testes. An œsophageal gizzard present. Calciferous glands present or wanting. No obvious intestinal gizzard; a strengthening of the musculature at the beginning of the intestine may be present. Sexual apparatus metagynous; seminal vesicles mostly short, not penetrating the septa so as to extend through several segments.

The only Indian genus is *Glyphidrilus*.

*Distribution.* The subfamily is endemic in S. Africa, Tropical E. Africa, Madagascar, Central and N.E. Africa; in S. Asia and the Malay Archipelago (gen. *Glyphidrilus*); and (gen. *Drilocrius*) in Central and S. America.

### 1. Genus GLYPHIDRILUS *Horst.*

1895. *Glyphidrilus* + *Bilimba*, Beddard, Monog. pp. 679, 686.
1900. *Glyphidrilus*, Michaelsen, Tier. x, p. 459.
1909. *Glyphidrilus*, Michaelsen, Mem. Ind. Mus. i, p. 244.
1910. *Glyphidrilus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 103.
1917. *Glyphidrilus*, Michaelsen, Zool. Jahrb. Syst. xli, p. 343.

Setæ anteriorly widely, posteriorly more closely paired. In the hinder part of the body *dd* equal to or little greater than *aa*. Male pores intraclitellar, behind segment xvi, on a flat surface included between a pair of long ridges (ridges of puberty). Spermathecal pores in front of male pores. A well-developed gizzard in front of 8/9, in viii or vii and viii. No calciferous glands or œsophageal sacs. One pair of nephridia per segment. Holandric and metagynous. Testes and funnels free. No copulatory sacs. Prostates present (? always).

*Distribution.* Kumaon Dist. (W. Himalayas); Jalpaiguri, Assam (E. Himalayas); Cuttack (Orissa); Lucknow (U.P.); Mysore; Travancore and the Malabar Coast; Burma. Outside India in Tropical E. Africa, the Malay Peninsula, and Malay Archipelago (Borneo, Sumatra, Java, Celebes).

The locality Kumaon Dist. (Kichha, near Naini Tal) is that of an immature species which could not be identified (Michaelsen, Mem. Ind. Mus. i, p. 244). Michaelsen points out that the Indian species form intermediate stages between the E. African species and those of the Malay Peninsula and Archipelago, not only geographically but as regards the specific characters also.

*Key to the Indian species of* Glyphidrilus.

1. Paired papillæ in a single longitudinal series on each side ..... 2.
   Paired papillæ in two or three series on each side .. *G. tuberosus.*
2. "Wings" end behind at or in front of segment xxvi..... *G. papillatus.*
   "Wings" end behind at xxxii or xxxiii ..... *G. annandalei.*

**1. Glyphidrilus annandalei** *Mich.*

1910. *Glyphidrilus annandalei*, Michaelsen, Abh. Ver. Hamburg, xix, p. 101.
1911. *Glyphidrilus annandalei*, Cognetti, Ann. Mag. N. H. (8) vii, p. 502, pl. xiii, figs. 11, 12; *G. achencoili* (laps.), ib. p. 506.
1913. *Glyphidrilus annandalei*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 92.
1916. *Glyphidrilus annandalei*, Stephenson, Rec. Ind. Mus. xii, p. 349.
1917. *Glyphidrilus annandalei*, Michaelsen, Zool. Jahrb. Syst. xli, pp. 344, 346.
1921. *Glyphidrilus annandalei*, Stephenson, Rec. Ind. Mus. xxii, p. 767.
1922. *Glyphidrilus fluviatilis*+*G. elegans*+*G. rarus*+*G. saffronensis*, Rao, Ann. Mag. N. H. (9) ix, pp. 53, 62, 64, 66, text-figs. 1–4.
1922. *Glyphidrilus annandalei*, Stephenson, Ann. Mag. N. H. (9), ix, p. 387.

Length 90–165 mm.; maximum diameter 2·5–4 mm. Segments 125–322. Colour light to dark grey, unpigmented; a slight rose

GSL



tint on the clitellum. Anterior end swollen, maximum thickness about segment ix, diameter decreases gradually in the middle and hinder parts of the body to only 1 mm. at the hinder end; in its posterior half the body is four-sided in section, the dorsal side the broadest; towards the hinder end the dorsal surface becomes more and more concave. Prostomium zygolobous, or sometimes prolobous; segments from ii onwards tri- or multiannular as far as xiv, after which the annulation becomes indistinct. Anus a longitudinal slit at the hind end on the dorsal surface, intersecting more or fewer of the terminal segments. Setæ very widely paired as far as xii, the intersetal distances diminishing behind this; $aa : ab : bc : cd : dd = 3 : 2 : 3 : 2 : 5$ at first, but behind = $4 : 2 : 4 : 2 : 7$. Nephridiopores in *b*. Clitellum ring-shaped, beginning in xvii or xviii (or even as far forward as xiii) and extending to xxxvi . . . xli (= 19–25), indistinctly limited behind and indeed more or less so in front also. Ridges of puberty ("wings") run between the lines *b* and *c*, from xxv, xxvii or xxviii to xxxii or xxxiii, occasionally to xxxv, usually continued forwards as lower ridges or angles as far forwards as xviii; the ridges are bent downwards somewhat towards the body-wall. Papillæ of puberty numerous, constant in position on each segment, but the number of segments bearing them is very variable; they are roundish cushions on the hinder part of their segments, in two series, median and lateral, the latter paired, and situated between *b* and *c*; the median series begins on xi, xii, xiii or xiv, and ends at varying levels back to xxvi, but occasional papillæ may be found further back, on xxxv, xxxvi or xxxvii, the total number varying from 2 to 14; the lateral series begins on xiii, or on or behind xv, ends in front of the "wings," and another short series may begin behind the "wings." Male pores as two point-like depressions in 29/30, in line with *b*. Spermathecal pores in groups of one to six, with the arrangement characteristic of the genus, in 13/14 to 16/17 or 17/18; most have the full number of five in each group.

Septa 6/7–11/12 thickened increasingly. A fairly large gizzard principally in viii, the anterior end apparently getting into vii. Last heart in xi. Meganephric. Two pairs large funnels free in x and xi. Four pairs large irregular seminal vesicles in ix–xii. Prostates apparently absent. Ovisacs may be present in xiv. Spermathecæ simple, thickly pear-shaped or spherical, with short and narrow stalk, in appearance sessile, the duct being embedded in the body-wall.

*Remarks.* This species forms an intermediate link between the Further Indian and Malayan species on the one hand and the isolated *G. stuhlmanni* of E. Africa on the other.

We have two independent descriptions of this species, Cognetti having described it before receiving Michaelsen's paper.

Autotomy appears to be common in the mature worms (Stephenson, 1921).

*Distribution.* Calicut, Malapuram, Tiruvallur, on the Malabar

coast; Arumanallur, Madatoray, Trivandrum, Vellany, Neyyantinkara, and ?Azhagiapandipuram in Travancore; Dubari, Madapur, Fraserpet, in Coorg; Shimoga and ? Kadur Dist., Mysore.

2. **Glyphidrilus papillatus** (*Rosa*).

1890. *Bilimba papillata*, Rosa, Ann. Mus. Genova, (2 *a*) ix, p. 386, pl. xii, fig. 1.
1895. *Bilimba papillatus*, Beddard, Monog. p. 687.
1896. *Glyphidrilus papillatus*, Michaelsen, Abh. Senckenb. Ges. xxiii, p. 196.
1900. *Glyphidrilus papillatus*, Michaelsen, Tier. x, p. 459.
1917. *Glyphidrilus papillatus*, Michaelsen, Zool. Jahrb. Syst. xli, p. 344.
1920. *Glyphidrilus papillatus*, Stephenson, Mem. Ind. Mus. vii, p. 258.

Length 100–120 mm.; maximum diameter 3–5 mm. Segments 202–330. Colour flesh or greyish, no distinct pigmentation. Anterior segments after v divided by secondary annulations. Posterior half flattened dorsally, ventral surface flattened for the greater part of its extent. Prostomium large, pro- or zygolobous. Dorsal pores absent. Setæ paired, the setal couples being behind the clitellum at the angles of the body; in postclitellar region *ab* rather less than $\frac{1}{2}aa$ and $=\frac{1}{2}bc=cd$, *dd* a little greater than *aa*; in front of clitellum setæ small and wider apart; in posterior part of body *dd* larger and *bc* smaller, $ab=\frac{2}{5}aa=\frac{1}{2}bc=cd=\frac{2}{7}dd$. Clitellum rather indefinite, xvi–xxvi . . . xxxiv (= 11–19). Wings ventrolateral, xviii–xxiii . . . xxvi, attached outside the line of *b*. Papillæ large, round, flattened or slightly depressed in the middle, on the posterior part of their segments, in two series, lateral and median; the lateral in line with or slightly dorsal to the attachment of the wings, usually paired, on any of the segments x–xvii, as well as occasionally on xxiii, xxiv, xxv or xxvi–xxviii; median papillæ not so common as the lateral, on xi–xv and on xvii and xviii, or may be absent altogether; the lateral may be only two pairs, or two on one side and one only on the other.

Septum 4/5 thin, 5/6 slightly, 6/7–9/10 moderately, and a few succeeding ones slightly thickened. Gizzard in vii and viii, 7/8 being adherent to it at its middle; rather small and fairly soft. Intestine begins in xvi. Hearts in x and xi. Testes and funnels free in x and xi. Seminal vesicles four pairs, ix–xii, usually deeply lobed, not always symmetrical. No prostates. Ovisacs in xiv, and apparently in xv also. Spermathecæ in four series on each side, in 13/14–16/17, with sometimes additional ones in the next anterior groove; each is a small elongated saccule, adherent to the body-wall; each series consists of five on each side, one each on the lines of *a*, *b*, *c*, and *d*, and one between *b* and *c*.

*Remarks.* The immature specimen which was described by Rosa was made the type of a new genus *Bilimba*; Michaelsen in 1896 showed that Rosa's worm belonged to *Glyphidrilus*.

*Distribution.* Cobapo, Biapo Dist., Burma; Lucknow.

### 3. Glyphidrilus tuberosus *Steph.*

1916. *Glyphidrilus tuberosus*, Stephenson, Rec. Ind. Mus. xii, p. 349, pl. xxxiii, fig. 37.

Length ca. 60 mm.; max. diameter 3 mm., average 2·5 mm. Segments 221, all very short behind clitellum. Colour light brown. Dorsal surface concave behind clitellum, ventral surface flat or concave; a section is thus foursided, the dorsal surface being the most extensive at the hinder end. Anus dorso-terminal. Prostomium prolobous or ? zygolobous, the delimiting groove being a shallow depression only. Setæ behind clitellum at the angles of the section; $aa=bc=2ab=2cd$; $dd=3cd$ or nearly so; in front of clitellum setæ widely paired and rather irregular, $ab=\frac{1}{2}aa$ or less. Clitellum from xiv, xv or xvi to xxviii or xxix (or xxx dorsally). Wings on xx to xxiv, continued forwards as a

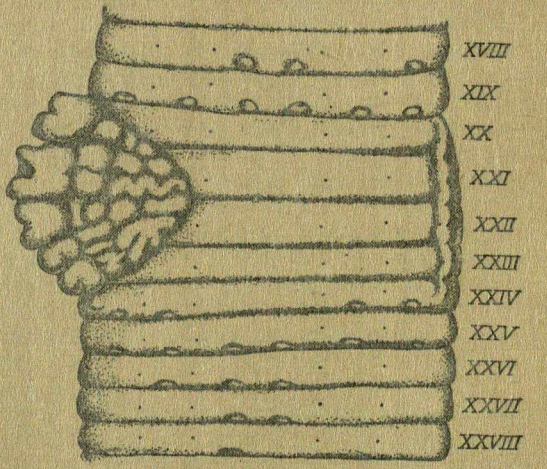


Fig. 262.—*Glyphidrilus tuberosus* Steph.; segments xviii–xxviii from the ventral surface, showing the papillæ in this region, with the ventro-lateral ridge on one side and the cauliflower-like excrescence on the other.

slight ridge to xv or xiv; they may grow out into a foliating tumour-like mass of numerous soft irregular closely apposed papillæ, extending ventralwards nearly to the line of *a* (text-fig. 262); similar patches may be present above the wings, between the mid-dorsal and the lateral lines. Papillæ small, white, rounded, on the posterior parts of their segments; an anterior set, on x, xi, and xii, a midventral and two lateral on each side, one of the lateral between *a* and *b*, and the other outside *b*; a middle set on xvii–xix, or xviii and xix, paired, the full number being three pairs per segment, one internal to *a*, one between *a* and *b*, and one outside *b*; a posterior group on xxiv to xxviii, similar to the last, *i.e.* all paired, but one or more may be wanting in any segment (text-fig. 262).

Septum 4/5 thin, 5/6 slightly, 6/7 somewhat thickened, 7/8 moderately, 8/2–11/12 or 12/13 slightly so. Gizzard in vii, sometimes extending into the hinder part of vi; degree of development varies, often in some degree vestigial. No calciferous glands. Intestine begins in xv. Last heart in xi. Testes and funnels in x and xi. Seminal vesicles four pairs, ix–xii. Ovisacs in xiv. Spermathecæ in xiv and xv, small subspherical sacs; the duct a short thin stalk, debouching into grooves 13/14 and 14/15; three or four on each side in each segment, in line with *a* and *b*, between *b* and *c*, and in line with *c*.

*Distribution.* Cuttack (Orissa); Jalpaiguri (Bengal).

## Subfamily CRIODRILINÆ.

1900. Criodrilinæ (part.), Michaelsen, Tier. x, p. 463.
1917. Criodrilinæ, Michaelsen, Zool. Jahrb. Syst. xli, p. 372.

Genital setæ longitudinally grooved. Male pores preclitellar, on xv, on glandular elevations. Calciferous glands wanting; an obvious gizzard wanting, but an indefinite strengthening of the muscular coat at the beginning of the intestine present. Sexual apparatus holandric and metagynous; no prostates; muscular copulatory sacs present. No spermathecæ.

The *Distribution* is that of *Criodrilus lacuum*, the only species till recently recognised, with, in addition, England (*Anagaster fontinalis* Friend).

### 1. Genus CRIODRILUS *Hoffmstr.*

1895. *Criodrilus*, Beddard, Monog. p. 665.
1900. *Criodrilus*, Michaelsen, Tier. x, p. 467.
1917. *Criodrilus*, Michaelsen, Zool. Jahrb. Syst. xli, p. 372.

Prostomium zygolobous. Middle part of body four-angled. Anus dorso-terminal. Setæ closely paired. Four pairs of seminal vesicles in ix–xii.

#### 1. Criodrilus lacuum *Hoffmstr.*

1914. *Criodrilus lacuum*, Stephenson, Rec. Ind. Mus. x, p. 256.
1915. *Criodrilus lacuum*, Stephenson, Mem. Ind. Mus. v, p. 145.

1884. *Criodrilus lacuum*, Vejdovsky, Monog. p. 57, pl. x, fig. 21, pl. xiii, figs. 12–24, pl. xiv, figs. 1–15.
1887. *Criodrilus lacuum*, Orley, Quart. Journ. Mic. Sci. xxvii. p. 551, pl. xxxviii, figs. 1–8.
1887. *Criodrilus lacuum*, Benham, Quart. Journ. Mic. Sci. xxviii, p. 561, pl. xxxviii, figs. 9–19.
1888. *Criodrilus lacuum*, Collin, Z. wiss. Zool. xlvi, p. 471, pl. xxiii.
1917. *Criodrilus lacuum*, Michaelsen, Zool. Jahrb. Syst. xli. p. 373.

(The above references contain descriptions of the worm and its habits, the last, by Michaelsen, consisting for the most part of a full account of the normal and genital setæ.)

Length 120–320 mm.; diameter 4–5 mm. or more. Segments

200–450 mm. Colour light or dark brown to green. Prostomium zygolobous. Body from about ix onwards quadrangular in section; anus postero-dorsal. Setæ ornamented, closely paired; with two longitudinal series of broad scars with curved, elevated, and irregularly toothed proximal edges, each taking up half the circumference of the seta, and alternating in the two series as regards their position on the shaft; *dd* only a little greater than *aa*. Clitellum not marked, indistinctly limited, xvi–xlvii (= 32). Male pores on xv, external to *b*, on large low glandular cushions which laterally are somewhat wrinkled, extending over xv and xvi, and nearly reaching to the line of *c*. Female pores on xiv, immediately outside *b*, on similar smaller cushions. Setæ *ab* of x–xiv, xvii, and xix often on glandular elevations, and so back to xxiii, the elevations becoming gradually smaller.

Gizzard rudimentary, in xii–xiv. Seminal vesicles four pairs, in ix–xii. Vasa deferentia opening on to the surface through a hemispherical gland (prostate ?). Spermathecæ absent. Genital setæ much thinner than the normal setæ, the nodulus situated markedly proximal; the distal half showing four longitudinal ridges separated by grooves; only setæ *a* of xii, xiii, xvi–xviii (?) thus modified.

*Remarks.* Unfortunately the specimens diagnosed as belonging to this species were not fully mature, and there is therefore an element of doubt in the identification.

*Distribution.* In India from the Chilka Lake on the E. coast. The species is widely spread in Europe, and occurs in Syria and Palestine; it is limnic in habitat.

## Subfamily LUMBRICINÆ.

1895. Lumbricidæ, Beddard, Monog. p. 687.
1900. Lumbricidæ, Michaelsen, Tier. x, p. 470.
1909. Lumbricidæ, Michaelsen, Mem. Ind. Mus. i, pp. 116, 246, 247.
1910. Lumbricidæ, Michaelsen, Abh. Ver. Hamburg, xix, pp. 17, 29.

Male pores anteclitellar, as a rule on xv, seldom further forwards, on a flat surface or on or between swollen glandular elevations. Spermathecal pores often wanting, usually in the region of the testis segments, often behind, seldom in front of them. Genital setæ (not known in all forms) longitudinally grooved. Œsophageal gizzard wanting; calciferous glands usually present; an obvious gizzard is developed at the beginning of the intestine. Sexual apparatus as a rule holandric, seldom (? only individually) metandric; metagynous. Copulatory sacs and prostates wanting.

*Distribution.* The subfamily is widely distributed in India, occurring throughout Kashmir and the Punjab, in both Western and Eastern Himalayas, at Calcutta, at Partabgarh and Mt. Abu in Rajputana, in the Nilgiris, Palnis, and Travancore, and in the

Nicobar Islands. But this wide distribution is due to the peregrine species, endemic species being found only in Kashmir, the Punjab (in the Western Himalayas), and at Calcutta. The headquarters of the subfamily is S. Europe, especially the Caucasus region; it is the dominant group over the whole of temperate Eurasia, being endemic in N. and N.W. Europe, Central and S. Europe, Japan, Turkestan, Transcaucasia, Asia Minor, Syria, and Palestine, with a few Indian species and one in S.W. Persia; it has founded a small colony of endemic forms in Eastern N. America.

The further division of the subfamily has given much trouble; the history of the attempts which have been made is given by Michaelsen (126), who finds that of the genera and subgenera which he recognized in the Tierreich volume a number must disappear, since they grade into one another in manifold ways. The only genera which can be definitely separated are *Helodrilus* (= *Allolobophora*), *Octolasium*, and *Lumbricus*; and of the subgenera of *Helodrilus* there is no sharp line between *Eisenia* and *Dendrobæna*, nor between *Eisenia* and *Eiseniella*, while there are difficulties in separating *Dendrobæna* and *Allolobophora*, *Allolobophora* and *Octolasium*, *Bimastus* and the subgenus *Helodrilus*. Michaelsen leaves the subgenera, however (*Eisenia*, *Eiseniella*, *Allolobophora*, *Bimastus*, *Dendrobæna*, and *Eophila*—the latter the equivalent of the subgenus *Helodrilus* of the Tierreich volume), considering that the distinction of subgenera need not be as definite as that of genera.

The generic name *Helodrilus*, used in the Tierreich volume, is replaced by *Allolobophora* in Michaelsen, 87 *a*, p. 40.

*Key to Genera and Subgenera of* Lumbricinæ.

| | | |
|---|---|---|
| 1. | Gizzard confined to one segment; spermathecal pores between *d* and the middorsal line | *Allolobophora* subgen. |
| | Gizzard taking up 2–4 segments | 2. [*Eiseniella*. |
| 2. | Testes and funnels free | 3. |
| | Testes and funnels mostly in testis sacs, seldom in cœlomic spaces incompletely closed by the junction of the septa or by strands of tissue (in the latter cases more than three pairs of seminal vesicles) | 7. |
| 3. | Spermathecal pores occurring singly (*i. e.*, not in groups) in or close to the middorsal line | *Allolobophora* subgen. [*Eisenia*. |
| | Spermathecal pores often absent, usually occurring singly, and then in or below *d*; often also in groups of several, and then partly in and partly above *d* | 4. *Allolobophora* (part.). |
| 4. | Two pairs seminal vesicles in xi and xii | 5. |
| | Three or four pairs seminal vesicles | 6. |
| 5. | Clitellum extending at least to 32/33, usually further back; spermathecæ usually present,—if absent, clitellum extends some distance back beyond 32/33 | subgen. *Eophila*. |
| | Clitellum extending at most to 32/33, usually not so far; spermathecæ absent | subgen. *Bimastus*. |

GSL



6. Setæ more or less closely paired; four pairs seminal vesicles in ix–xii, those of x approximately as large as those in ix .... subgen. *Allolobophora*.
Setæ mostly widely paired or separated, seldom closely paired; usually three pairs seminal vesicles, in ix, xi, and xii, seldom (only when the setæ are widely paired) a fourth pair of small seminal vesicles in x, these being much smaller than those in ix. subgen. *Dendrobæna*.
Testes and funnels enclosed in a single unpaired testis sac; three pairs seminal vesicles in ix, xi, and xii; two pairs spermathecæ ..... *Lumbricus*.
Testes and funnels enclosed in paired testis sacs, or in incompletely closed cœlomic spaces; in the last case, as usually, more than two pairs spermathecæ; four pairs seminal vesicles ..... *Octolasium*.

The subgen. *Eiseniella* has not so far been found in India.

## 1. Genus ALLOLOBOPHORA *Eisen.*

1895. *Allurus* + *Tetragonurus* + *Allolobophora* (part.), Beddard, Monog. pp. 695, 697, 698.
1900. *Helodrilus* + *Eisenia* + *Eiseniella*, Michaelsen, Tier. x, pp. 471, 474, 479.
1910. *Helodrilus*, Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 10.
1918. *Allolobophora*, Michaelsen, Zool. Jahrb. Syst. xli, p. 40.

Testes and funnels free.

There is now no other character which will apply to all the forms which come under this large genus. The prostomium is usually epilobous, but any other form may occur. The setæ may be closely paired, or widely paired, or even separated, *i. e.*, not in pairs at all. Spermathecæ may be absent, or there may be two, three, or four pairs, or the spermathecæ may be in groups. The gizzard may be confined to one segment (subgen. *Eiseniella*), or may take up more than one. The seminal vesicles may be two, three, or four pairs.

*Distribution.* In India is found in Kashmir, the N.W. Frontier Province, the Punjab, Western and Eastern Himalayas, Bengal, Rajputana, and S. India. It appears to be endemic in Kashmir, the Western Himalayas, and at Calcutta, but by far the greater number of the records are of peregrine species. Outside India the genus is endemic in the whole area of the subfamily.

### Subgenus EISENIA *Malm.*

1895. *Allolobophora* (part.) Beddard, Monog. p. 698.
1900. *Eisenia* (gen.), Michaelsen, Tier. x, p. 474.
1910. *Eisenia* (subgen.), Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 8.

Prostomium epi- to tanylobous. Setæ closely or widely to very widely paired. Spermathecal pores two or three pairs, in 8/9–10/11, above *d*, in or near the middorsal line. Gizzard taking

up more than one segment. Three or four pairs of seminal vesicles, in ix, xi, and xii, or in ix–xii.

The two Indian species are easily separated by their colour; the transverse pigmented bands over the dorsum in *A.* (*E.*) *fœtida* are very distinctive.

1. **Allolobophora (Eisenia) fœtida** (*Sav.*).

1891. *Allolobophora fœtida*, Rosa, Ann. Hofmus. Wien. vi, p. 381
1895. *Allolobophora fœtida*, Beddard, Monog. p. 702.
1900. *Eisenia fœtida*, Michaelsen, Tier. x, p. 475.
1909. *Eisenia fœtida*, Michaelsen, Mem. Ind. Mus. i, p. 245.
1910. *Helodrilus* (*Eisenia*) *fœtidus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 104.
1913. *Helodrilus* (*Eisenia*) *fœtidus*, Michaelsen, Mt. Mus. Hamburg, xxx, p. 92.
1914. *Helodrilus* (*Eisenia*) *fœtidus*, Stephenson, Rec. Ind. Mus. x, p. 363.
1916. *Helodrilus* (*Eisenia*) *fœtida*, Stephenson, Rec. Ind. Mus. xii, p. 352.
1917. *Helodrilus* (*Eisenia*) *fœtidus*, Stephenson, Rec. Ind. Mus. xiii, p. 414.

Length 60–90 mm.; diameter 3–4 mm. In life with red, purple, or brown segmental bands over dorsum, separated by paler intervals; the bands slightly marked in ix–xi, except middorsally; bands sometimes two per segment; ventral surface pale. Prostomium epilobous $\frac{1}{2}$. Dorsal pores from 4/5. Setæ slender, ornamented, closely paired; $aa = bc$; $dd$ = half the circumference. Clitellum from xxiv, xxv, or xxvi to xxxii (= 7–9). Ridges ("walls") at maturity on 3–4 segments, xxvii or $\frac{1}{2}$xxviii to xxx or xxxi. Male pores with fairly large raised areas which do not transgress the limits of xv. Spermathecal pores two pairs, in 9/10 and 10/11, near the middorsal line.

*Distribution.* Simla and neighbourhood; Kodaikanal and neighbourhood, Palni Hills; Coonoor, Nilgiri Hills; Ponmudi, Travancore; Sevok, Darjiling Dist.; Nicobar Islands.

2. **Allolobophora (Eisenia) rosea** (*Sav.*).

1909. *Eisenia rosea*, Michaelsen, Mem. Ind. Mus. i, p. 245.

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1895. *Allolobophora rosea*, Beddard, Monog. p. 714.
1900. *Eisenia rosea*, Michaelsen, Tier. x, p. 478.

Length 25–60 mm.; diameter 3–4 mm. Segments 120–150. Flesh-coloured in life, unpigmented. Prostomium epilobous $\frac{1}{2}$. Dorsal pores from 4/5. Setæ in general slender, in the anterior part of the body very slender, closely paired; *aa* rather greater than *bc*; *dd* anteriorly equal to about half the circumference, posteriorly equal to one-third the circumference. Clitellum from xxiv, xxv, or xxvi to xxxii to xxxiii (= 7–9). Ridges ("walls") generally from xxix to xxxi, less often xxx to xxxi. Male pores in

large transverse furrows on transversely elongated elevated glandular areas which do not transgress the limits of xv. Spermathecal pores two pairs, in 9/10 and 10/11, close to the mid-dorsal line. Ventral or lateral or all setæ of ix or x or (and) xii or xiii, more rarely of xxiv, situated on transversely elongated papillæ, and modified as genital setæ, 0·8 mm. long and 20 $\mu$ thick, grooved and simply curved.

*Distribution.* Gurez, Kashmir.

Subgen. ALLOLOBOPHORA *Eisen* em. *Rosa.*

1895. *Allolobophora* (gen.) (part.), Beddard, Monog. p. 698.
1900. *Allolobophora* (subgen.), Michaelsen, Tier. x, p. 480.
1910 *Allolobophora* (subgen.), Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 4.

Prostomium mostly epilobous, seldom tanylobous. Setæ more or less closely paired. Spermathecal pores at most three pairs or pairs of groups, in *cd*. Gizzard taking up more than one segment. Seminal vesicles four pairs, in ix–xii, those of x approximately as large as those of ix (? always).

The two Indian species are immediately distinguishable by the position and extent of the clitellum and ridges of puberty.

### 3. Allolobophora (Allolobophora) caliginosa (*Sav.*) f. typica.

1909. *Helodrilus* (*Allolobophora*) *caliginosus* f. *typica*, Michaelsen, Mem. Ind. Mus. i, p. 245.

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1895. *Allolobophora caliginosa* (part.), Beddard, Monog. p. 699.
1900. *Helodrilus* (*Allolobophora*) *caliginosus* (*typicus*), Michaelsen, Tier. x, pp. 482, 483.

Length 60–160 mm.; diameter 4–6 mm. Segments 104–248. Colour very variable in life, grey, flesh-coloured, brown, yellowish, slate-blue, but never purple. Prostomium epilobous $\frac{1}{3}$, tongue cut off behind. Dorsal pores from 9/10 or less often 8/9. Setæ closely paired, the lateral especially closely; *aa* greater than *bc*; *dd* = half the circumference or somewhat less. Clitellum saddle-shaped, xxvi, xxvii, or xxviii to xxxiv or xxxv (= 7–10). Tubercles of puberty two pairs on xxxi and xxxiii. Male pores in transverse slits, on usually much elevated glandular areas, which take up xiv–xvi (these areas seldom slight and inconspicuous, not elevated). Spermathecal pores two pairs, in 9/10 and 10/11, on *cd*. Setæ *ab* of ix, x, and xi usually on broad papillæ (and so also some of those in the clitellar region ?), transformed into genital setæ, grooved, somewhat longer and thinner than the normal setæ, slightly curved.

Septa 5/6–9/10 thickened, 7/8 most so. Seminal vesicles of ix and x small.

*Distribution.* Simla.

*a.* subsp. trapezoides (*Ant. Dug.*).

1909. *Helodrilus* (*Allolobophora*) *caliginosus* f. *trapezoides*, Michaelsen, Mem. Ind. Mus. i, p. 245.
1914. *Helodrilus* (*Allolobophora*) *caliginosus* f. *trapezoides*, Stephenson, Rec. Ind. Mus. x, p. 363.
1916. *Helodrilus* (*Allolobophora*) *caliginosus* f. *trapezoides*, Prashad, J. Bombay Soc. xxiv, p. 495, pl. i, figs. 5, 9–12; pl. ii, fig. 1.
1917. *Helodrilus* (*Allolobophora*) *caliginosus* subsp. *trapezoides*, Stephenson, Rec. Ind. Mus. xiii, p. 413.
1917. *Helodrilus caliginosus*, Stephenson, Quart. J. Mic. Sci. lxii, pp. 269, 279, pl. xix, figs. 6, 10.
1919. *Helodrilus caliginosus*, Stephenson & Prashad, Tr. Roy. Soc. Edin. lii, p. 470, pl. figs. 12, 13.
1920. *Helodrilus caliginosus* var. *trapezoides*, Stephenson, Mem. Ind. Mus. vii, p. 260.
1922. *Helodrilus* (*Allolobophora*) *caliginosus* subsp. *trapezoides*, Stephenson, Rec. Ind. Mus. xxiv, p. 440.

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1895. *Allolobophora caliginosa* (part.), Beddard, Monog. p. 699.
1900. *Helodrilus* (*Allolobophora*) *caliginosus trapezoides*, Michaelsen, Tier. x, p. 483.

Tubercles of puberty conjoined to form a wall from xxxi to xxxiii or xxxiv. Otherwise as in the f. *typica*.

*Remarks.* The ridges may be formed of imperfectly fused tubercles; or they may extend forwards to the anterior limit of the clitellum, becoming more cut up into tubercles in the anterior segments. The pharyngeal gland cells have been studied by Stephenson (87), and the calciferous glands by Stephenson and Prashad (91).

*Distribution.* Gilgit; Gurez, Gandarbal, Anchar Lake (Kashmir); Lahore, Ferozepur, Peshawar, Mardan (Punjab and N.W. Frontier Prov.); Simla, Naini Tal (W. Himalayas); Mt. Abu (Rajputana); Ootacamund (Nilgiris). The species and its subspecies are widely distributed over the whole world.

4. **Allolobophora (Allolobophora) prashadi** (*Steph.*).

1922. *Helodrilus* (*Allolobophora*) *prashadi*, Stephenson, Rec. Ind. Mus. xxiv, p. 440.

Length 62 mm.; diameter 3 mm. Segments 133. Colour grey with a slightly pinkish tinge. Prostomium proepilobous. Dorsal pores from 4/5 or 5/6. Setæ closely paired; *aa* = nearly twice *bc*, *ab* is greater than *cd*, *dd* is less than half the circumference. Clitellum from 1/*n* xxiii or xxiv to xxxii or xxxiii (= 9 to more than 10), saddle-shaped; ridges of puberty xxix–xxxi. Male pores on very prominent hemispherical papillæ on xv, which encroach also on xiv and xvi; centres of the papillæ just outside the line *b*. No spermathecal pores. Ventral setæ of xii, and sometimes those of xi and x, situated on papillæ.

Septa 6/7–8/9 much thickened, 9/10 fairly thick, and succeeding septa as far as 13/14 gradually diminish in thickness. Gizzard

occupies xvii and xviii. Testes and funnels free in x and xi. Seminal vesicles in ix, x, xi, and xii; those in x the smallest, though not much smaller than those in ix; those of xi and xii much lobulated. No spermathecæ. The lateral setæ of xi and xii 0·76 mm. long, almost straight, fairly sharply pointed, the distal portion grooved (type of the clitellar setæ of *Lumbricus terrestris*).

*Remarks.* This species disagrees with the great majority of the subgenus, and resembles *Bimastus*, in having no spermathecæ.

*Distribution.* Gandarbal, Kashmir.

Subgen. DENDROBÆNA *Eisen* em. *Rosa*.

1895. *Allolobophora* (part.), Beddard, Monog. p. 698.
1900. *Dendrobæna* (subgen.), Michaelsen, Tier. x, p. 488.
1910. *Dendrobæna* (subgen.), Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 4.

Skin mostly with red pigmentation. Prostomium usually epilobous, seldom tanylobous. Setæ mostly widely paired or separated, seldom closely paired. Spermathecal pores in *c* or *d*, seldom absent, usually two pairs in 9/10 and 10/11, occasionally with one or two additional pairs in neighbouring segments. Gizzard extending over more than one segment. Usually three pairs of seminal vesicles, in ix, xi, and xii; seldom (only where there are widely paired setæ) a fourth pair in x, which are then much smaller than those in ix.

The two Indian species are immediately distinguished by the position of the clitellum.

**5. Allolobophora (Dendrobæna) kempi** (*Steph.*).

1922. *Helodrilus* (*Dendrobæna*) *kempi*, Stephenson, Rec. Ind. Mus. xxiv, p. 441; text-fig. 5.

Length 91 mm.; diameter 6 mm. Segments 128. Colour light grey, non-pigmented. Prostomium epilobous $\frac{1}{2}$, tongue not closed behind. Dorsal pores from 9/10. Setæ small; anteriorly $ab=\frac{1}{3}$ $aa=\frac{1}{2}bc=cd$; behind male apertures the distance between the setæ of a pair increases, and becomes still larger behind the clitellum; in middle of the body the setæ are no longer paired, $ab=\frac{1}{2}$ to $\frac{2}{3}$ $aa=1\frac{1}{4}$–$1\frac{1}{2}bc=2cd$; $dd=\frac{1}{3}$–$\frac{2}{5}$ of the circumference. Nephridiopores just above line of setæ *b*. Clitellum saddle-shaped, xxix–xxxiv (= 6); ridges of puberty indistinct, perhaps equal in extent to clitellum. Male pores as transverse slits on xv, with tumid anterior and posterior lips, the slits reaching from the line of *b* to that of *c*. Spermathecal pores in 9/10 and 10/11, in line with setæ *d*.

Septa 5/6–15/16 thickened, 6/7–8/9 most so. Gizzard occupying segments xvii and xviii; œsophageal pouches in x, prolonged back as calciferous glands, not set off from the tube, in xi and xii. Last heart in xii, smaller than that in xi, and at a deeper level. Testes and funnels free in x and xi. Seminal vesicles four pairs, in ix–xii, those of x equal in size to those of ix. Spermathecæ in

x and xi as small round sacs sessile on the body-wall. Ventral setæ of xv slightly modified; a faint sculpturing of the distal portion of the shaft by a numerous series of transverse markings, slightly jagged and convex towards the insertion of the seta.

*Distribution.* Kufri, Simla Hill States.

6. **Allolobophora (Dendrobæna) rubida** (*Sav.*) f. **typica.**

1909. *Helodrilus* (*Dendrobæna*) *rubidus* f. *typica*, Michaelsen, Mem. Ind. Mus. i, p. 248.

1895. *Allolobophora bœckii*, Beddard, Monog. p. 705.
1900. *Helodrilus* (*Dendrobæna*) *rubidus*, Michaelsen, Tier. x, p. 490.

Length 50–60 mm.; diameter 3–4 mm. Segments 50–100; body cylindrical. Colour pale red dorsally. Prostomium epilobous $\frac{2}{3}$. Dorsal pores from 5/6. Setæ widely paired; $aa = 1\frac{2}{3}\,ab$, $bc = 2cd$, $cd$ greater than $ab$; $dd = 4cd$. Clitellum from xxvi or xxvii to xxxi or xxxii (= 5–7). Tubercles of puberty on xxix and xxx. Male pores with small glandular areas confined to xv. Spermathecal pores two pairs, in 9/10 and 10/11, in *c*. Setæ *ab* of xvi usually on large broad papillæ, transformed to genital setæ, 0·6 mm. long and 20 $\mu$ thick, bent in a simple curve distally, otherwise almost straight, grooved.

*Distribution.* Naini Tal, W. Himalayas.

*a.* f. **subrubicunda** (*Eisen*).

1909. *Helodrilus* (*Dendrobæna*) *rubidus* f. *subrubicunda*, Michaelsen, Mem. Ind. Mus. i, p. 248.

1895. *Allolobophora subrubicunda*, Beddard, Monog. p. 707.
1900. *Helodrilus* (*Dendrobæna*) *rubidus* var. *subrubicunda*, Michaelsen, Tier. x, p. 490.

Length 65–90 mm.; diameter ca. 4 mm. Segments 60–110; body more or less flattened, especially in the clitellar region. Colour light to deep red. Prostomium epilobous $\frac{2}{3}$–$\frac{3}{4}$. Clitellum xxv or xxvi to xxxi or xxxii (= 6–8). Ridges ("walls") on xxviii–xxx. Genital setæ of the previous form, 0·8 mm. long. Otherwise as for the f. *typica*.

*Distribution.* Simla, W. Himalayas; Sandakphu and Phallut, Darjiling Dist., E. Himalayas.

Subgenus Eophila *Rosa*.

1895. *Allolobophora* (part.), Beddard, Monog. p. 698.
1900. *Eophila* (subgen.), Michaelsen, Abh. Ver. Hamburg, xvi, p. 9.
1900. *Helodrilus* (subgen.), Michaelsen, Tier. x, p. 495.
1910. *Eophila* (subgen.), Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 4.

Clitellum extending to at least 32/33, mostly further back.

Spermathecal pores seldom absent, usually 2–7 pairs or pairs of groups, in *cd*, or, if in groups, partly in and partly above *cd*. Gizzard taking up more than one segment. Seminal vesicles two pairs, attached to septa 10/11 and 11/12, in xi and xii. Spermathecæ usually present—if absent, clitellum extending back some distance behind 32/33. Mostly worms of moderate size, unpigmented.

7. **Allolobophora (Eophila) mariensis** (*Steph.*).

1917. *Helodrilus* (*Helodrilus*) *mariensis*, Stephenson, Rec. Ind. Mus. xiii, p. 414; text-fig. 6.

Length ca. 100 mm.; maximum diameter 6 mm. Segments 151. Colour greenish grey, clitellum buff. Anterior end tapers rapidly, posterior end cut off straight, four segments visible on the flat posterior end. At and behind the middle a section is four-sided, the dorsal side being the longest; towards the hinder end all the surfaces are concave. Prostomium epilobous $\frac{1}{3}$. Dorsal pores from 4/5. Setæ closely paired; $aa = 1\frac{1}{2}bc$ or nearly; in front of clitellum the lateral pair are below the lateral line of the body, in middle of body they are about in the lateral line, and towards the hinder end above it, but below the dorso-lateral angle of the body. Clitellum xxvii–xxxiv (=8). Tubercles at the site of the ventral setæ of all the clitellar segments except the last, almost forming a "wall" on each side; ventral setal bundles of x and xi, or of ix, x, and xi, also seated on glandular cushions. Male pores on large round papillæ on xv, the papillæ also taking up parts of xiv and xvi, the pores outside the line *b*. Spermathecal pores in 9/10 and 10/11, in line with *cd*.

Septum 5/6 somewhat thickened, 6/7 considerably so, 7/8, 8/9, and 9/10 very strong, then diminishing in thickness. Gizzard in xvii, xviii, and a small part of xix, firm and cylindrical. Œsophagus swollen in x, and in addition a small pair of yellowish projections (crypts) opening into the general lumen; œsophagus ridged internally from vi backwards to xii. Last heart in xii. Seminal vesicles of moderate size, in xi and xii. Spermathecæ two pairs, small, ovoid, sessile, at the anterior borders of x and xi.

*Distribution.* Murree, W. Himalayas.

Subgenus BIMASTUS *H. F. Moore.*

1895. *Allolobophora* (part.), Beddard, Monog. p. 698.
1900. *Bimastus* (subgen.), Michaelsen, Tier. x, p. 501.
1910. *Bimastus* (subgen.), Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 4.

Clitellum extending back to at most 32/33, usually not so far. Tubercles of puberty wanting or not obvious, not sharply defined. Gizzard taking up more than one segment. Two pairs of seminal vesicles, attached to septa 10/11 and 11/12, in xi and xii. No spermathecæ. Usually small worms, with reddish pigmentation.

*Key to the Indian species of the subgenus* Bimastus.

1. No tubercles or "walls" of puberty ..... *A.* (*B.*) *eiseni.*
   Tubercles or "walls" present ..... 2.
2. "Walls" or tubercles on xxviii and xxix only.. *A.* (*B.*) *constricta.*
   "Walls" or tubercles beginning on xxv or xxvi and extending to xxix or xxx..... 3.
3. Clitellum on xxv–xxxii (= 8); *ab* = *cd* ..... *A.* (*B.*) *indica.*
   Clitellum on xxiv–xxx (= 7); *ab* greater than *cd* *A.* (*B.*) *parva.*

8. **Allolobophora (Bimastus) constricta** *Rosa.*

1909. *Helodrilus* (*Bimastus*) *constrictus*, Michaelsen, Mem. Ind. Mus. i, p. 246.
1910. *Helodrilus* (*Bimastus*) *constrictus*, Michaelsen, Abh. Ver. Hamburg, xix, p. 104.
1916. *Helodrilus* (*Bimastus*) *constrictus*, Stephenson, Rec. Ind. Mus. xii, p. 352.
1922. *Helodrilus* (*Bimastus*) *constrictus*, Stephenson, Rec. Ind. Mus. xxiv, p. 442.

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1895. *Allolobophora constricta*, Beddard, Monog. p. 711.
1900. *Helodrilus* (*Bimastus*) *constrictus*, Michaelsen, Tier. x, p. 503.

Length 20–30 mm.; diameter 3 mm. Segments 90–105. Colour red dorsally, especially in the anterior part of the body. Prostomium epilobous $\frac{2}{3}$. Setæ widely paired; *bc* greater than *cd*, *cd* greater than *ab*. Dorsal pores from 5/6. Clitellum xxvi–xxxi (= 6). No tubercles of puberty. Male pores with conspicuous glandular areas. Setæ *ab* of xvi usually on large broad indistinctly limited papillæ.

*Remarks.* Some of my specimens did not agree very closely with the above diagnosis; the clitellum extended as far as xxxii behind, including the whole of the segment dorsally and half or two-thirds of it ventrally; there was no pigmentation, and the papillæ in the region of setæ *ab* of xvi were wanting.

*Distribution.* Simla Hills, W. Himalayas; Darjiling, E. Himalayas; Ootacamund, Nilgiris.

9. **Allolobophora (Bimastus) eiseni** (*Levins.*).

1909. *Helodrilus* (*Bimastus*) *eiseni*, Michaelsen, Mem. Ind. Mus. i, p. 246.
1916. *Helodrilus* (*Bimastus*) *eiseni*, Stephenson, Rec. Ind. Mus. xii, p. 352.

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1895. *Allolobophora eiseni*, Beddard, Monog. p. 705.
1900. *Helodrilus* (*Bimastus*) *eiseni*, Michaelsen, Tier. x, p. 503.

Length 30–48 mm.; diameter 2–4 mm. Segments 75–110. Colour dorsally a bright violet. Prostomium tanylobous. Dorsal pores from 5/6. Setæ closely paired. Clitellum from xxiv or xxv to xxxii (= 8–9). No tubercles of puberty. Male pores with conspicuous glandular areas.

*Distribution.* Naini Tal, Painsur (both in Kumaon Dist., W. Himalayas).

GSL



10. **Allolobophora (Bimastus) indica** (*Mich.*).

1909. *Helodrilus* (*Bimastus*) *indicus*, Michaelsen, Mem. Ind. Mus. i, p. 246.
1907. *Helodrilus* (*Bimastus*) *indicus*, Michaelsen, Mt. Mus. Hamburg, xxiv, p. 188.

Length 58–75 mm.; maximum diameter ca. 6 mm. Segments 87–107. Colour grey, unpigmented. Prostomium epilobous $\frac{2}{3}$; tongue not closed behind, lateral borders of tongue convergent behind. Dorsal pores from 5/6. Setæ closely paired; $aa = bc = \frac{1}{3}dd$; $ab = cd =$ ca. $\frac{1}{2}aa$. Clitellum saddle-shaped, xxv–xxxii (=8); on xxxii only developed dorsally. Glandular cushions on xxvi–xxx, internal to the ventral borders of the clitellum, extending from internal to *a* to outside *b* (extending further outward beyond *b* than inwards beyond *a*); smaller on xxvi. Male pores as deep transverse clefts on xv, between *b* and *c* but nearer *b*, on broad longitudinal glandular cushions which include xiv and xvi. Spermatophores may be borne on the surface of the body lateral to the male pores; they are irregular discs somewhat longer than broad.

Gizzard in xvii and xviii. Calciferous glands not set off from the œsophagus. Seminal vesicles large, in xi and xii. Spermathecæ absent.

*Remarks.* This is rather an aberrant member of the subgenus, and inclines towards *Eophila* in size and pale colour. It seems to be closely allied to *A.* (*B.*) *syriaca* Rosa, the chief distinction being the arrangement of the setæ.

*Distribution.* Calcutta.

11. **Allolobophora (Bimastus) parva** *Eisen.*

1909. *Helodrilus* (*Bimastus*) *parvus*, Michaelsen, Mem. Ind. Mus. i, p. 248.
1914. *Helodrilus* (*Bimastus*) *parvus*, Stephenson, Rec. Ind. Mus. x, p. 363.
1916. *Helodrilus* (*Bimastus*) *parvus*, Stephenson, Rec. Ind. Mus. xii, p. 352.
1916. *Helodrilus* (*Bimastus*) *parvus*, Prashad, J. Bombay Soc. xxiv, p. 497, pl. i, figs. 8, 13, pl. ii, fig. 2.
1917. *Helodrilus* (*Bimastus*) *parvus*, Stephenson, Rec. Ind. Mus. xiii, p. 414.
1917. *Helodrilus parvus*, Stephenson, Quart. J. Mic. Sci. lxii, p. 278, pl. xix, figs. 7, 8.
1919. *Helodrilus parvus*, Stephenson and Prashad, Tr. Roy. Soc. Edin. lii, p. 474, pl. fig. 11.
1920. *Helodrilus parvus*, Stephenson, Mem. Ind. Mus. vii, p. 260.
1922. *Helodrilus* (*Bimastus*) *parvus*, Stephenson, Rec. Ind. Mus. xxiv, p. 442.

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1895. *Allolobophora parva*, Beddard, Monog. p. 705.
1900. *Helodrilus* (*Bimastus*) *parvus*, Michaelsen, Tier. x, p. 502.

Length 25–40 mm.; diameter 1–2 mm. Segments 85–111, usually about 90. Colour brownish red. Prostomium epilobous

$\frac{1}{2}$–$\frac{4}{5}$. Dorsal pores from 5/6. Setæ paired, the dorsal closer than the ventral; $ab = \frac{1}{4}aa = \frac{1}{3}bc = 1\frac{1}{4}cd$; $dd$ = nearly half the circumference. Clitellum saddle-shaped, xxiv or xxv to xxx, and may even encroach on xxxi dorsally (= 6 to more than 7); tubercles or "walls" from xxv or xxvi to xxix or xxx. Male pores with small but distinct glandular areas. Ventral body-wall of xiv–xvi greatly thickened and glandular.

No septa specially thickened. Seminal vesicles compactly racemose.

*Remarks.* Stephenson has studied the pharyngeal gland cells (87), and Stephenson and Prashad the calciferous glands (91).

*Distribution.* Gorai, Srinagar (Kashmir); Peshawar, Mardan (N.W. Frontier Prov.); Lahore, Lyallpur, Ferozepur (Punjab); Kasauli, Barogh, Naini Tal (W. Himalayas); Partabgarh (S. Rajputana).

## 2. Genus **OCTOLASIUM** *Örley* em. *Rosa.*

1895. *Allolobophora* (part.), Beddard, Monog. p. 691.
1900. *Octolasium*, Michaelsen, Tier. x, p. 504.
1910. *Octolasium*, Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 10.
1917. *Octolasium*, Michaelsen, Zool. Jahrb. Syst. xli, p. 40.

Prostomium mostly epilobous, seldom tanylobous. Setæ usually separated, seldom closely paired. Tubercles of puberty fused to form walls. Spermathecal pores in *c* or between *c* and *d* or somewhat below *c*. Gizzard taking up more than one segment. Testes and funnels usually enclosed in two pairs of testis sacs; if no sacs, the septa of the testis segments united by horizontal bands, or fused at their borders so as to form narrow chambers. Four pairs seminal vesicles, in ix–xii.

*Distribution.* In India only recorded from Simla. Outside India is endemic in Southern Europe.

### 1. Octolasium lacteum *Örley.*

1909. *Octolasium lacteum*, Michaelsen, Mem. Ind. Mus. i, p. 248.
1914. *Octolasium lacteum*, Stephenson, Rec. Ind. Mus. x, p. 364.
1922. *Octolasium lacteum*, Stephenson, Rec. Ind. Mus. xxiv, p. 443.

1895. *Allolobophora profuga*, Beddard, Monog. p. 712.
1900. *Octolasium lacteum*, Michaelsen, Tier. x, p. 506.

Length 40–100 mm.; diameter 3–5 mm. Segments 100–165. Colour bluish grey, milky, seldom reddish brown. Prostomium epilobous $\frac{1}{3}$–$\frac{2}{3}$, seldom tanylobous. Dorsal pores from 8/9, 9/10, or 10/11. Setæ widely paired to separated; in general *ab* equal to or greater than *bc*, *bc* smaller than *cd*; in the anterior part of the body the pairs are distinct, *ab* smaller than *bc*, *bc* greater than *cd*. Clitellum xxx–xxxv (=6); "walls" xxxi–xxxiv, often encroaching to a greater or less extent on xxx and xxxv.

Male pores usually with large glandular areas, which encroach on xiv and xvi. Spermathecal pores two pairs, in 9/10 and 10/11, in line with *c*.

Testis sacs present.

*Distribution.* Simla and neighbourhood.

### 3. Genus **LUMBRICUS** *L.* em. *Eisen.*

1895. *Lumbricus*, Beddard, Monog. p. 721.
1900. *Lumbricus*, Michaelsen, Tier. x, p. 508.
1910. *Lumbricus*, Michaelsen, Annuaire Mus. St. Pétersb. xv, p. 10. p. 10.
1917. *Lumbricus*, Michaelsen, Zool. Jahrb. Syst. xli, p. 41.

Usually darkly pigmented. Prostomium tanylobous. Ventral and lateral setæ closely paired. Clitellum saddle-shaped. Tubercles of puberty fused to form walls. Male pores between *b* and *c*; female pores immediately outside *b*. Spermathecal pores two pairs, in 9/10 and 10/11, in *cd*. Gizzard taking up more than one segment. Testis sacs fused to form a single median chamber in x and xi. Seminal vesicles three pairs, in ix, xi, and xii.

*Distribution.* In India the genus is represented by only a single peregrine species, in the Nicobar Islands. The genus is endemic in Europe.

#### 1. Lumbricus rubellus *Hoffmstr.*

1891. *Lumbricus rubellus*, Rosa, Ann. Hofmus. Wien, vi, p. 381.
1895. *Lumbricus rubellus*, Beddard, Monog. p. 722.
1900. *Lumbricus rubellus*, Michaelsen, Tier. x, p. 509.

Length 70–150 mm.; diameter 4–6 mm. Segments 85–150. Colour dorsally bright reddish brown to violet, slightly iridescent. Dorsal pores from 7/8. Setæ in general fairly slender and closely paired, the lateral somewhat more closely than the ventral; *aa*= *bc* or a trifle more, *bc*=approximately 5*ab* and 6*cd*; *dd*=half the circumference. Clitellum from xxvi (seldom) or xxvii to xxxii (= 6 or 7). "Walls" from xxviii to xxxi, usually broader on xxviii and xxx and somewhat more elevated. Male pores inconspicuous, without glandular area.

Septa 6/7–14/15 (?) somewhat thickened.

*Distribution.* Nicobar Islands.

# ADDENDA.

On p. 107 the following key is to be added:—

*Key to the Indian species of* Aulodrilus.

| | |
|---|---|
| 1. Oar-shaped setæ present, but not in the anterior dorsal bundles | *A. remex.* |
| Oar-shaped setæ, if present, occur only in the anterior half of the body. | 2. |
| 2. Needles of dorsal and ventral bundles single-pointed; no oar-shaped setæ recorded; male pores on x | *A. stephensoni.* |
| Needles of dorsal and ventral bundles mostly bifid; oar-shaped setæ in anterior half of body; male pores on vii | *A. kashi.* |

On p. 108 descriptions of two additional species of *Aulodrilus* are to be inserted, as follows:—

2. **Aulodrilus kashi** *Mehra.*

1922. *Aulodrilus kashi*, Mehra, P. Z. S. 1922, p. 946, pls. i–iii, figs. 1–12, text-figs. 1–7.

Length 20–28 mm.; diameter 0·26 mm. near anterior end, 0·13 mm. near hinder end. Segments 31–70. Anus wide, terminal. Setæ begin in ii; in dorsal bundles 8–10 in number, of three kinds: (1) capilliform (these usually absent from the first two or three bundles), ca. 100 $\mu$ long, slightly sickle-shaped; (2) needles, 75–92 $\mu$ long, with double curve and forked distal extremity, nodulus distal (distal : proximal :: 1 : 2), outer prong shorter and much thinner than inner, some appearing singly-pointed; (3) oar-shaped setæ, less numerous than the others, found in the segments of the anterior half of the body, 66–80 $\mu$ long, flattened at the distal end, which may be either rounded or bluntly pointed, nodulus distal (1 : 2). Ventral setæ are crotchets of the usual form, 60–100 $\mu$ (the higher measurement in the anterior half of the body), the inner prong four times as thick as the outer, which appears as a fine process as long as or nearly as long as the inner; the shaft shorter and more curved in the posterior part of the body than in the anterior; nodulus distal (2 : 3 or 1 : 2). Penial setæ are the modified ventral setæ of segment vii, usually two per bundle, ca. 0·25 mm. long, the shaft slightly curved, the tip pointed; distal portion somewhat broader (12 $\mu$) than proximal, with blade-like inner and thickened outer edge;

proximal part of shaft 7 $\mu$ thick. Clitellum includes segments vii and viii. Spermiducal chamber as a midventral depression quadrangular in shape on vii.

A large portion of the body-cavity of segment vi is separated off laterally and ventrally from the smaller peripheral portion, and contains all the organs belonging to the segment; it is filled with a huge mass of developing sperms. The dorsal vessel runs on the left side, near the ventral vessel, except in the first six segments; commissural vessels are present throughout the body; in segment vi a pair of hearts between dorsal and ventral vessels; no cutaneous plexus; no supra-intestinal or sub-intestinal vessels. The cerebral ganglion is deeply cleft in front, slightly so behind. The testes are in vi, the ovaries in vii. Vas deferens in vii, short, slightly curved, opening behind into the atrium. Atrium an ovoid chamber, passing into the atrial duct, which is much convoluted and enclosed in the cœlomic sac, a chamber surrounded by a muscular sheath; terminal portion of the atrial duct evaginable as a penis. The prostate, a solid mass surrounding part of the vas deferens and most or all of the ventral and part of the dorsal surface of the atrium, communicates with and discharges into the atrium. Sperm-sac median and dorsal, occupying vii and viii; ovisac in viii. Spermathecæ in vi; ampulla sac-like; duct narrow, about one-third the length of the ampulla, opening to the exterior about the middle of the length of the segment.

*Distribution.* Benares; found living in tubes.

3. **Aulodrilus stephensoni** *Mehra.*

1922. *Aulodrilus stephensoni*, Mehra, P. Z. S. 1922, p. 963, pl. iii, fig. 13, text-figs. 8, 9.

Length 17·5 mm. Segments 56. Dorsal setæ begin in ii, 3–9 per bundle, 2–3 hair setæ and 1–6 needles; the needles singly pointed, shorter than the hairs, the nodulus distal (1 : 2). Ventral setæ similar to the dorsal needles. Penial setæ the modified ventral setæ of x, 1–2 per bundle, resembling those of *A. kashi*. Spermiducal chamber very shallow, on x. Spermathecal apertures on ix. Clitellum includes segments x and xi.

Hearts in viii; lateral commissures throughout the body. Sexual organs three segments further back than in the previous species; the peripheral portion of segment ix separated off by a partition, as that of vi in *A. kashi*.

*Remarks.* Described from a single specimen, found along with the last.

*Distribution.* Benares.

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