CEYLON JOURNAL OF SCIENCE.

SPOLIA ZEYLANICA

VOL. XXI.

EDITED BY
A. H. MALPAS, M.M., F.L.S., F.Z.S.,
Director, Colombo Museum, and Marine Biologist to the Ceylon Government.

FEBRUARY, 1938—OCTOBER, 1939.

CEYLON
The Director, Colombo Museum

ENGLAND
Dulau & Co., Ltd., 29, Dover Street, London, W.1.

Printed for the Ceylon Government at the Government Press, Colombo, Ceylon

1——J. N. 90445—505 (12/39)

CONTENTS

Volume XXI.
Part I.

(*Published : February 10, 1938.*)

Part II.

(*Published : February 10, 1939.*)

CONTENTS—(*contd.*)

Volume XXI, Part II.—(*contd.*)

Part III.

(*Published : October 24, 1939.*)

ERRATA

CEYLON JOURNAL OF SCIENCE (SECTION B) VOL XXI, PT. 2

p. 99, line 14, *insert* ♀ *before* with

p. 99, line 16, *insert* ♀ *before* lacking

p. 110, line 38, *for* acknowledgement, *read* acknowledgment

p. 125, line 39, *for* Rabbler's, *read* Babbler's

p. 130, line 10, *for* altitutes, *read* altitudes

p. 139, line 21, *for* labourers, *read* labours

p. 143, line 9, *for* Elyia, *read* Eliya

p. 146, line 26, *for* 1935 *Hipposideros speoris* Phillips, *Manual*, p. 92, *read* 1935 *Hipposideros speoris speoris* Phillips, *Manual*, p. 92

p. 165, line 4, *for* occurence, *read* occurrence

p. 168, line 13, *for* Family 1., *read* Family 1

p. 172, line 5, *for* , *read* Vol. V, p. 6

p. 182, line 21, *for* **Dugong' dugong,** *read* **Dugong' dugung**

p. 202, Table I, last cage, under ' Onchosphere—size ' for ' 27 × 20 ' read ' 27 × 30 '

p. 213, line 18, for ' *Masculature* ' read ' *Musculature* '

p. 216, line 33, for ' 0.825 ' read ' 0.315 '

p. 216, line 35, for ' 0.352 ' read ' 0.325 '

p. 217, Table I, under diameter of scolex of *P. coryllidis* for ' 305-515 ' read ' 305-315 '

p. 267, Table I, No 8. For *bimammilbary*, read *bimammillary*

p. 273, Legend to fig. 3, line 5, for *public*, read *pubic*

p. 273, line 15, for *not* read *out*

p. 273, line 21, delete *is*

p. 278, line 18, for *plate* A read *Plate XXXIV*

p. 281, line 5, delete *other*

p. 284, line 25, for *Amim*, read *Anim*

p. 287, Paragraph omitted at top of page thus:

" *Distribution* Assam; north of Brahmaputra. N. Kamrup (1,200 ft.) and Bogra Nadi (2,000-3,000 ft.)

Remarks resembles the last . . . . etc."

p. 290, line 36, for *Tenasserium* read *Tenasserim*

p. 293, line 1, for *francoisi*, read *françoisi*

p. 293, line 4, Line omitted " *Distribution* Tonkin "

p. 295, line 6, for *Peninsula*, read *Peninsular*

p. 295, line 18, for chracteristics, read characteristics

p. 298, line 36, for *be without*, read *have*

p. 298, line 37, for *femoralis*, read *melalophus*

J. N. 98816-605 (4/40)

New Avian Cestodes of the Family Dilepididae from *Collocalia unicolor unicolor* (Jerd.), the Indian Edible-nest Swiftlet, with descriptions of *Pseudangularia thompsoni*, *P. triplacantha* gen. et spp. nov. and *Notopentorchis collocaliae* gen. et sp. nov.

BY

D. R. R. BURT, B.Sc., F.L.S., F.R.S.E.

Lecturer in Zoology, Ceylon University College

(With Six Text Figures)

Collections of tapeworms from the Edible-nest Swiftlet obtained in Ceylon during the past few years, comprise four different species. Three of these appear to be undescribed forms of the family Dilepididae, two belonging to the sub-family Dilepidinae and the other to the sub-family Paruterinae.

I propose here to define the new genus of the Dilepidinae, describe the two species. then discuss the new genus and species, and follow the same procedure with regard to the new species of Paruterinae.

Pseudangularia gen. nov.

Dilepidinae: Rostellum armed with a crown of three rows of hooks. Genital pores irregularly alternate. Genital canals pass dorsal to the excretory vessels. Testes numerous, posterior and dorsal to the female genitalia. Internal and external seminal vesicles present. Vagina dilated, dorsal to the cirrus. Vagino-receptacular aperture surrounded by dumb-bell shaped body Uterus sac-shaped, lobed. Adults in birds. Type: *Pseudangularia thompsoni* gen. et sp. nov.

Pseudangularia thompsoni gen. et sp. nov.

Host: Collocalia unicolor unicolor (Jerd.), the Indian Edible-nest Swiftlet.

Locality: Near Bandarawela, Ceylon, 4,000 ft. Sixteen Swiftlets were shot. and of these eleven were infested with cestodes. It was observed that the most heavy infestations were found in young birds. Adult birds, if parasitized at all, usually contained but one worm, but in sub-adult birds the number varied from four to seven.

External: The worms are small, measuring up to 10 mm. long by 1.1 mm. at the broadest region. The proglottides, about 50 in number, are all broader than long with salient postero-lateral margins.

Scolex: The scolex is broad basally, narrowing to the apex. The length of the scolex is 450 μ, and the greatest breadth in the region of the suckers, is 265 μ. The suckers are circular in outline, unarmed, with a diameter of 82 to 85 μ. The rostellum, 170 μ in diameter distally and 265 μ long, lies in the rostellar sac which extends to the region of the suckers (Fig. 1). The rostellum is armed with a crown

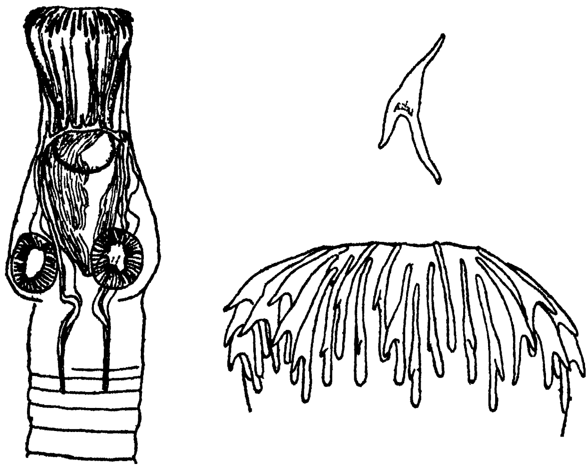


Fig. 1. *Pseudangularia thompsoni* gen. et sp. nov. Scolex × 90, showing rostellum and excretory vessels. Rostellar hook × 400. Rostellar hooks × 300, showing arrangement at three levels.

of about 42 hooks, 52 to 55 μ long, arranged in three definite rows. The scolex is sharply marked off from the neck which is very short, measuring only about 150 μ in length.

Male genitalia: There are about 30 testes lying posteriorly but extending dorsally over the female genital glands; they extend more anteriorly on the aporal side than on the poral side. In late mature and early gravid proglottides the testes may attain a diameter of 85 µ. The vas deferens expands into a convoluted external seminal vesicle lying in the anterior mid-ventral region before it enters the cirrus-sac. The latter, 240 µ long by 115 µ broad in mature proglottides, lies transversely in the anterior region of the proglottis, extending from the mid-line of the proglottis to the region of the excretory vessels. In late mature and early gravid proglottides the cirrus-sac is relatively larger and its proximal end lies aporal to the centre. A strong muscular layer invests the cirrus-sac, the fibres being arranged longitudinally relative to the length of the sac. The cirrus-sac is attached by muscles from its proximal end to the anterior wall and aporal region of the proglottis. Within the cirrus-sac the vas deferens expands into a convoluted internal seminal vesicle which in turn narrows to continue as the ductus ejaculatorius. Surrounding the beginning of this duct, lying close to the aporal end of the cirrus-sac, and attached to it by muscles, is a muscular bulb (Fig. 2). This bulb

Fig. 2. *Pseudangularia thompsoni* gen. et sp. nov. Cirrus sac × 175. Taken mainly from one horizontal section, but cirrus and terminal part of vagina reconstructed from several sections.

measures 46 µ long by 32 µ at its widest part, and contains two small chambers connected by a duct the lumen of which is about 1 µ in diameter. On emerging from this bulb the duct has a diameter of 10 µ but it narrows to a uniform diameter of 4 µ in its course through the cirrus-sac. In those cases where the cirrus is in an involuted condition the course of the duct is sinuous but where the cirrus is fully everted it runs a straight course, to continue through the cirrus as the inner tube of that organ. The cirrus consists of a wider base armed for a length of 60 µ with recurved spines 3 µ long succeeded by a narrow terminal region 5 µ in diameter. The cirrus lies in the ductus hermaphroditus which opens into the genital atrium, the latter opening to the exterior about one-fifth the length of the proglottis from the anterior end. The genital apertures, which do not open on genital papillae, alternate irregularly.

Female genitalia. The ovary is bilobed (Fig. 3), each lobe consisting of a number of digitiform acini The two ovarian lobes are connected by a transverse isthmus from which the oviduct arises. The vitelline and shell glands lie posterior to the isthmus, the latter gland being dorsal and anterior to the former. A large receptaculum lies dorsal to

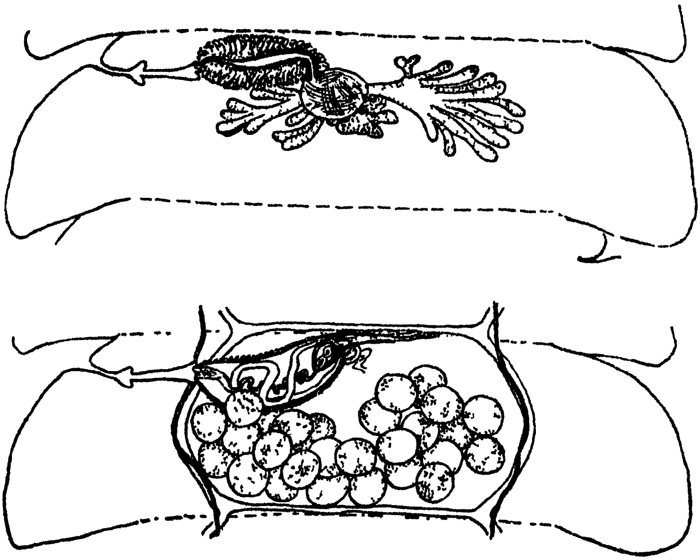


Fig. 3. *Pseudangularia thompsoni* gen et sp. nov Female and male genitalia of mature proglottis × 100, reconstructed from horizontal sections. As the vagina would obscure the cirrus, and the testes obscure the ovaries in one figure, the genitalia are shown separately.

the ovarian isthmus, and it narrows to unite with the oviduct, the common duct expanding in gravid proglottides into an irregular sac-shaped, slightly lobed uterus, which lies dorsal to the ovary but ventral to the testes in the middle field. The vagina is wide and its muscular walls are surrounded by a thick layer of glandular cells. It lies dorsal to the cirrus opening into the ductus hermaphroditus at the base of the cirrus, and extending medially narrowing down to enter the receptaculum seminis. The vagino-receptacular aperture is provided with a double sphincter-like apparatus similar to that seen in *P. triplacantha* sp. nov. the two muscular rings, however, are not equal in size for that at the vaginal end of the apparatus measures 24 µ in diameter, and that at the receptacular end 34 µ in diameter.

Uterine ova measure 13 to 14 μ in diameter. Onchospheres were not obtained.

Muscular system: A conspicuous longitudinal layer of about thirty dorsal and thirty ventral muscles separates the cortex from the medulla. The cortical layer is relatively thick.

Excretory system: Dorsal and ventral excretory vessels are present on each side, the ventral vessels being connected by a transverse vessel posteriorly in each proglottis. In the scolex dorsal and ventral vessels unite lateral to the rostellum and a vessel, surrounding the rostellar sac, and receiving ducts from the anterior region of the scolex, connects the vessels on the two sides.

In selecting the patronymic *thompsoni* for this species, I dedicate it with affection to my friend and teacher, Sir D'Arcy W. Thompson, Professor of Natural History, St. Andrews.

Pseudangularia triplacantha gen. et sp. nov.

Host: Collocalia unicolor unicolor (Jerd.) 1840, the Indian Edible-nest Swiftlet.

Locality: Near Bandarawela, Ceylon, 4,000 ft. The birds were shot between Bandarawela and Diyatalawa near a railway tunnel, in which they nest. Two specimens and a fragment were obtained. One specimen was mature with the terminal proglottides gravid, while the other is very immature showing no mature proglottides.

External: The strobila is 20 mm. long, and posteriorly at the broadest region 0.84 mm. broad. It consists of 47 proglottides, which (except for the first 17) are longer than broad. The posterior proglottides measure 0.92 mm. long by 0.84 mm. broad. Mature proglottides have salient postero-lateral margins, and possess a large genital papilla situated in the anterior third of the lateral margin.

Scolex. The scolex is longer than broad measuring 400 μ by 310 μ (Fig. 4). The suckers, round in outline and measuring 95 to 110 μ in diameter are situated posteriorly in the wider part of the scolex. The rostellum is large measuring 245 μ broad by 265 μ long; it lies in the rostellar sac which extends to the posterior limit of the scolex. The rostellum is armed with a crown of about 60 hooks arranged at three definite levels. The hooks are all of approximately the same length, 45 μ.

Neck: There is no neck, strobilation commencing immediately posterior to the scolex.

Male genitalia: The male sexual glands develop before the female, so that in the anterior proglottides the testes are developed, and posteriorly where the ovary is attaining maturity the testes are degenerating. This however does not apply to the cirrus and vesiculae seminales which attain their full development concomitantly with that of the female genitalia. The testes are about thirty in

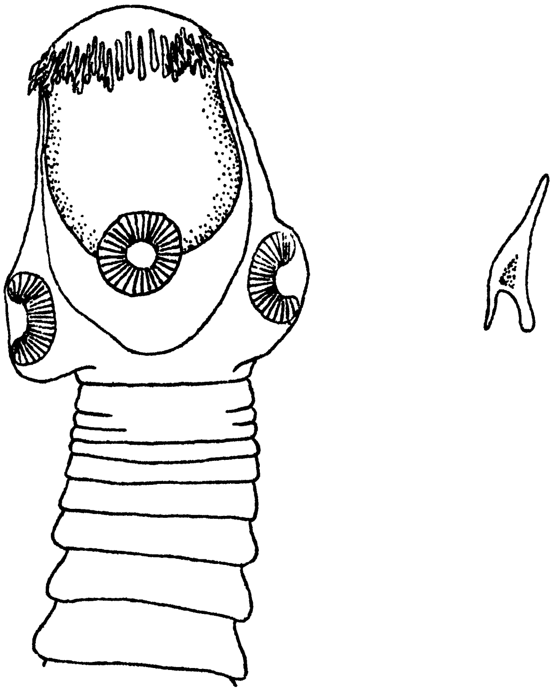


Fig. 4. *Pseudangularia triplacantha* gen. et sp. nov. Scolex × 140. Rostellar hook × 450.

number, the variation observed being from 28 to 33. In immature proglottides they lie anteriorly in the middle field, but with the development of the ovary they are pushed to the posterior limit of the proglottis, but extend dorsally over the ovary and on the aporal side almost to the anterior limit of the proglottis. The testes attain a diameter of 70 μ before degenerating. The vasa efferentia unite and enlarge to form a much convoluted external seminal vesicle which lies ventral to the cirrus extending both anterior and posterior to that organ. The cirrus-sac is large and conspicuous, 470 μ long by 81 μ broad. It lies obliquely, the proximal end lying aporally against the anterior margin of the proglottis, while the distal end opens into a muscular canalis hermaphroditus which leads into the genital atrium in the base of the genital papilla. The cirrus-sac contains a large convoluted internal seminal vesicle which leads through the ductus ejaculatorius into the cirrus. The cirrus is formed of a thicker base

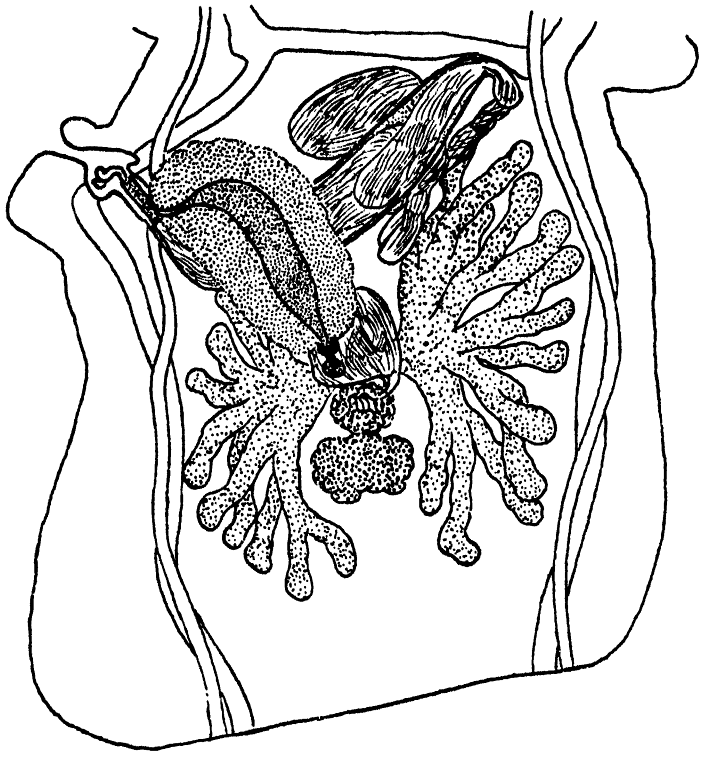


Fig. 5. *Pseudangularia triplacantha* gen. et sp. nov. Mature proglottis × 140, reconstructed from horizontal serial sections. The degenerating testes are omitted.

83 μ long by 15 μ broad, which tapers into the narrow terminal portion of variable length depending on the extent of extrusion of the organ. The base of the cirrus (except for the proximal 10 μ of it) is armed with minute recurved spines 3 μ long and set 2 μ apart. The narrow terminal portion is unarmed.

Female genitalia: The ovaries, when mature, are two large digitate glands lying ventro-laterally, connected by a narrow transverse isthmus 16 μ in diameter in the mid ventral line of the proglottis: from this the oviduct arises posteriorly (Fig. 5). Lying posterior to the isthmus, between the lateral moieties of the ovary are the vitelline and shell glands. The shell gland, 70 μ in diameter, lies immediately posterior and dorsal to the ovarian isthmus, and the vitelline gland lies posterior and ventral to the shell gland. Lying above, and extending in front of the ovarian isthmus is the large receptaculum seminis which narrows abruptly to unite with the oviduct close to the junction with the vitelline gland. The sac-shaped uterus arises from the common duct, but in the most mature proglottis obtained it was not sufficiently developed to be able to determine its ultimate shape and extent. Consequently onchospheres were not obtained.

The vagina is a relatively large, expanded, conspicuous structure, its muscular walls invested with a thick layer of glandular cells. It lies dorsal to the cirrus extending from the opening into the ductus hermaphroditus at the base of the cirrus to the centre of the proglottis. The lumen measures 44 μ at its widest. The vagina narrows towards the centre of the proglottis to open into the receptaculum seminis through what appears to be a double sphincter muscle. This structure is dumb-bell shaped consisting of two muscular rings 31 μ in diameter, connected by a narrower region measuring 14 μ in diameter, while the lumen of the central region is 7 μ in diameter. The inner muscular ring surrounds the opening into the receptaculum seminis. The genital ducts both lie dorsal to the excretory vessels and the genital apertures alternate irregularly.

Muscular system: The parenchyma is divided into cortex and medulla by a definite layer of longitudinal fibres consisting of about 20 dorsal and 20 ventral fibres. The breadth of the cortex is about 1/16th the depth of the proglottis. All the genital glands are contained within the medulla.

Excretory system: There are two lateral vessels on each side, the ventral vessels being connected by a transverse vessel posteriorly in each proglottis. The ventral vessel measures 17 μ in diameter and the dorsal vessel 7 μ.

DISCUSSION.

No genus of the Dilepidinae has so far been described as possessing three rows of rostellar hooks, but in certain respects the hooks in the genus *Angularella* Strand 1928 (Syn. *Angularia* Clerc, 1906) resemble those of the new genus. The character of the hooks in *Angularella* is quoted by Fuhrmann (1932) as " une rangée de crochets disposés en zig-zag " and by Meggitt 1924 (for *Angularia*) as " a zig-zag crown of numerous hooks ". Clerc's figure of the only described species of this genus *A. beema*, shows an expanded rostellum with hooks rather widely separated and although arranged in a zig-zag show little regularity in arrangement, and they certainly do not arise at three levels only. They appear to lie in at least four levels if indeed there is any regularity in their disposition. In the new genus the hooks are arranged in a more or less regular zig-zag, and although they lie definitely at three levels it must be a matter of opinion whether this be regarded as three rows of hooks or a single row. Many genera of the Dilepidinae are described as having two rows of hooks or a double crown, the hooks of one row alternating with those of the other. There is no reason why this condition should not be regarded as zig-zag, or chevron pattern, or like the sign of Aquarius, except that the hooks arise at two distinct levels. In a similar way where the hooks lie at three levels it appears correct to describe the condition as three rows, and not as one row in zig-zag. The arrangement of the genital pores, and the relation of the genital ducts to the excretory vessels are similar in *Angularella* and the new genus *Pseudangularia*, for in both cases the genital pores alternate irregularly and the genital ducts pass dorsal to the excretory vessels. On the analogy of the value of the differentiating characters of other genera of this sub-family, the new genus could be separated from *Angularella*, even if one could regard the arrangement of the hooks in both genera as similar; for the genera *Anomotaenia* Cohn 1900, *Bancroftiella* Johnston 1911, *Latcrotaenia* Fuhrmann 1906, and *Paruterina* Fuhrmann 1911, all possess two rows of hooks, irregularly alternate genital pores, and genital ducts passing between the excretory vessels, but are separated by the position and arrangement of the testes and the condition of the uterus.

The testes are arranged in *Angularella* close to the posterior border, while in the new genus the field extend dorsal to the female genital glands, and on the aporal side approaches the anterior border of the proglottis. The large vagina of the new genus, lying dorsal to the cirrus, is a character shared with *Trichocephaloides* Sinitsin 1896, but the latter genus has one row of rostellar hooks and unilateral genital pores. The peculiar dumb-bell shaped body, surrounding the vagino-receptacular aperture, and interpreted as a double sphincter muscle, appears to be a character shared by no other genus of this sub-family, and it is regarded as a differentiating character.

The principal characters differentiating *Pseudangularia thompsoni* and *P. triplacantha* are summarized in Table I.

TABLE I

	P. thompsoni	*P. triplacantha*
Strobila : length ,, greatest breadth	10 mm. 1.1 mm.	20 mm. 840 μ
Proglottis (mature)	broader than long	longer than broad
Scolex : length × breadth	450 × 265 μ	400 × 310 μ
Rostellum : length × breadth	265 × 170 μ	265 × 245 μ
Suckers : diameter	82 to 85 μ	95 to 110 μ
Rostellar hooks : number ,, ,, size	42 52 to 55 μ	60 45 μ
No. of testes	30	30
Cirrus sac : arrangement ,, ,, length × breadth	transverse 240 × 115 μ	oblique 470 × 81 μ
Genital pore	no genital papilla	on genital papilla
Ovarian isthmus	anterior to centre of proglottis	centre of proglottis

Notopentorchis gen. nov.

Paruterinae: Rostellum armed with a double crown of hooks. Genital apertures irregularly alternate. Genital ducts pass ventral to the excretory vessels and nerve. Testes few, dorsal in position. Uterus sac-shaped, becoming spherical with paruterine organ developing anterior to it. Adults in birds. Type: *Notopentorchis collocaliae* gen. et sp. nov.

Notopentorchis collocaliae gen. et sp. nov.

Host: Collocalia unicolor unicolor (Jerd.), the Indian Edible-nest Swiftlet.

Locality: Gammaduwa, Central Province, Ceylon, 3,500 ft.

External: The worm measures 26 mm. in length, its breadth increasing from 88 μ in the exceedingly narrow neck region to 290 μ towards the posterior end. The anterior region of the strobila is narrow but it increases in breadth as the proglottides become mature. There is no sharp line of demarcation between scolex and neck. The first proglottides, apparent 622 μ from the anterior end of the scolex, are much broader than long, mature proglottides are slightly broader than long with salient postero-lateral margins, while late mature and gravid proglottides are longer than broad

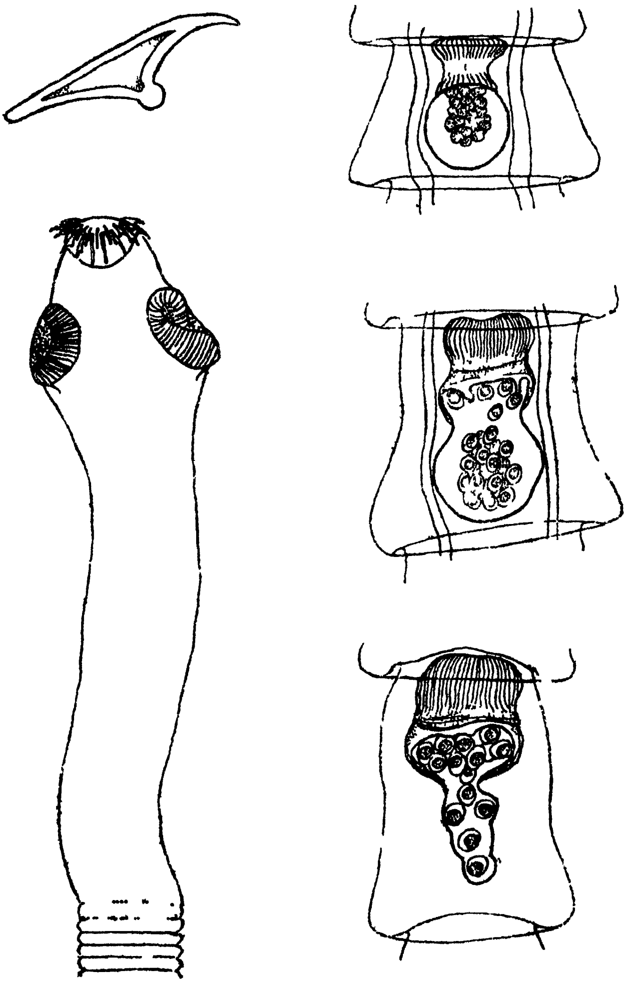


Fig 6 *Notopentorchis collocaliae* gen et sp nov Rostellar hook × 1,500 Scolex × 142 Gravid proglottides × 78, showing development of paruterine organ and manner in which uterus is enveloped

Scolex: The length of the scolex is about 220 µ, and the greatest breadth, in the region of the suckers is 150 µ. The rostellum, solid and shallow, measuring 82 µ in diameter and 52 µ in length, is armed with a double crown of hooks; those of the anterior row have a length of 24 µ and those of the posterior row a length of 27 µ. The suckers are round in outline and 75 µ in diameter (Fig. 6).

Male genitalia: There are five testes situated dorsally, above, but within the lateral limits of the excretory vessels. They attain a diameter of 60 to 70 µ in mature and early gravid proglottides. The vasa efferentia pass ventrally to unite in a coiled vas deferens which passes to the lateral margin ventral to the excretory vessels. The vas deferens terminates in a small cirrus-sac which measures 35 µ long by 30 µ broad, and which contains an internal seminal vesicle. The cirrus-sac does not extend medially as far as the longitudinal excretory vessels. The genital pore is situated slightly anterior to the middle of the lateral margin The genital pores alternate irregularly.

Female genitalia: The ovary, lying in the mid-ventral line, is a large and compact gland consisting of a few blunt acini, and showing a greater development aporally. The shell gland is 35 µ in diameter and lies dorsal and posterior to the ovary, while the vitelline gland lies posteriorly close to the transverse excretory vessels and measures 48 µ in diameter. The vagina is a narrow duct about 5 µ in diameter opening into the genital atrium immediately posterior to the cirrus. It passes ventral to the excretory vessels to enlarge, median to the vessels, into a receptaculum seminis. The uterus is double at first but expands into a simple sac, which, with the development of the paruterine organ, becomes spherical (Fig. 6). The paruterine organ develops anterior to the uterus which it gradually engulfs. The onchospheres measure 28 µ in diameter and are armed with six hooks 19 µ in length.

DISCUSSION

There are five genera of the sub-family Paruterinae possessing the character of a double crown of hooks on the rostellum. These genera are *Biuterina* Fuhrmann 1902, *Paruterina* Fuhrmann 1906, *Culcitella* Fuhrmann 1906, *Deltokeras* Meggitt 1927, and *Sphaeruterina* Johnston 1914. They are separated by various combinations of characters relating to the arrangement of the genital pores, the position of the genital ducts relative to the excretory vessels, the number and arrangement of the testes, the shape of the uterus and the nature and position of the paruterine organ. The main differences between these genera are expressed in Table II.

TABLE II

Genera and References to literature	*Genital pores*	*Relation of genital ducts to excretory vessels*	*Testes*	*Uterus*	*Paruterine organ*
Biuterina Fuhrmann 1902 Also Fuhrmann 1932	irregularly alternate	between	--	single, divided later	anterior, variable
Paruterina Fuhrmann 1906 Also Fuhrmann 1932 Goeze 1782 Wolffhügel 1900	unilateral or irregularly alternate	between	posterior and lateral	—	anterior
Culcitella Fuhrmann 1906 Also Fuhrmann 1932	unilateral or irregularly alternate	between	numerous, posterior and lateral	transverse sac	anterior
Deltokeras Meggitt 1927 Also Fuhrmann 1932	unilateral	?	numerous, posterior	sac-shaped	surrounds uterus
Sphaeruterina Johnston 1914 Also Fuhrmann 1932	irregularly alternate	between	few, posterior	rounded	with anterior dilation
Notopentorchis gen. nov.	irregularly alternate	ventral	few, dorsal	sac-shaped later spherical	anterior

Among the hook-bearing genera the new genus shows a certain relationship to *Sphaeruterina*, in that both have few testes and a rounded uterus, but it is definitely distinguished from this genus by the position of the testes, and the relation of the genital ducts to the excretory vessels. Among the unarmed genera *Anonchotaenia* Cohn 1900 shows some common characters, for it has irregularly alternating genital pores, genital ducts lying ventral to the excretory vessels and few dorsal testes. The unarmed rostellum however, in association with incomplete strobilation anteriorly, and vermiform embryos and eggs, serve to distinguish this genus. It would appear that the differences between the new genus and the unarmed genus *Anonchotaenia* are of the same order as the differences between the armed genus *Culcitella* Fuhrmann 1906 and the unarmed genus *Metroliasthes* Ransom 1900. There is no genus as at present constituted into which the new species may be placed, and as it differs from the known genera in a degree not less than that distinguishing the other genera from each other, the new genus *Notopentorchis*, as defined above, is deemed to be both necessary and valid.

REFERENCES TO LITERATURE

COHN, L. 1900.—Zur Kenntnis einiger Vogeltaenien. *Zool. Anz.*, Bd. 23, pp. 91-98

CLERC, W. 1906.—Notes sur les cestodes d'oiseaux de l'Oural, II. *Centralbl. Bakt. u. Parasitol.* Bd. 42, pp. 713-730

FUHRMANN, O. 1902.—Sur deux nouveaux genres de cestodes d'oiseaux. *Zool. Anz*, Bd. 25, pp. 357-360

1906.—Die taenien der Raubvögel. *Centralbl. f. Bakt. u. Parasitol.* Bd. 41, pp. 79-89, 212-221

1911.—Vogelcestoden der Aru Inseln. *Abhandlung der Senckenbergischen Naturforschenden.* Ges. Bd. 34, pp. 251-266

1932.—Les ténias des Oiseaux. *Mémoires de l'Université de Neuchatel*, pp. 84-135

GOEZE, J. A. E. 1787—Besuch einer Naturgeschichte der Eingeweidewürmer thierischer Körper. *Leipzig.* pp. 405-406

JOHNSTON, H. 1911.—New Species of Avian Cestodes. *Proc. Linn. Soc. of N. S. Wales*, Vol. 36, pp. 58-80

1914.—Some New Queensland Endoparasites, *ibid.* vol. 26, pp. 76-84

MEGGITT, J. F. 1924.—The Cestodes of Mammals, *London*, pp. 54-61, 75-78

1927.—On Cestodes collected in Burma, *Parasitology* vol. 19, pp. 141-153

SINITSIN, D. F. 1896.—Les vers endoparasites des Oiseaux des environs de Varsovie. *Trav. Lab. du Cabinet de Zoologie de l'Université de Varsovie*, pp. 1-20

STRAND, E. 1926.—Miscellanea nomenclatorica zoologica et palaeontologica. *Arch. Naturgesch. Berlin*, 92 A, 8, pp. 30-75

RANSOM, B. H. 1900.—A New Avian Cestode Metroliasthes (n. gen.) lucida (n. sp.) *Trans. Amer. Micrsc.* Soc., Vol. 21, pp. 213-226

WOLFFHÜGEL, K. 1900.—Beitrag zur Kenntnis der Vogelhelminthen. *Freiburg i. Br.* pp. 153-164.

CEYLON J. SCI. (B) VOL. XXI, PT. 1. (February 10, 1938)

A New Avian Cestode, *Pseudochoanotaenia collocaliae* gen. et sp. nov. (Dipylidiinae), from *Collocalia unicolor unicolor*

BY

D. R. R. BURT, B.Sc., F.L.S., F.R.S.E.

Lecturer in Zoology, Ceylon University College

(With Two Text Figures)

Over a dozen specimens of this cestode were obtained from *Collocalia unicolor unicolor* (Jerd.), the Indian Edible-nest Swiftlet, at Gammaduwa, Central Province, Ceylon (3,500 ft.)

External The worms are small measuring from 6 to 10 mm. in length, and are composed of about 55 proglottides. The greatest breadth of the strobila is in the region of the early gravid proglottides which measures 600 to 900 μ. The proglottides have salient postero-lateral margins, and, with the exception of the terminal gravid ones, are broader than long. The genital pores show an alternating arrangement which varies from irregularly alternate in some worms to an almost regular alternation in others. As this is an example of a variation in a genetic character, which, on the observation of one worm alone might result in placing the worm in another genus, an estimation was made of the degree of variation from the regularly alternating condition in different worms. This was done by counting the number of occasions in which the genital pores alternated regularly and expressing the result as a percentage of the possible condition which would be realized if all the pores alternated regularly. The results are summarized in the accompanying table In 23 consecutive proglottides of one specimen the genital pores alternated regularly in every case except two (91% regularly alternate), while at the other end of the series is a worm with 25 consecutive proglottides of which only 17 showed regular alternations of the pores (71% regularly alternate). The average for 7 worms is 81% regularly alternate.

Number of proglottides observed :	25	29	23	19	9	20	20
Number of regular alternations :	17	24	20	16	6	14	16
Percentage regularly alternate :	71	86	91	88	75	74	84

Scolex: The scolex is almost spherical but tapers apically, and it measures from 165 to 200μ in diameter. The suckers, situate rather posteriorly in the scolex, are longer than broad, measuring 95 to 120 μ at their greatest diameter. The rostellum is small, and in all specimens examined it lies invaginated at the apex of the rostellar sac and has the appearance of a small cavity opening at the apex of the scolex by a minute pore (Fig. 1). The rostellar sac measures from 140 to 210 μ in length, but its breadth 66 to 82 μ is less variable, while the rostellum measures 20 μ in diameter in the invaginated condition. The neck is short and fairly well marked off from the scolex, and the first proglottides are apparent about 350 μ from the anterior end of the scolex.

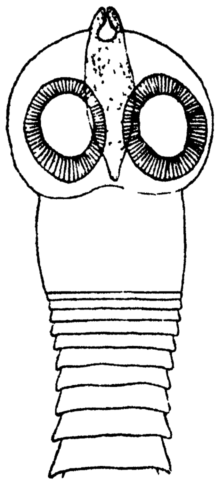


Fig. 1. *Pseudochoanotaenia collocaliae* gen. et sp. nov. Scolex × 112

Male genitalia: There are about 14 testes present, the number varying from 12 to 15. The testes, which attain a diameter of 55 to 65 μ when fully developed, lie in the posterior field of the proglottis, and only extend forward over the female genital glands in late mature proglottides. The vasa efferentia can be easily distinguished in early gravid proglottides where they measure 1.5μ in diameter. They pass medially to unite in the vas deferens (6.5 μ in diameter) which follows a sinuous course to the anterior limit of the proglottis where it is much convoluted and richly provided with prostate glands. The cirrus-sac is large, measuring 120 μ long by 23 μ broad, but it contains no internal seminal vesicle, for the ductus ejaculatorius shows a uniform diameter of 3 μ within the sac. The cirrus-sac lies anterior to the vagina and opens into the genital atrium situated on the lateral margin at a point one-third the length of the proglottis from the anterior end.

Female genitalia The female genitalia attain their maximum development after the male genitalia, at the time when the testes have started to empty of their ripe sperms. The ovary is bilobed, the lobes being blunt and connected by a rather broad ovarian isthmus. The ovary is asymmetrical and it lies obliquely with the aporal lobe larger and extending further forward than the poral lobe. The vitelline gland lies centrally, posterior to the ovarian isthmus, and above it, on the

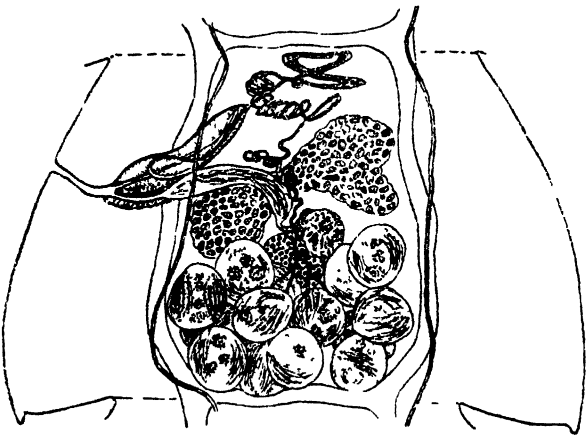


Fig. 2. *Pseudochoanotaenia collocaliae* gen. et sp. nov. Mature proglottis × 275

anterior aporal side lies the shell-gland. The vagina has the walls of its distal region richly provided with glands, and on passing between the longitudinal excretory vessels the vagina enlarges into a receptaculum seminis which leads medially curving round the upper part of the poral lobe of the ovary. The duct formed by the union of the oviduct, vitelline duct, and vagina, passes through the shell gland, and in gravid proglottides passes into the reticulate uterus. The uterus is transient, it appears first as a reticulum and after receiving the ova its walls become constricted between the ova to form uterine egg-capsules, each containing a single egg. The ova when first liberated measure 14.5 μ in diameter; eggs of the latest stage observed were 24 to 27 μ in diameter, but onchospheres were not present.

Excretory system: The ventral longitudinal vessels are large and conspicuous with an average diameter of 21 μ, and they are connected posteriorly in each proglottis by a transverse vessel. The dorsal longitudinal vessels are narrow measuring 8.5 μ in diameter. The genital ducts pass between the longitudinal excretory vessels and dorsal to the lateral nerve.

Muscular system: A layer of longitudinal muscles, consisting of about 20 dorsal and 20 ventral bundles of fibres, divides the parenchyma into cortex and medulla. The thickness of the medulla measured dorso-ventrally in the mid-region of the proglottis is less than a third the thickness of the proglottis.

DISCUSSION

This worm cannot be referred to any of the existing genera of Cyclophyllidea so that it is necessary to create a new one for its reception. The presence of a rostellum and egg-capsules indicates that the genus belongs either to the sub-family Davaineinae or the sub-family Dipylidiinae. The rostellum was found to be unarmed, but as hooks may be deciduous and become detached this is no criterion that the rostellum is always unarmed. However, as there are no unarmed genera in the Davaineinae and as the uterus in that sub-family is sac-shaped before breaking down to form egg-capsules, it would appear that the worm belongs to the Dipylidiinae. In the latter sub-family there are genera with reticulate uteri which are transformed into egg-capsules, and there is one genus in which the presence of rostellar hooks is doubtful. The two genera of the Dipylidiinae most closely akin to the new genus are *Choanotaenia* Railliet 1896 and *Eugonodaeum* Beddard 1913. The new genus differs from *Choanotaenia* in that the latter genus has one or two rows of rostellar hooks and a sac-shaped, lobed uterus, but in other respects the two genera are similar for in both there are irregularly alternate genital pores, genital ducts passing between the longitudinal excretory vessels, posterior testes and egg-capsules, each with a single egg. *Eugonodaeum* resembles the new genus in that rostellar hooks are unknown in both, and both possess genital ducts passing between the excretory vessels, posterior testes, and egg-capsules each with a single egg, but *Eugonodacum* has unilateral genital pores which is a feature sufficiently characteristic to distinguish it.

There is some doubt as to the correct interpretation of the appearance of the rostellum and the rostellar sac. The cavity at the apex of the scolex is considered as an unarmed, invaginated rostellum, lying within the somewhat muscular rostellar sac, on analogy with the condition seen in *Paricterotaenia uncinata* (Fuhrmann 1918) and *Hymenolepis cantaniana* (Polonio 1860). In *Paricterotaenia uncinata*, also found in one of the Cypseliformes—*Collocalia leucopygia*, the hook-bearing part of the rostellum is minute, and when retracted lies in a cavity, and in *Hymenolepis cantaniana*, where the rostellum is unarmed, I have observed both the everted and invaginated conditions, the latter being very similar to that seen in this worm. It may be that the hook-bearing region has become detached in the worms examined, but this would not indicate the identity with *Paricterotaenia* for in the latter genus the uterus is persistent and is not resolved into egg-capsules.

The new genus is defined as follows.—

Pseudochoanotaenia gen. nov.

Dipylidiinae: Rostellum ? unarmed. Genital apertures regularly or irregularly alternate. Genital ducts pass between the longitudinal excretory vessels. Testes posterior. Cirrus-sac large. Uterus at first reticulate, later transformed into egg-capsules each containing a single egg. Parasites of Birds

Type species: *Pseudochoanotaenia collocaliae* gen et sp. nov.

Synopsis of characters

Pseudochoanotaenia collocaliae gen et sp nov.

Host. *Collocalia unicolor unicolor* (Jerd)

Type locality · Gammaduwa, Central Province, Ceylon.

Size. 6 mm. to 10 mm. long by maximum breadth of 600 to 900 μ.

Proglottides · about 55, with salient postero-lateral margins.

Scolex: 165 to 200 μ in diameter.

Suckers: longer than broad, maximum diameter 95 to 120 μ.

Rostellum: ? unarmed, 20 μ diameter.

Rostellar sac: 140 to 210μ long, by 66 to 82 μ broad.

Genital pores: irregularly alternate tending to regularly alternate.

Genital ducts: pass between longitudinal excretory vessels.

Testes: 12 to 15, usually 14; 55 to 65 μ in diameter, posterior to female genital glands.

Ovary: bilobed, asymmetrical with poral lobe larger, lying obliquely in an antero-aporal, postero-poral direction.

Vitellaria: compact, central.

Uterus: reticulate, breaking down into egg-capsules, each with a single egg.

Eggs · 24 to 27 μ in diameter—no onchospheres observed.

REFERENCES

BEDDARD, F. E. 1913.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea XI. On a new Tapeworm from Oedicnemus. *Proc. Zool. Soc. London*, pp. 861-877, 9 figs.

FUHRMANN, O. 1918.—Cestodes d'Oiseaux de la Nouvelle Calédonie et des Isles Loyalty. *F. Sarasin et J. Roux. Nova Caledonia, Zoologie*, Vol. 2, No. 14, pp. 417-418, figs. 14, 15

FUHRMANN, O. 1932.—Les Ténias des Oiseaux. *Mémoires de l'Université de Neuchatel*

RAILLIET, A. 1896.—Quelques rectifications de nomenclature des parasites. *Rec. Med. vet.* (8) Vol. 3, no. 5

CEYLON J. SCI. (B) VOL. XXI, PT. 1. (*February 10, 1938*)

New Avian Cestodes of the Sub-family Dilepidinae from the Eastern Swallow (*Hirundo rustica gutturalis*), with descriptions of *Vitta magniuncinata* and *Vitta minutiuncinata* gen. et spp. nov.

BY

D. R. R. BURT, B.Sc., F.L.S., F.R.S.E.

Lecturer in Zoology, Ceylon University College

(With Five Text Figures)

Collections of cestodes from the Eastern Swallow, shot at Ohiya and the Horton Plains, comprise three different species. Six birds were shot, four of which were infested with cestodes; two birds had over a dozen specimens of the species described first in this paper, one bird had a single specimen of the second species, while the fourth bird had a single specimen of a species identified as *Amoebotaenia globata* (Linstow). The two new forms belong apparently to an undescribed genus of the sub-family Dilepidinae and they form the basis of this paper. The procedure adopted in this account is to define the new genus, describe each species, and then discuss the new genus and the new species.

Vitta gen. nov.

Dilepidinae: Rostellum armed with a double crown of hooks. Genital pores irregularly alternate. Genital ducts pass dorsal to the longitudinal excretory vessels. Testes numerous and posterior, but may extend dorsal and lateral to the female genital glands. Cirrus unarmed. Female genital glands large. Uterus sac-shaped, lobed. Outer egg-membrane with a tapering process at each pole. Parasites of Birds.

Type species: *Vitta magniuncinata* gen. et sp. nov.

Vitta magniuncinata gen. et sp. nov.

Host: Hirundo rustica gutturalis Scop. 1786.

Locality: Ohiya and Horton Plains, Uva Province, Ceylon, 6,000 to 7,000 ft.

External: Externally this worm is characterized by its short length and its broad flattened strobila. The length varies from 17 to 20 mm., and the greatest breadth is 1.5 mm. The strobila consists of 50 to 60 proglottides with slightly salient postero-lateral margins, and the proglottides are broader than long although not disproportionately so. The ratio of breadth to length varies from 3 : 1 in early mature to 9 : 5 in late mature proglottides, and in gravid proglottides the ratio is 5 : 3 - 4. The postero-lateral margins of late mature and gravid proglottides are re-entrant.

Scolex: The scolex is broad basally, narrowing rapidly to a truncate apex. It measures 310 to 320 μ in diameter and 218 to 265 μ in length, including the rostellum. Four small suckers 75 to 82 μ in diameter, directed antero-laterally, are situated rather posteriorly. The rostellum is mushroom-shaped (Fig. 1) and measures 140 to 177 μ long by 144 to 165 μ in diameter at its widest part distally. It is armed with 48 to 51

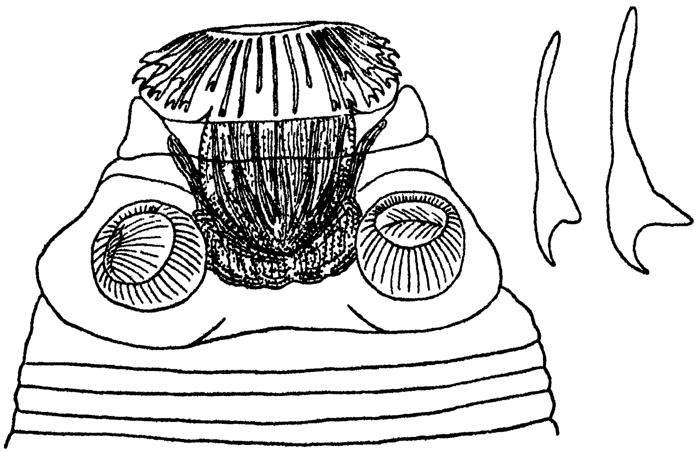


Fig. 1. *Vitta magniuncinata* gen. et sp. nov. Scolex × 220, Rostellar hooks × 660

large hooks, arranged in two rows. The hooks of the anterior row (47 to 52 μ long) are half as numerous as those of the posterior row (56 to 60 μ long) and they are arranged so that each anterior hook lies in the space between each pair of posterior hooks. There is no neck, strobilation starting immediately posterior to the scolex.

Male genitalia: There are 75 to 83 testes in each proglottis, slightly more numerous aporally than porally, arranged in a field which lies posteriorly but extends dorsal and lateral to the female genital glands. The testes attain a maximum diameter of 85 μ before they empty, and their mean diameter in mature proglottides is 68 μ. The vas deferens expands to form a convoluted seminal vesicle before it enters the cirrus-sac in which it again expands into an internal seminal vesicle. The cirrus-sac, when fully developed, measures 337 μ long by 78 μ in diameter, and it lies transversely, close to the anterior margin of the proglottis. The cirrus leads into the genital atrium the aperture of which is situated about one-eighth the length of the proglottis from the anterior margin. The genital pores are irregularly alternate.

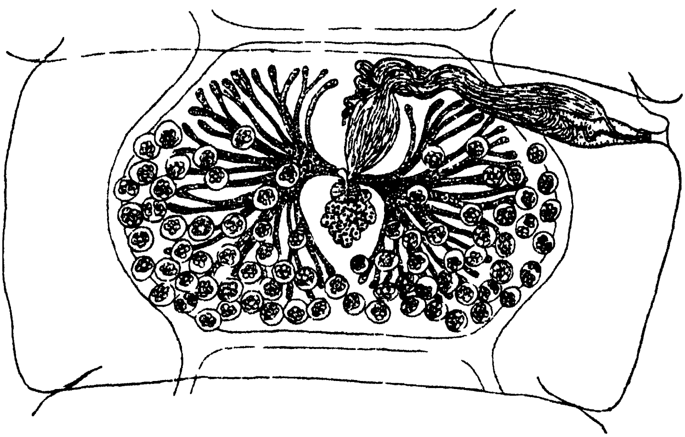


Fig. 2. *Vitta magniuncinata* gen. et sp. nov. Mature proglottis × 67

Female genitalia: The ovary is flattened and alate, each wing being composed of a large number of narrow digitiform acini, and the two wings are connected by a narrow transverse ovarian isthmus from which the oviduct arises. The ovary is slightly asymmetrical with the aporal lobe larger than the poral. The yolk gland is compact being formed of a number of short blunt acini, and it lies centrally posterior to the ovarian isthmus, and antero-dorsal to it lies the shell gland. The greater part of the vagina becomes modified in fecundated proglottides to form a receptaculum seminis. The terminal part of the vagina opening into the genital atrium is narrow and measures 60 μ in length, but mid-way between the lateral margin and the longitudinal excretory vessels the vagina expands to form the distal part of the receptaculum seminis. This part lies antero-dorsal to the cirrus-sac and follows a sinuous course towards the mid-line of the proglottis where it turns posteriorly and forms the proximal part of the receptaculum, a large ovoid sac which attains a size of 312 μ long by 200 μ in diameter. The uterus is sac-shaped and deeply lobed, and in fully gravid proglottides it extends lateral to the longitudinal excretory vessels. The outer envelope of the egg is provided at each pole with an elongate narrowing process (Fig. 3). The breadth of the egg in the centre varies from 24 to 26 μ, and the length of the egg between the tips of the processes measures 66 to 80 μ. The embryo measures 16 to 20 μ in diameter.

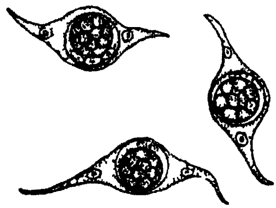


Fig. 3. *Vitta magniuncinata* gen. et sp nov. Eggs from uterus × 360

Excretory system: A dorsal and ventral longitudinal excretory vessel are present on each side, the ventral vessels being connected posteriorly in each proglottis by a transverse vessel. The dorsal vessel measures 15 μ in diameter, but the ventral vessel is less uniform measuring 30 to 38 μ in diameter. The genital ducts pass dorsal to the longitudinal excretory vessels.

Muscular system: Transverse muscles are poorly developed, the most conspicuous muscles being two layers of about 40 bundles of longitudinal fibres, lying each dorsally and ventrally, dividing the parenchyma into cortex and medulla.

Vitta minutiuncinata gen. et sp. nov.

Host: Hirundo rustica gutturalis Scop. 1786.

Locality: Ohiya, Uva Province, Ceylon, 6,000 ft.

External: The worm measures 36 mm. in length by 1.62 mm. at its broadest region. The strobila is composed of more than 100 proglottides which are broader than long with salient postero-lateral margins. The ratio of length to breadth in mature proglottides varies from 3 : 8, to 1 : 2, and in gravid proglottides from 1 : 2, to 3 : 4.

Scolex: The scolex is sub-globose, obtusely pointed apically, 347 μ in diameter by 265 μ in length. The suckers are rounded and measure 225 to 230 μ in diameter, and they are directed antero-laterally. The rostellum which is broadest distally measures 230 μ long by 82 μ in diameter. The rostellum is armed with a double row of 32 to 36 small hooks 17 to 19 μ long. The hooks are disposed in pairs, each pair in the anterior row lying in the space between each pair in the posterior row.

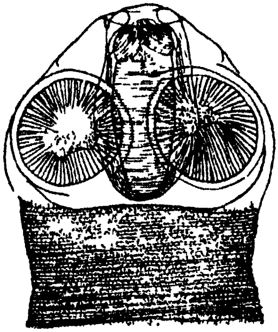


Fig. 4. *Vitta minutiuncinata* gen. et sp. nov. Scolex × 125

Male genitalia: There are 52 to 60 testes which occupy the posterior half of the proglottis overlapping but slightly the female genital glands (Fig. 5). The vas deferens is much convoluted and increases in diameter as it approaches the cirrus-sac, which part of the vas deferens apparently functions as a seminal vesicle. The cirrus-sac is small and does not extend median to the longitudinal excretory vessels. It measures 135 μ long by 32 μ in diameter. The coiled ductus ejaculatorius lying within the sac is not expanded into an internal seminal vesicle. The cirrus-sac lies anterior to the vagina and leads into the genital atrium which opens to the exterior on the lateral margin one-sixth the length of the proglottis from the anterior end. The genital apertures are irregularly alternate.

Female genitalia. The ovary occupies the anterior half of the proglottis and when fully developed extends laterally just under the longitudinal vessels but not into the cortex. The ovary is formed of long, rather thick digitiform acini, the two halves of the ovary being joined by a wide and indistinct ovarian isthmus. The vitelline gland lies ventrally in the centre of the proglottis, and the shell gland lies dorsal and anterior to it. The vagina is a comparatively thick-walled tube 8 μ in diameter with a lumen 2 μ in diameter. It leads from the genital atrium, into which it opens posterior to the cirrus, and follows a sinuous course passing above the longitudinal excretory vessels to enlarge into an almost spherical receptaculum seminis with a diameter of 100 μ. The receptaculum seminis lies aporally just anterior to the

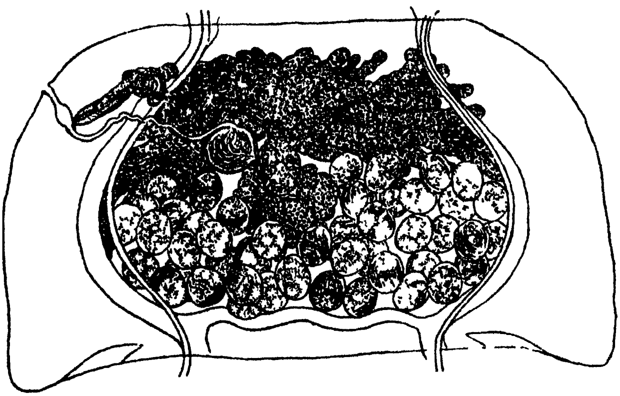


Fig. 5. *Vitta minutiuncinata* gen. et sp. nov Mature proglottis × 100

centre of the proglottis. The uterus is sac-shaped and deeply lobed, and it extends lateral to the longitudinal excretory vessels in gravid proglottides. In fully gravid proglottides the walls of the lobulations appear as septa dividing the cavity of the uterus. The outer membrane of the egg is produced into a tapering process at each pole. The egg measures 80 μ in length and 22 μ in diameter. The embryo measures 17 to 18 μ in diameter.

Excretory system. A dorsal and ventral longitudinal excretory vessel are present on each side, the ventral vessels being connected posteriorly in each proglottis by a transverse vessel. The ventral vessels increase in size in the posterior proglottides and are very conspicuous. The dorsal vessels measure 6 μ in diameter.

Musculature: The cortex is separated from the medulla by a layer of longitudinal muscles of which there are about 36 dorsal and 36 ventral bundles of fibres in addition to many smaller bundles. The circular and transverse muscles are poorly developed.

DISCUSSION

The characters of the two species described above indicate that they must belong to the Dilepidinae. In this sub-family most of the genera are founded on differences in the number of rows of rostellar hooks, the arrangement of the genital pores (regularly or irregularly alternate, or unilateral), the position of the genital ducts relative to the longitudinal excretory vessels, the number and arrangement of the testes, and the shape of the uterus. Various combinations of these characters distinguish the different genera, but there is no combination of characters of any genus so far described which is the same as that of these two species. The following genera possess the characters of alternate genital pores, and ducts passing dorsal to the longitudinal excretory vessels:—*Angularella* Strand 1928, (syn. *Angularia* Clerc 1903), *Catenotaenia* Janicki 1904, *Liga* Weinland 1857, *Parorchites* Fuhrmann 1932, *Pseudangularia* Burt 1938, and *Gidhaia* Johri 1934. The present genus is distinguished from *Angularella* by the double row of rostellar hooks, from *Catenotaenia* by the form of the rostellum and the shape of the uterus, from *Liga* by the irregular alternation of the genital pores and the absence from the eggs of tubular processes surmounted by swellings, from *Gidhaia* (in which genus the scolex is not known) by the position of the testes, and from *Pseudangularia* by the presence of two rows of hooks and the position of the testes. It is distinguished from *Parvirostrum* Fuhrmann by the large size of the female genital glands, by the large rostellum and the position of the testes, the relation of the genital ducts to the longitudinal excretory vessels not being given as a diagnostic character in this genus. In many respects the new genus resembles *Anomotaenia* Cohn, a genus which includes a number of species parasitic in Swallows and Swifts, but it has the fundamental difference of the relation of the genital ducts to the longitudinal excretory vessels. Apart from this fundamental difference the other generic characters agree, namely, the presence of two rows of rostellar hooks, irregularly alternate genital pores, posterior and lateral testes and sac-shaped uterus, and in addition a number of species of *Anomotaenia* possess eggs with polar processes of the outer envelope.

The new genus is named *Vitta* with the definition given above, and *Vitta magniuncinata* is selected as the type species.

There can be no question as to the specific differences between the two species *Vitta magniuncinata*, and *Vitta minutiuncinata*. Although only a single specimen of the latter species was obtained, a series of the former species was examined and *minutiuncinata* can find no place within this series. The following table gives the outstanding differences between the two species:—

	Vitta magniuncinata	*Vitta minutiuncinata*
Rostellar hooks : number size	48 to 51 47–52 μ, 56–60 μ	32 to 36 17 to 19 μ
Suckers : diameter	75 to 82 μ	225 to 230 μ
Testes : number	75 to 83	52 to 60
Cirrus-sac : size	305 by 68 μ	135 by 32 μ
Ovary : acini isthmus	digitiform, thin narrow	digitiform, thick broad, indistinct
Receptaculum seminis	central, 312 × 200 μ	aporal, spherical 100 μ

Apart from these measurable differences, the general appearance of the two worms is different, and the broad flattened strobila of *Vitta magniuncinata* is distinctive.

Both species possess polar prolongations of the outer membrane of the egg, and so this character is included in the diagnosis of the genus. But this character is not confined to the new genus *Vitta* for several species of *Anomotaenia* also possess this peculiarity, namely *Anomotaenia depressa* (von Siebold) and *Anomotaenia ovolaciniata* (von Linstow), both parasitic in *Hirundo rustica rustica* Lin. and in *Chelidonaria urbica* (Lin.). In *Anomotaenia depressa* there are 28 to 30 rostellar hooks with lengths of 50 μ and 42 μ, which number approaches that of *V. minutiuncinata* while the size is different, and the sizes of the hooks approach those of *V. magniuncinata* while the number is distinctly different. The suckers of *Anomotaenia depressa* are large like those of *V. minutiuncinata*, but the number of testes is smaller than in either of the two new species. The description of *Anomotaenia ovolaciniata* is very incomplete and this worm has apparently not been redescribed since its first description in 1867. *Anomotaenia ovolaciniata* possesses 38 to 40 rostellar hooks of two sizes 18 μ and 15 μ. The number exceeds that of *V. minutiuncinata* although the two sizes are comparable. *Anomotaenia ovolaciniata* can however be distinguished from both of the new species by its characteristic cirrus which is short and thick (28 μ long by 12 μ broad) and armed with spines, characters possessed by neither of the latter species.

It is thought that a number of species at present described as belonging to the genus *Anomotaenia*, may prove, on a closer examination of the relation of the genital ducts to the longitudinal excretory vessels, to belong to this new genus, for which reason species of the genus *Anomotaenia* are included in this discussion.

Synopses of the diagnostic characters of the new species:

Vitta magniuncinata gen. et sp. nov.

Host: *Hirundo rustica gutturalis* Scop. 1786.

Locality: Ohiya, Uva Province, Ceylon.

Strobila: 17 to 20 mm. long by 1.5 mm. greatest breadth, of 55 to 60 proglottides.

Scolex: 310 to 320 μ in diameter, by 218 to 265 μ long.

Rostellum: mushroom-shaped, 140 to 177 μ long, by 144 to 165 μ greatest diameter.

Hooks: 48 to 51, arranged in two rows; hooks of anterior row 47 to 52 μ long and half as numerous as hooks of posterior row 56 to 60 μ long.

Suckers: small, 75 to 82 μ in diameter.

Testes: 75 to 83 in number, maximum diameter 85 μ, mean diameter 68 μ, more numerous aporally; situate posterior, lateral, and dorsal to female genitalia.

Cirrus-sac: 305 μ long by 68 μ in diameter (maximum size 337 μ by 78 μ).

Seminal vesicles: internal and external seminal vesicles present.

Ovary: large, alate, flattened; formed of long narrow digitiform acini.

Vagina: swollen in mature proglottides except distal 60 μ of length.

Receptaculum seminis: large, median, attains size of 312 μ by 200 μ.

Eggs: outer envelope with a tapering process at each pole; size 60 to 80 μ by 24 to 26 μ.

Embryos: 16 to 20 μ in diameter.

Vitta minutiuncinata gen. et sp. nov.

Host: *Hirundo rustica gutturalis* Scop. 1786.

Locality: Ohiya, Uva Province, Ceylon.

Strobila: of more than 100 proglottides, 36 mm. long by 1.62 mm. maximum breadth.

Scolex: 347 μ in diameter, by 265 μ in length.

Suckers: round in outline, 225 to 230 μ in diameter.

Rostellum: 230 μ long by 82 μ broad.

Hooks: 32 to 36 hooks arranged in a double row; 17 to 19 μ long.

Testes: 52 to 60 testes occupying the posterior half of the proglottis.

Cirrus-sac: 185 μ long by 82 μ in diameter, does not extend median to the longitudinal excretory vessels.

Seminal vesicles: external seminal vesicle present, internal seminal vesicle absent.

Ovary: large, composed of thick digitiform acini; occupies anterior half of proglottis and extends lateral to longitudinal excretory vessels.

Receptaculum seminis: spherical, aporal, 100 μ in diameter.

Eggs: with a tapering process of outer envelope at each pole, 80 μ long by 22 μ in diameter.

Embryos: 17 to 18μ in diameter.

REFERENCES

BURT, D. R. R. 1938.—New Avian Cestodes of the Family Dilepididae from *Collocalia unicolor unicolor* (Jerd.), the Indian Edible-nest Swiftlet, with descriptions of *Pseudangularia thompsoni*, *P. triplacantha* gen. et spp. nov. and *Notopentorchis collocaliae* gen. et sp. nov. *Ceylon Journal of Science*, B. vol. XXI, pp. 1-14

COHN, L. 1900.—Zur Kenntniss einiger Vogeltaenien. *Zool. Anz.*, vol. 23, pp. 91-98

FUHRMANN, O. 1908—Noveaux ténias d'oiseaux. *Rev. Suisse de Zoologie*, vol. 16, pp. 60-62, figs. 49-50

FUHRMANN, O. 1932.—Les Ténias des Oiseaux. *Mémoires de l'Université de Neuchatel*, pp. 90, 106-111, figs. 82, 83

JOHRI, L. N. 1934.—Report of a collection of Cestodes from Lucknow (U. P. India). *Records of the Indian Museum*, vol. xxxvi, pp. 169-171, fig. 8

LÜHE, M. 1910.—Die Süsswasserfauna Deutschlands, Heft 18, Cestodes, Jena, pp. 107-108, figs. 119, 120.

STRAND, E. 1928.—Miscellanea nomenclatorica zoologica et palaeontologica. *Arch. Naturgesch.* Berlin. 92A, 8 pp. 30 75

VON JANICKI, C. 1904.—Bemerkungen über Cestoden ohne Genitalporus. *Ctbl. f. Bakt. u. Parasitol*, vol. 36, pp. 222, 223, 1 fig.

VON LINSTOW, O. 1877.—Helminthologica. *Arch. f. Naturgesch.* Jahrg. 43, p. 14, pl. 1, fig. 21

1896.—Helminthologische Mitteilungen. *Arch. mikrosk. Anat.* vol. 48, pp. 388 396, pl. 17, figs. 21-24

VON SIEBOLD, C. T. 1836.—Zur Entwicklungsgeschichte der Helminthen, in *Burdoch, K. F., Die Physiologie als Entfahrungswissenschaft.* Leipzig., vol. 2, pp. 201-206

WEINLAND, F. 1857.—Observations on a new genus of Taenioids. *Proc. Boston Soc. Nat. Hist.*, vol. 6, pp. 59-63

CEYLON J. SCI. (B) VOL. XXI, PT. 1. (February 10, 1938)

The External and Radiological Anatomy of a Foetal Asiatic Elephant

BY

W. C. OSMAN HILL, M.D.

Anatomy Department, Ceylon Medical College, Colombo

(With Two Plates and Five Text Figures)

Few elephantine foetuses have hitherto been described and most of them have been African specimens (see Eales 1931). Eales has dealt with some points concerning a mid-term Asiatic foetus in her paper on the mandible; but there appears to be no general account of the external features of a foetus of this species.

The following account is based on a preserved specimen loaned to me by the Director, Colombo Museum. No history is attached to the specimen, but, for reasons stated in my account of its vascular anatomy, published in this part, I have concluded that it had reached a stage between mid and full-term, probably nearer to the former. Eales' Indian foetus was estimated as having attained the tenth month of intrauterine life. The present specimen had probably passed through twelve of the possible eighteen months gestation[1].

In studying the radiographic anatomy of the skull I have had occasion to make comparison with an adult skull in this department and also with newly born skulls, two in the collection of the Colombo Museum and one in the Zoological Department of University College, Colombo.

I. EXTERNAL ANATOMY (Plate I)

General form and proportions

The general appearance is definitely that of an elephant, and can be mistaken for no other animal. The trunk is well developed, the head of typical elephantine form and proportions; the torso stout and deep dorso-ventrally, with scarcely any neck; and the limbs cylindroidal,

1 Wilson (*J. Bomb. Nat. Hist. Soc.*, 1922) gives twenty-two months as the gestation period of *Elephas maximus*.

with blunt, truncated extremities. The general proportions can be ascertained from the measurements in the accompanying table.

TABLE 1. *Body measurements of foetal elephant in millemetres*

Maximum length (crown-rump).	315.
Length of tail.	168.
Head length (forehead-back of skull).	87.
Shoulder-ischium.	215.
Forehead-shoulder.	100.
Maximum height.	266.
Ht. at withers.	242.
Ht. at croup.	235.
L. of proboscis (from angle of mouth).	175.
L. of proboscis (from forehead) (on X-ray).	150.
L. of lower lip (from angle of mouth).	53.
Max. transverse cephalic diameter.	83.
Bigonial breadth.	46.
Trans. diameter of mouth (between external angles).	52.
Trans. diameter of mouth (between internal angles).	27.
Thickness of cheek.	12.5.
Across palate.	26.
Palpebral fissure.	10.
Interocular breadth.	62.
Ear length.	63.
Ear breadth.	51.
Height of neck.	81.
Max. depth of torso.	166.
Bimammillary diameter.	29.
Shoulder-elbow.	104.
Elbow-wrist.	80.
Wrist-palm.	57.
Length of forefoot.	39.
Breadth of forefoot.	32.
Interiliac.	80.
Hip-knee.	102.
Knee-malleolus.	84.
Malleolus-sole.	32.
Length of hind foot.	41.
Breadth of hind foot.	25.
Anus-tip of penis.	145.

The skin surface of the foetus is everywhere smooth, unwrinkled and hairless. Some pigment is present in the skin, giving, in the preserved specimen, a dirty brownish colouration, but this is patchy, due to the localized shedding of some layers of epidermis through faulty preservation.

The foetal flexed posture is scarcely appreciable in this specimen compared with the great degree of flexion exhibited by the African and Asiatic foetuses figured by Eales. In the present example the back is strongly arched, but the limbs are not markedly contracted.

Head

The general form of the head is pyriform, somewhat compressed laterally. The broad end is attached by the short, thick neck, to the torso. The narrow end or muzzle is prolonged forwards and downwards, the upper jaw forming the proboscis and the lower a much shorter, but sharply pointed, lower lip.

The proboscis, 150 mm. long, from its tip to the free edge of the nasal opening of the skull, is a soft, flexible organ tapering gradually to its tip, where it measures 7 mm. dorso-ventrally and 12 mm. from side to side. The dorsal margin at the tip is produced to form a short, conical finger-like process, 5 mm. long. No such process is formed ventrally, but the ventral margin is much thickened and prominent, narrowing towards the two sides. The free extremity of the proboscis presents the two narial openings, separated by a median vertical septum, 2 mm. thick. Each opening is oval in outline and measures 2.5 mm. dorso-ventrally and 2 mm. from side to side. The dorsal aspect of the proboscis is convex from side to side and shows numerous transverse furrows. The ventral surface is flatter, especially at the proximal end. At the level of the symphysis menti its diameter is 15 mm. dorso-ventrally, by 27 mm. from side to side. At its proximal end the ventral aspect of the proboscis extends into a flat triangular area continuous behind with the roof of the mouth with no appreciable change in character until the concavity of the palate is reached, apart from cessation of skin pigment, which occurs at the junction of the skin with the mucous membrane. The proboscis is thus to be regarded, as pointed out by Boas and Paulli (1908) as incorporating the upper lip as well as the nose of other mammals.

The forehead is evenly convex, and does not show the frontal boss characteristic of the adult Asiatic Elephant though the outline does not shear off to the extent seen in the African species.

The eyes and accessory parts are very small and widely separated. The anterior third of the palpebral fissure is narrower than the rest and is occupied by a well developed lacus lachrymalis. The rest is filled by the globe of the eye. The medial (*i.e.*, anterior) canthus is less sharp than the lateral. The eyelids are not provided with eyelashes and their borders are quite smooth. A number of sulci separate the periphery of the lids from the surrounding skin. Those bordering the lower lid are deeper than those for the upper lid.

The mouth is a wide transverse slit bounded above by the inferior surface of the proboscis and below by the pointed lower lip. Its lateral angles are guarded by the free anterior edge of the cheeks, which are very thick (see Table I). There is no true vestibulum oris, for the alveolo-labial sulcus is not developed. Further back, within the cheeks, there is a broad, shallow bucco-alveolar groove, better marked in the lower than the upper jaw. The palate is concave from side to side and also from before backwards. Anteriorly it is continuous with the inferior surface of the proboscis. Just posterior to the junction is a series of pits probably representing the entrance to the organ of Jacobson.

Laterally, at the junction of the palate, proboscis and cheeks, is on each side, a deep oblique pit, indicating the site of the future tusk, of which the walls of this pit will form the sheath. Half a dozen fully marked transverse rugae are visible on the anterior portion of the palate They are concave forwards on each side of the mid-line, forming thus a series of double arches.

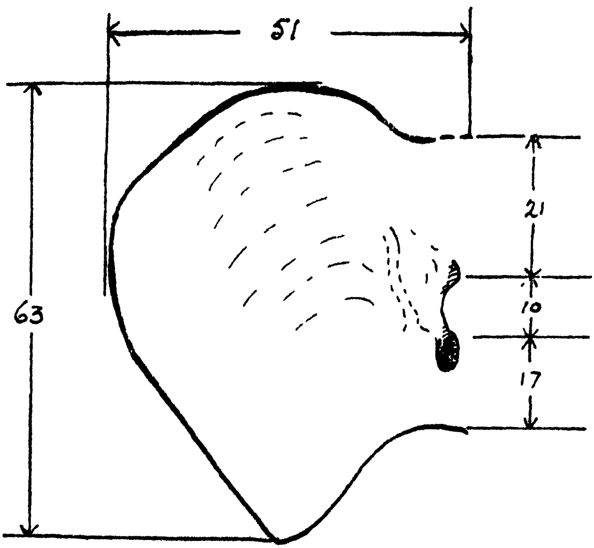


Fig. 1. Diagram of the right ear, with method of measurement

The tongue conforms to the shape of the space between the two rami of the mandible. It is convex from side to side as well as from before backwards. Anteriorly it ends in a free, pointed apex. The dorsal surface of the tongue is quite smooth, but the binocular microscope shows a number of very scattered rounded papillae, especially numerous towards the lateral border. The under surface of the tongue is smooth. It is connected by a fraenum to the mandible in the mid-line anteriorly.

The ear is composed mainly of a flat flap of skin, roughly triangular in outline and attached anteriorly to the side of the head by a vertical line of attachment 48 mm. long. The apex of the triangle lies ventrally and the base, which is convex upwards, lies dorsally. In front of the attached portion of the flap is a small tragus, guarding the external auditory meatus. This is a relatively small oval opening which faces upwards and posteriorly and which leads into a narrow canal in the opposite direction. Posterior to the meatal opening is a slight vertical elevation representing an antitragus. Dorsal to the tragus, and separated from it by a slight notch, is another vertical fold, very poorly marked, passing on to the upper part of the main flap. This is a feeble helix. No other folds are detectable.

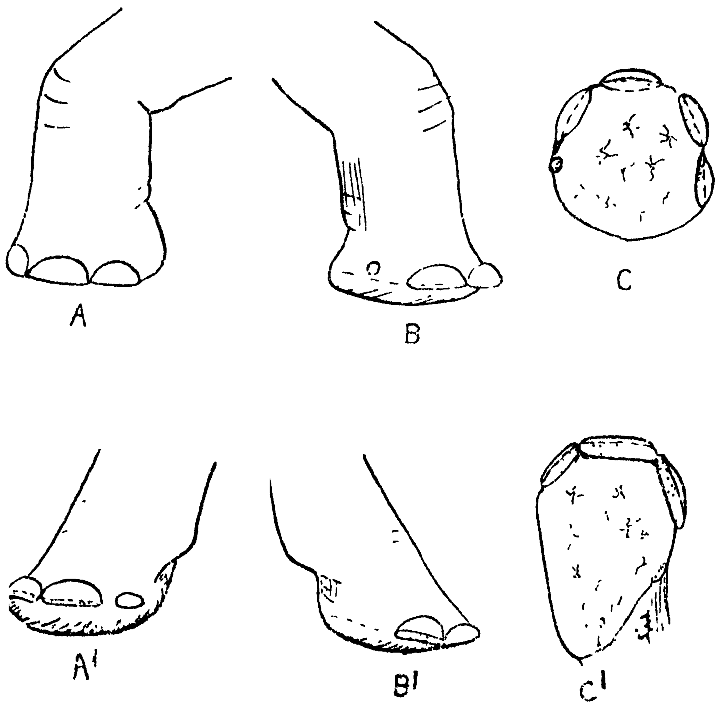


Fig. 2. Fore and hind foot of foetal Asiatic Elephant × 1

A. Left manus; lateral aspect. B. The same; medial aspect. C. The same; plantar aspect
A'. Left pes; lateral aspect. B'. The same, medial aspect. C'. The same, plantar aspect.

The Fore and Hind Feet

The hand, measured from the dorsum of the wrist to the plantar surface, is considerably longer than the foot. The hand is cylindroidal, and its distal extremity only is converted into a walking surface. The latter has therefore a roughly circular outline (see Fig. 2), but is slightly longer antero-posteriorly than from side to side. The digits are not individually recognizable apart from the nails developed at their extremities. Of these, two lie along the lateral margin, one directly anterior, and another on the medial margin. A fifth rudimentary nail lies behind the last mentioned one on the medial border. The nails are scarcely harder than the surrounding skin.

The foot (Fig. 2, lower figures) is compressed laterally so that it measures almost twice as much antero-posteriorly as it does in its lateral measurement. The plantar surface is oval or subtriangular, being somewhat broader in front than behind. The digits are not recognizable except for the toe nails. These are four in number, and are situated one at the extreme anterior margin, and one on each side of this. The fourth is rudimentary and is situated behind the third on the lateral margin of the foot. It is not so vestigial as the pollicial nail on the fore-foot.

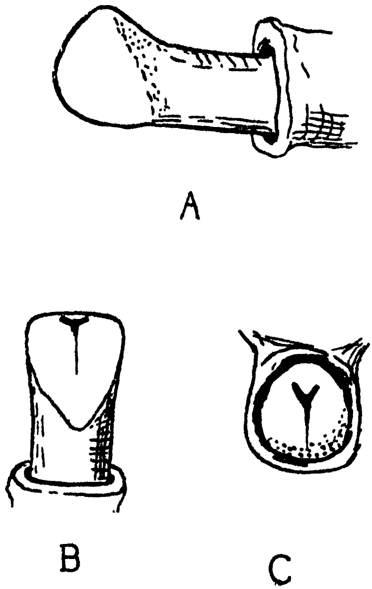


Fig. 3. The glans penis of a foetal Asiatic Elephant

A. Left lateral view; B. Ventral view; C. Apical view.

External Genitalia

There is no scrotum. The penis is enclosed within a sheath of skin which extends from a point 10 mm. ventral to the anus along the ventral belly wall to within 15 mm. of the caudal margin of the umbilical cord. The glans protrudes from the anterior end of this sheath, which thus slings the penis to the belly wall as in true Ungulates. The re-entrant layer of the prepuce is continued beyond the corona glandis for some 5 mm. along the body of the penis. This portion of the organ is subcylindrical. The glans is bluntly rounded, and bevelled off ventrally thus resembling a human glans turned upside down. The urethral orifice is situated symmetrically on the most anterior part of the glans. It is a triangular orifice with two long lateral lips and a small dorsal lip (fig. 3).

II. RADIOLOGICAL ANATOMY

The state of ossification of the skeleton can readily be made out in the radiograph (Plate II). The general condition is one of advanced ossification; for all the main bones are represented by their primary centres. No secondary or epiphyseal centres are detectable, and it is therefore evident that considerable portions of the skeleton are still in a cartilaginous state.

The Skull

Both cranium and face are well advanced in bone formation, and the general form already resembles that of the adult, except that the cranium is more globular, and the more specialized parts of the face are not yet very prominent.

The cranium takes an almost equal share with the face in the formation of the skull. It appears to be no more than a bony shell around the brain, for there is no indication of the development of the characteristic pneumaticity of the cranial bones of the post-natal animal. Of its constituent elements, the exoccipitals, supraocipital, frontals, parietals and squamosal can be readily detected, but other bones are not easily recognizable individually in the radiograph. The exoccipitals unite around the foramen magnum behind, thus excluding the supraoccipital as in the adult. In the face the short, outstanding nasals can be seen and below these the premaxillae and maxillae. No incisor tooth rudiment is identifiable with certainty, but molar calcifications are present in the maxilla and mandible. A dark shadow (on the negative) indicates the outline of the nasal fossae, interrupted anteriorly by the lateral margin of the external opening of the fossa, formed by the premaxilla ascending to meet the frontal. The shadow is also interrupted horizontally by the zygoma. Above the latter lies the orbit,

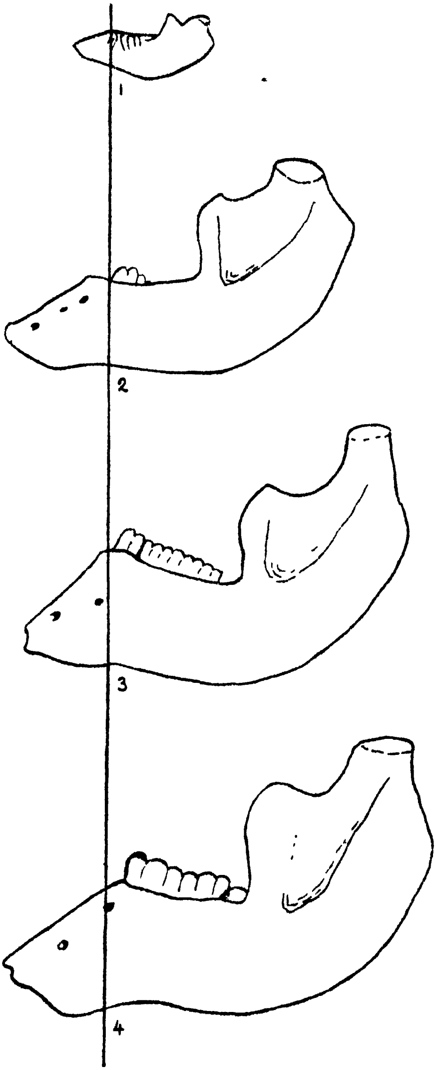


Fig. 4. Outline drawings of the mandibles of (1) a mid-term foetus and (2-4) three early post-natal stages of the Asiatic Elephant. All reduced to ⅓

The foetal mandible has been traced from the radiograph; the others were drawn with a dioptograph after orienting the mandibles in a Kubuskraniophor in such a manner that the two condyles were in the same horizontal and vertical planes and the median plane at right angles to them. The vertical line passes through each mandible so as to touch the anterior border of the first molar, except in the last where that tooth has already been shed, and in which the line passes through the closed part of the alveolar border.

which freely communicates behind the temporal fossa. The image of the bony palate can be seen lying horizontally, parallel to the zygomatic arch and extending well back.

The Mandible

In view of the work of Eales (1931) on the growth of the mandible in the Elephant, this part needs special attention. From the outline drawings in Fig. 4 above, the growth changes in the mandible can be appreciated. The first stage shown is that of the foetus under consideration. This is followed by the outlines of three successive post-natal stages in the same species.

In the foetal mandible the horizontal ramus or " body " is relatively large and straight, whilst, the vertical ramus is barely represented. The symphysis reaches as far forwards as the upper jaw, or a little beyond. The alveolar border is relatively straight, and there is no deflection of that portion of mandible anterior to that bearing the molar tooth rudiments. The lower margin of the jaw forms a gentle convexity increasing towards the angle.

The youngest post-natal stage in the accompanying figure shows the mandible of an elephant corresponding closely with the six months old African animal discussed by Eales. There is still a good deal of bone anterior to that part of the alveolar margin which bears the molar teeth, and this part is moreover, deflected downwards. It differs from the African animal, however, in so far that the symphysis still projects further forwards than the upper jaw. The lower margin is straighter, and even slightly convex at one point. The vertical portion is now well developed and forms roughly a right angle with the axis of the " body ".

In the third animal whose mandible is represented in Fig. 4 the upper jaw projects further forwards than the lower. There is now comparatively little bone anterior to the molars. The portion of the alveolar border anterior to the first molar is strongly deflected downwards, and the root of the first molar is actually exposed anteriorly at the commencement of this deflection. The deflected portion forms a sharp edge, and meets the symphysis in a beak-like arrangement below. The lower border of the mandible is similar to the previous stage, but the angle is now scarcely visible.

The oldest mandible represented in Fig. 4 is very similar to the preceding, except for its larger size. As in the last, the mandible does not project as far forwards as the upper jaw. The small first molar has already been shed and the second molar now occupies the most anterior part of the tooth-bearing portion of the alveolar margin. That part of the alveolar border which was previously occupied by the first molar has grown forwards and become incorporated with the sharp-edged, downwardly deflected part of the jaw. The other parts need no special description in this specimen.

The above series of mandibles thus serves to confirm the essential points brought out by Eales' work on the same question, although there are apparently minor differences between the Indian and African species. It is clear therefore that in both species the mandible, during its development, undergoes phases similar to those believed to have been passed through in its palaeontological history.

Vertebral Column

The vertebral column has attained its specific form and curvature. The vertebrae are represented by primary ossifications forming centra and neural arches, whilst in the thoracic region there are additional ossifications in the elongated spinous processes. The cervical region forms an almost straight line, extending backwards and slightly ventralwards from the foramen magnum. A sharp angle is formed between it and the thoracic region of the column. The remainder of the column forms an evenly arched curve, the summit of which is in the hinder part of the thoracic region. The anterior and posterior limbs, with their girdles, form the supports of this arch.

The vertebral formula is C 7, Th. 19, L 5, S 2, C 20. This formula differs somewhat from those given by Owen (1866) and Huxley (1881). Owen allows twenty thoracic vertebrae, but there are only nineteen pairs of ossified ribs in the present foetus. Owen allows twenty-three thoraco-lumbar vertebrae, whereas in our foetus there are twenty-four. This is due to the fact that in the foetus only two vertebrae are truly sacral, whereas Owen allowed three. The last lumbar of Owen's series evidently becomes " sacralized " during further development. Only twenty caudal vertebrae show bony centres in the foetus, but there are evidently others still cartilaginous in the terminal part of the tail. The last fifteen of the ossified foetal caudal vertebrae are represented by centra only.

The wedge-shaped concavity at the back of the neck in the angle between the cervical and thoracic vertebrae, is filled with a mass of muscular and fibrous tissue. Evidently a highly developed ligamentum nuchae is present here, and shadows on the radiograph indicate roughly the direction and strength of its fibres. They pass upwards and forwards from the cervical neural arches towards the occiput, in contrast to the elongated spinous processes of the thoracic vertebrae, which proceed backwards throughout the series. There is no anticlinal vertebra.

Sternum and Ribs

The sternum is not shown in the radiograph, since it had been removed. The isolated sternum was studied, however, as a cleared

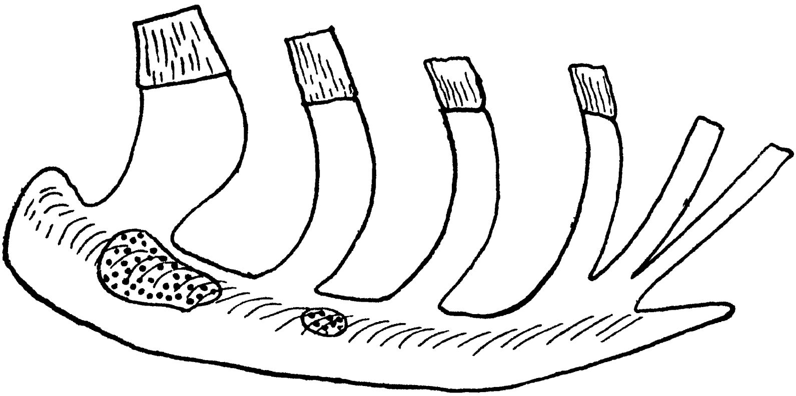


Fig. 5. Lateral view of the sternum to show position of ossific nuclei

preparation. It is mainly cartilaginous but well formed and has a deep ventral keel, the latter being markedly produced forwards (see Fig. 5).

The sternum with the six costal cartilages which reach it on each side, forms a single cartilaginous mass. Two ossific centres are detectable in this, both laterally compressed and situated in the junction of the body and keel. The anterior centre is large and triangular in outline, and the posterior smaller and more rounded. Their relation to the costal cartilages is indicated in Fig. 5. The sternum lies with its anterior end 30 mm. ventral to the cervico-thoracic angle of the vertebral column. The axis of the sternum proceeds backwards and ventralwards from this point. The first two pairs of ribs are therefore short and stout. The next four pairs are longer, the last of this series being the longest ribs of all. Thereafter the ribs become rapidly shorter, and splayed out from their fellows. This gives the peculiar outline to the thoracic cavity, well seen in the radiograph, and also explains the peculiar relations of the thoracic viscera, to which attention has already been called in my account of the circulatory system (*vide* p. 46 of this

11——J. N. 67692 (8/37)

volume). The obliquity, and expansiveness of the diaphragm are also accounted for by these skeletal arrangements. The outline of the thoracic cavity may be described as triangular, with its apex below, and its base formed by the thoracic part of the vertebral arcade. The abdomen, on the contrary, has a triangular outline, with its apex above, and its base below,—formed by the ventral abdominal wall. The belly had been emptied of its contents, hence its clearness in the radiograph.

Appendicular skeleton

The pectoral girdle is represented solely by the scapula. This is triangular in form, with a blunt apex at the glenoid, where obviously the head and neck of the organ are still unossified. The "vertebral" border faces posteriorly more than dorsally and is not properly ossified. The axillary border is sharper and concave.

The pelvic girdle consists of a bar-like ilium, an ischium and a small pubic ossicle on each side. As pointed out above, the ilium gains union only with two vertebrae in the sacro-iliac joint. The bone lies rather vertically, and the ischium is in line with it. The pubes are largely cartilagious.

Of the long bones of the limbs, primary ossifications, representing the shafts, are present in humerus, radius, ulna, femur, tibia and fibula. No epiphyseal centres are present, so that the ends of the shaft in all these bones are flat. These bones appear to consist almost entirely of dense bone. There is no medullary cavity in any of them, but there is some cancellous tissue near the ends of the humerus and femur, and much more in the bones of the forearm and crural region.

The femora are longer than the humeri, and on both the proximal ends are broader than the distal, the difference being more extreme in the case of humerus than femur. Radius and ulna cross one another as in the adult elephant. Tibia and fibula are distinct and have an appreciable space between them. The radius and ulna are subequal, except that the proximal end of the ulna is enlarged. The tibia is very stout, but the fibula is weak.

No ossifications are present in carpus or tarsus, except for a nodule representing the calcaneum, but metacarpals and metatarsals have their primary centres developed. The former are more advanced than the latter. One row of phalanges, presumably the middle row is also represented by its primary ossifications. These too are better developed in the hand than the foot, the discrepancy being of greater degree than with the last mentioned bones. These statements, based primarily on the X-ray picture have been confirmed by dissection.

SUMMARY

1. The external features of a mid-term foetus of *Elephas maximus* have been described and comparison made with the African species.

2. The skeleton of the foetus has been studied radiographically.

3. Special attention has been drawn to the mandible which has been compared with a series of post-natal stages. The growth of this bone presents features suggestive of repetition of its phylogenetic history, as already shown for the African species by Eales.

4. The state of ossification of the limbs is less advanced than would be expected from known facts concerning other Ungulates (*c.f.* Harris's (1935) statements on the pig, sheep, etc.). It is more in keeping with the development of the human skeleton

REFERENCES TO LITERATURE

Boas, J. E. V. and Paulli, S. (1908). *The Elephant's Head* (Copenhagen), pp. 49 50

Eales, N. B. (1931). *Proc. Zool. Soc.*, pp. 115-125, Pl. 1

Harris, H. A. (1935). *Growth and Dentition.* Reprinted from *Dental Record*—no pagination

Huxley, T. H. (1871). *Anat of Vertebrated animals*, pp. 248 *et seq.*

Owen, R. (1866). *Comp. Anat. of Vertebrates* II, p. 437 *et seq.*

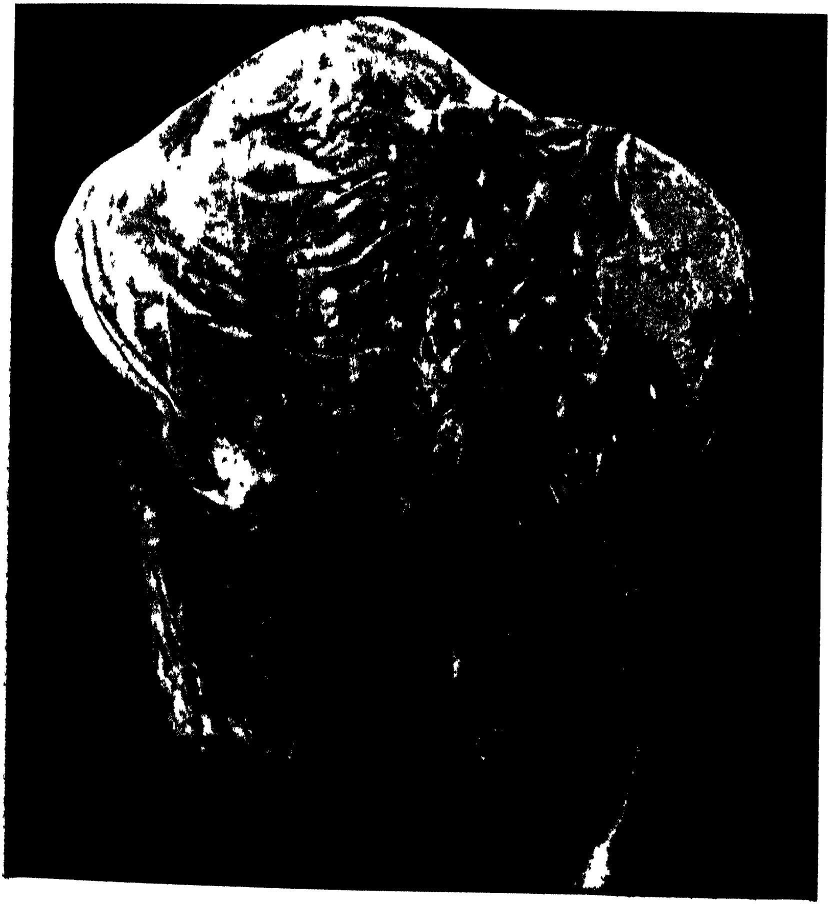
EXPLANATION OF PLATES

Plate I.

Photograph of advanced foetus of Asiatic Elephant (*Elephas maximus*).

Plate II.

Radiograph of the same foetus.



FOETAL ASIATIC ELEPHANT ♂

CEYLON J. SCI. (B) VOL. XXI, PT. 1. (*February 10, 1938*)

Studies on the Cardiac Anatomy of the Elephant
II.—The Heart and Great Vessels of a Foetal Asiatic Elephant

BY

W. C. OSMAN HILL, M.D.,

Anatomy Department, Ceylon Medical College, Colombo

(With Two Plates and One Text Figure)

The loan of a foetal specimen of an Asiatic Elephant (*Elephas maximus*) from the Colombo Museum, by the kindness of the Director of that institution, has enabled me to make a comparison with the heart of an adult previously dissected and in part reported on (Hill, 1936). Hitherto elephantine foetal anatomy has been dealt with in detail only for the African species, upon which a monograph and other papers have been published by Eales (1925-29). The specimen at my disposal has therefore enabled me to make important comparisons with the African form for the first time. In the present contribution I propose to limit my remarks to the heart and great vessels. I hope to publish later an account of the external anatomy.

No data are available regarding the specimen beyond the fact that it has been in formalin for many years. It is well preserved, but unfortunately the abdominal viscera had been removed in part. I found the thoracic viscera intact, but very brittle from long standing in formalin. Before dissection, therefore, I had the organs placed in glycerine for some weeks. This did not entirely overcome the brittleness, but dissection was made much easier thereby. As regards age, the foetus appears to have been somewhat older than mid-term, judged from its state of development. It measured 315 mm. in length from forehead to rump, the tail being an additional 168 mm. The specimen is thus larger than the older of the two African foetuses measured and figured by Eales (1931) and judged to be at the tenth month of prenatal life, or a little less than half term. The general appearance and state of development of the present specimen are similar to this African foetus, but the present one is undoubtedly in better state of preservation, and it is not so greatly flexed in posture.

GENERAL FORM OF THE HEART AND ITS RELATIONS TO NEIGHBOURING VISCERA

The heart is relatively large and remarkable for its great breadth, small cranio-caudal measurement and bifid apex. In all these respects the present specimen agrees with the African animal and to some degree with the adult of the Indian species. The breadth is relatively greater than in the adult, and the apical duplicity is more marked than in the adult which I dissected. The organ is also more flattened dorso-ventrally than in the adult. The ventricles are large in proportion to the atria, as in the African foetus. The coronary sulcus is well marked, and, even at this early stage, well loaded with fat, thus rendering the exposure of the coronary vessels a matter of considerable difficulty.

The heart is surrounded by a firm fibrous pericardium which is attached to the diaphragm postero-ventrally. The diaphragm, as is well known in the Elephant, is very obliquely placed, being more horizontal than vertical when the animal is placed in the quadrupedal posture. The result of this is that the diaphragmatic aspect of the pericardium, and heart, face almost ventrally instead of posteriorly. Correspondingly the apex of the pericardium, instead of being directed straight forwards, is projected dorsalwards, and the roots of the issuing vessels are thus directed towards the vertebral column rather than towards the thoracic inlet. The pericardium lies almost wholly anterior to the lungs, which thus come to occupy the postero-dorsal portion of the thoracic cavity on each side. Inflation of the lungs at birth would no doubt alter these relations somewhat, but the general lie of the heart and its pericardium would not be materially modified thereby. The great vessels, as they emerge from the pericardial apex, are bunched together to form a relatively small bundle, so that the pericardium presents a broad expanse when viewed from the dorsal side.

The thymus is related in the usual way to the antero-ventral part of the pericardium. The phrenic nerves proceed caudally on each side of the pericardium, ventral to the roots of the lungs.

The fibrous pericardium is lined by a serous layer which is reflected on to the surface of the heart around the roots of the great vessels. As usual there is an arterial and a venous reflection. The arterial reflection is narrow and tubular, on account of the close relation of the systemic and pulmonary aortae. The venous reflection is spread out so as to include the two precaval, the postcaval and the several pulmonary veins.

Size of the Heart

The heart almost completely fills its pericardium. It measures 47 mm. from side to side and the same from the apex to the roots of the emergent great vessels. Dorso-ventrally (*i.e.*, from the vertebral to the sternal aspect in an ordinarily oriented heart) it measures only 30 mm. There is no difference in thickness between the walls of the two ventricles, both being on the average 5 mm. thick. The atrial walls, on the contrary are very thin,—about the thickness of ordinary notepaper.

RELATIVE PROPORTIONS AND POSITIONS OF THE DIFFERENT CHAMBERS OF THE HEART

About two-thirds of the heart is composed of the ventricular chambers. These lie postero-ventral to the atria. The latter form a cuboidal mass lying antero-dorsally. They are hidden somewhat on their ventral face by the ascending aortic stems, but, on either side of these, the main atrial chambers are visible, no auricular appendages having as yet developed. Even in the adult these appendages are not very apparent.

Externally the two ventricles appear to take an equal share in the formation of the cardiac wall. The interventricular furrows proceed caudally almost vertically from the coronary sulcus to the bifid apex, the two summits of which are of approximately equal prominence. The two atria are also approximately equal in their share of the cardiac parietes. They are deeply grooved antero-ventrally for the aortic stems. The interatrial sulcus is not so well marked as in the adult heart. The coronary and interventricular sulci are deep, but, even at this stage, are filled with masses of fatty tissue in which the coronary arteries are embedded.

The Atria

The Right Atrium

This is a thin-walled chamber of cuboidal form lying to the right of the base of the heart. It measures in this foetus 20 mm. across, 25 mm. from back to front and 20 mm. from above down. It is thus somewhat longer in the dorso-ventral measurement than in the other two dimensions. This gives it a broad right lateral wall and narrow dorsal and ventral walls. The lateral wall is smooth and evenly convex. The dorsal and ventral walls form vertically placed sharper borders, with no prolongation ventrally to form an appendix. The ventral margin clasps the right side of the two aortic stems. The dorsal wall is occupied by the terminations of the great veins, namely the two precavals and the postcaval. The postcaval is the largest of the three and occupies the postero-lateral angle of the dorsal wall. The postero-medial angle is occupied by the opening of the left precaval which receives the coronary venous sinus just before opening into the atrium. Prior to this the left precaval is laid against the left margin of the dorsal wall of the right atrium, thus masking the interatrial sulcus in this position. The right precaval embouches on an area near the antero-lateral angle of the dorsal wall of the atrium, directly cranial to the opening of the postcaval. The dorsal wall, in the area between these three openings, is smooth, flat, and covered with epicardium, but a slight sulcus terminalis joins the lateral ends of the openings of the postcaval and right precaval veins.

In the interior of the right atrium a crista terminalis indicates the site of the sulcus terminalis of the exterior. At the vault this crest is arched forwards. It is very sharp, but the atrial wall slopes away from it more gradually medially than laterally. Laterally there is thus formed a deep pocket on the atrial wall. There are no true musculi pectinati on this part of the chamber, but there are two transversely disposed bands of muscular tissue sweeping across the atrial wall and ending at the atrio-ventricular junction. The more dorsal of the two is the better developed. The rest of the atrial wall is smooth.

The interatrial septum is obliquely disposed, with its right surface facing as much ventrally as to the right. A large circular hole, the foramen ovale, is situated in the middle of it, affording free communication with the left atrium. The foramen is guarded by an arched muscular margin, especially above. The obliquity of the part of the septum dorsal to the foramen gives a false impression of the continuity of the dorsal walls of the two atria. The left precaval vein descends, on the exterior of the heart, dorsal to this part of the septum and opens into the right atrium at the lower end of it. The portion of the septum guarding it therefore acts as a valvular arrangement. This is a Thebesian valve, but the description of it thus given differs somewhat from that given of the same region in the heart of the African Elephant's foetus by Eales (1929), as this, in turn, differs from the confused accounts given by previous observers in the hearts of adult Elephants. It does not correspond to the Thebesian valve of adult human anatomy, but to the left venous valve of the fifth week human embryo's heart. This valve-like flap is closely approximated to the lip-like margin of the opposite wall of the precaval opening, rendering the latter slit-like, with its long axis lying mainly dorso-ventrally. The postcaval orifice is larger and rounded, and lies immediately to the right of the previous opening. There is a slight endocardial fold, or Eustachian valve, guarding the ventral edge of the opening, and the right margin of this is continuous medially with the ventral end of the lower lip of the left precaval orifice. The right precaval orifice lies cranial to the postcaval opening, and is large and rounded, without any valvular arrangement. The atrio-ventricular opening is constricted, but almost circular in outline. Its valvular mechanism is described with the right ventricle.

The Left Atrium

This chamber is of similar shape to its fellow, being somewhat greater in the dorso-ventral measurement than in the other dimensions. Thus it measures 21 mm. in its transverse and cranio-caudal diameters, but 27 mm. dorso-ventrally. Internally it extends farther to the right, especially dorsally, than would be expected from surface inspection, on account of the extreme obliquity of the interatrial septum. It has a smooth, evenly convex lateral wall, the same as the right atrium; but its ventral margin projects farther than that of the right atrium, so clasping the roots of the aortic stems to a greater degree. No part of the chamber, however, can be regarded as an appendix to the rest. The ventral margin is further different from that on the right side in being sharper. The dorsal border is not so sharp, and passes round to the dorsal surface, which is flat, broad and smooth, with the openings of the pulmonary veins at the four corners. These veins are five in number, the same as in the adult heart previously described, though the arrangement is slightly different. In the foetus there is an upper and a lower (*i.e.*, cranial and caudal) vein from each lung occupying the respective angles of the dorsal wall of the left atrium. The lower vein from each lung is the larger, and drains the body of the lung. The upper vein is responsible for the drainage of the apical part of its own lung only. The fifth vein is a small vessel draining the azygos lobe of the right lung, and opens immediately beyond the margin of the lower or main right pulmonary vein, and to its caudal side. The openings of the lower pulmonary veins are slightly oblique and infundibuliform. Those of the upper veins are much more oblique and not infundibuliform. There are no valves in connection with these venous openings.

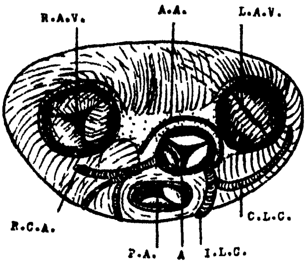
The Ventricles

The Base of the Ventricles

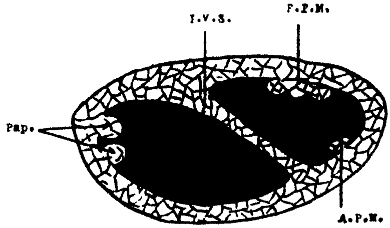
The base of the ventricular mass, after removal of the atrial chambers, presents a thick, fleshy surface for inspection, with the two atrio-ventricular and two arterial openings perforating the mass. The outline of the base is ovoid, with the major axis lying transversely (Fig. 1, A). The ventral edge of the oval is more prominent than the dorsal, which is flattened. The two ends of the oval are the same size. The two atrio-ventricular openings are each the same diameter (15 mm.) and circular in outline. The right opening is guarded by a typical tricuspid valve, with the cusps arranged one medially (*i.e.*, septal), one ventro-laterally (*i.e.*, infundibular) and the third dorsally. No accessory cusps are visible. The left orifice is guarded by a mitral valve showing two large cusps situated one ventro-medially and the other dorso-laterally. Situated between the ventral halves of the two atrio-ventricular orifices is the systemic aortic opening. It lies nearer to the left atrio-ventricular orifice than the right. It is circular in outline and about two-thirds the diameter of the atrio-ventricular orifices. It is guarded by the semilunar valve, with three cusps, arranged one dorsally and two ventrally. The stems of the two coronary arteries can be seen on dissection proceeding from the right and left ventral sinuses of the aorta and embracing the opening of the pulmonary aorta, which lies immediately ventral to the systemic aortic orifice. This opening is more ovoid in outline, being flattened dorso-ventrally. It is guarded by another semilunar valve, the cusps of which are arranged two dorsally and one ventrally. The wall of this opening is fleshy at the level where the systemic aortic opening has a fibrous wall, the infundibulum proceeding cranially for a considerable distance before the fibro-elastic arterial wall begins, as already noted in the adult heart of this species.

The Right Ventricle

This chamber is a fleshy-walled cavity which measures, externally, 29 mm. from base to apex, 35 mm. across and 27 mm. dorso-ventrally at the base. It is therefore unlike the typical mammalian ventricle, but resembles that of the early embryo of most mammals in being broader than long. From the left anterior angle the base is prolonged cranially and dorsally into the muscular infundibulum, which, after a time, becomes the pulmonary aorta. The muscular fibres are here arranged annularly around the tube, whereas on the rest of the ventricle the superficial musculature, at any rate, passes obliquely from base to apex, but turns medially towards the apex, so as to dive deeply into the interventricular septum. A few fibres towards the basal end of the ventricle, adjacent to the ventral interventricular sulcus, pass in the opposite direction, *i.e.*, from the sulcus obliquely laterally and towards the apex, interlacing as they go with the main body of fibres mentioned above. More numerous fibres, having a similar course laterally from the interventricular furrow, are found on the dorsal aspect of the ventricle. No attempt has been made to study the deeper musculature on this specimen.



A



B

Fig. 1. A. Basal view of the ventricular mass of the heart of a foetal Asiatic Elephant

R.A.V., Right atrio-ventricular opening
L.A.V., Left atrio-ventricular opening
A.A., Atrial artery
R.C.A., Right coronary artery
P.A., Pulmonary aorta
A., Systemic aorta
I.L.C., Interventricular branch of left coronary artery
C.L.C., Circumflex branch of same

B. Section across the middle of the ventricular mass

I.V.S., Interventricular septum
P.P.M.. Large posterior papillary muscle of left ventricle
A.P.M., Anterior papillary muscle of same
Pap., Papillary muscles of right ventricle

The cavity of the right ventricle is of peculiar shape. It is narrow dorso-ventrally, but very broad from side to side. Its dorsal wall is formed largely by the right ventricular aspect of the interventricular septum, which is placed very obliquely, facing almost directly ventrally rather than to the right. The right ventricular chamber therefore forms a deep, narrow gutter between the peripheral muscular wall and the interventricular septum. The bottom of the gutter is crossed by relatively few trabecular strands, and there is no moderator band crossing the cavity. The papillary muscles are two in number, situated close together and springing one behind the other from the right lateral wall of the ventricle. Their chordae tendinae are numerous, but short and thick, and pass to the dorsal and the right ventral (infundibular) cusps of the tricuspid valve. The chordae from the remaining (septal) cusp pass down and end directly on the septal wall, without forming a papillary muscle.

The Left Ventricle

The general form of this chamber is similar to that of the right. It measures 31 mm. from base to apex, 28 mm. across and 32 mm. dorso-ventrally. It is therefore less flattened dorso-ventrally than its fellow. Its wall is no thicker than that of the right. The left ventricular aspect of the interventricular septum forms its ventral wall in large part, in correlation with the obliquity of the septum. Its musculature is more obliquely disposed than that of the right ventricle. The superficial fibres sweep from the ventral part of the coronary sulcus and from the ventral interventricular sulcus outwards and apically, with sinuous curves on the more basal fibres. These basal fibres carry on around the left margin and become more transversely oriented as they go. They seem to fade out before they reach the dorsal interventricular furrow, being masked by a tract of descending fibres which arise from the atrio-ventricular junction and proceed directly to the apex, parallel to the interventricular furrow. A few fibres with an intermediate direction are found interlacing with the two main systems on the dorsal wall of the chamber.

The interior of the left ventricle has a similar, relatively smooth wall, as described for the right. Instead of being gutter-shaped, it is pyramidal with dorsal, ventral and septal walls. The apex, internally, is therefore pointed instead of merely forming part of the transverse gutter as in the case of the right ventricle. There are two short, thick papillary muscles. One is situated on the dorsal wall. It is very large, occupying most of the dorsal wall. It terminates in three summits, each with a bunch of chordae tendineae, the latter inserting on the dorso-lateral cusp of the mitral valve. The other papillary muscle is smaller, has a single summit, and arises from the ventral wall of the ventricle. Its chordae end in the ventro-medial cusp and on a small accessory cusp between it and the other main cusp of the mitral valve. The aortic opening is situated well to the left, and neither of the cusps of the mitral valve is arranged so as to form a partial septum dividing the aortic introit from the body of the ventricle as in the adult human heart.

The Aortic Stems

The two aortae, systemic and pulmonary, are very closely bound together. The pulmonary stem arises from the infundibulum and proceeds cranially, dorsally and somewhat to the left. Its origin, which is at a rather higher level than that of the systemic aorta, presents three externally visible dilatations, but thereafter the stem is dorso-ventrally flattened. It reaches the concavity of the arch of the systemic aorta, communicates therewith by means of a very short, wide ductus arteriosus, and then becomes constricted in its lateral dimension immediately before dividing into the two terminal pulmonary arteries.

The systemic aorta commences, at a lower level than the pulmonary, in three dilatations or sinuses of Valsalva. These are arranged one opposite to each of the three cusps of the aortic semilunar valve, *i.e.*, one dorsally and two ventrally, as in the adult heart. The dorsal sinus of Valsalva is a blind one, the other two having the origins of the right and left coronary arteries. From here onwards the aortic stem is curiously moulded by surrounding parts, so as to give it the appearance of having a spiral twist. It is related ventrally to the pulmonary stem, which grooves it, and dorsally to the ventral aspect of the atria, at their junction. The general direction of the systemic aorta, in its first or ascending part, is cranially, dorsally and with an inclination to the right. After passing the pulmonary stem it curves more dorsally and returns to the median position, and thereafter inclines to the left, thus entering its second or transverse part, which lies outside the pericardium. A final slight bend caudally is now sufficient to bring it into line with the thoracic vertebral column, thus commencing its third or " descending " portion. The first part is 28 mm. long and has an external maximum diameter (in its transverse dimension) of 11 mm. It only measures 8 mm. in its more compressed, dorso-ventral dimension. The coronaries are the only branches from the ascending portion. The remaining branches will be considered later.

The Coronary Blood-vessels

1. *The Coronary Arteries*

Only two coronary arteries arise directly from the aorta in this foetus. The third artery described recently by me (1936) in the heart of an adult elephant, under the name " atrial artery ", is present in the foetus, but arises from the left coronary soon after the latter has left the aorta.

The left coronary artery arises at a lower level with regard to its related valve cusp, than the right, being wholly below the free margin of the cusp. Its orifice further differs in being more oblique and funnel-shaped. The vessel proceeds ventrally, to the left of the pulmonary stem, and, after giving off the atrial artery dorsally, it divides into two terminal branches, circumflex and ventral interventricular. These are arranged much as in the adult heart already described, but the circumflex branch proceeds farther round in the coronary sulcus on to the dorsum of the heart, on the anterior side of the coronary venous sinus, terminating, just to the left of the crux, by turning on to the dorsal wall of the left atrium. It gives a marginal branch before passing on to the dorsal surface of the heart. The ventral interventricular artery supplies chiefly the left ventricle, the supply for the right coming mainly from the right coronary.

The atrial artery proceeds from its origin dorsally into the fatty tissue between the aorta and the atrial wall. Its main stem does not turn aside on reaching the interatrial sulcus, as in the adult, but proceeds along the surface of the aorta, deeply embedded in the groove between it and the atrium, until it reaches the base of the right ventricle. Here it passes beneath the right coronary artery and its accompanying vein, without communicating therewith, eventually diving into the ventricular muscle. Had an anastomosis been formed with the right coronary a condition essentially the same as that found by Cave (1936) in the heart of the adult Indian Elephant preserved in the Royal College of Surgeons would have been attained. As its stands, however, the arrangement is intermediate between Cave's specimen and my own previous account. Other vessels, corresponding to those described in connection with the atrial artery in my former account, were noted in the foetus. Thus, there was a dorsally directed vessel mounting the atrial wall to the right of the right precaval vein and sending a branch into the sulcus terminalis, whilst another was traceable into the interatrial sulcus between the right precaval and the upper right pulmonary vein.

The right coronary has a rounded orifice situated entirely above the level of its corresponding semilunar cusp. Its main stem is very short and directed to the right. It breaks up almost at once into three branches. The first turns ventrally and towards the apex and supplies the infundibulum and a strip of ventricular muscle beyond this as far as the apex. The next sweeps on to the right margin and supplies a considerable area of ventricular muscle. The last is a continuation of the main artery, and proceeds dorsalwards in the coronary sulcus on to the dorsal surface of the heart as far as the crux. Here it gives off a large dorsal interventricular artery and continues thence over the crux as a fine vessel, passing caudal to the coronary venous sinus to supply a large part of the dorsal aspect of the left ventricle. The last portion of the right coronary is therefore separated from the terminal part of the circumflex branch of the left coronary by the interposed coronary sinus.

2. *The Cardiac Veins*

The great cardiac vein commences ventrally at the apex and proceeds cranially in the ventral interventricular furrow. Before gaining the base, however, it gradually turns aside and comes to lie beneath the circumflex branch of the left coronary artery, not separated from it as in the adult heart. It follows this artery round the base on to the dorsum of the heart and opens into the terminal portion of the left precaval vein. Its last part is related to both coronary arteries as described above. It receives tributaries as already described in the adult heart.

A second vein does the duties of both the right and middle cardiac veins of the adult heart previously described. This commences on the ventral aspect of the right ventricle, near the base, and is directed alongside the right coronary artery in the coronary sulcus. It does not open into the right atrium on its most lateral part, but carries on in the sulcus to the dorsum, where it receives tributaries from the dorsal ventricular wall before opening into the right atrium.

Ramifications of the Great Vessels

The account given by Eales (1929) of the great vessels and their distribution in the foetal African Elephant contains so many interesting points that it seemed desirable to include here a brief resumé of the same structures in the Indian foetus.

1. *Branches of the Systemic Aorta* (Plate III)

After giving off the two coronary vessels the next branches do not appear till the transverse part of the arch is reached. This gives off two vessels, a brachiocephalic trunk and a left subclavian. The former is a short, wide trunk coming off the summit of the arch and dividing at once into innominate and left common carotid arteries. The left subclavian comes off a shade farther on and has an almost transverse course from its commencement. This condition seems to fall into the usual arrangement for the Asiatic Elephant, where the brachiocephalic is short, indistinct or absent, in which last event the innominate and right subclavian arise directly from the aorta, as in Man. In the African Elephant, on the contrary, the brachiocephalic trunk is constant and more distinct.

The further branching of these vessels is not quite the same as described for the African animal. The subclavians give off internal thoracic, cervical and vertebral arteries, as in Eales' foetus. The two common carotids diverge around the trachea and come to lie lateral to the large thyroid gland. A large vessel to the thyroid gland is given off low down by the right common carotid, but near the apex of the lateral lobe of the gland by the left. No other branches are given off before the bifurcation, which takes place very high in the neck, opposite the angle of the mandible. No thyroid artery was noted arising from the bifurcation.

The descending thoracic aorta and abdominal aorta together follow the concavity of the vertebral column from the middle of the thoracic region as far as the last lumbar vertebra, where the main vessel ends by dividing into four main branches. From the middle of the thoracico-abdominal trunk a very short wide vessel is given off,—the coeliac. The vessel thus resembles the aorta of an early embryo rather than that of a well-advanced foetus. Whilst still in the thorax, the aorta contributes bronchial arteries to the root of each lung, the intercostal vessels to the lower spaces and smaller branches to the oesophagus and diaphragm. Passing between the crura of the diaphragm, two large posterior phrenic arteries are given off. These pass to the abdominal surface of the diaphragm, but to their stems the adrenal gland, on each side, is firmly adherent, and draws its own supply. Ventrally the large coeliac is here given off, insinuating itself into the fork formed by the union, at this high level, of the two common iliac veins, which here sit astride the aorta. Just caudal to this the anterior mesenteric is given off. Laterally, opposite the formation of the postcaval vein, the two urogenital arteries arise. These divide later into a large renal artery and a smaller testicular vessel on each side. Paired lumbar arteries also arise from the aorta. These arise on its dorsal aspect, and the higher ones have a recurrent course to reach the side of their appropriate vertebral bodies. A posterior mesenteric artery is the next in order from the aorta; but there is no postrenal as described by Eales in the African Elephant. At its termination the aorta breaks up at once into two medium-sized external iliac arteries and two much larger hypogastric arteries. There are also given off, in the angle between the external iliac and the aorta, on each side, ilio-lumbar arteries; whilst from the angle between the two hypogastrics a relatively large middle sacral artery arises.

The hypogastric arteries, after supplying the pelvic walls and contents, proceed on the ventral belly wall to the umbilicus.

2. *The Caval Veins and their Tributaries* (Plate IV)

There are no innominate veins in the Elephant. The two precavals are formed by the union, at the root of the neck, of the jugular and subclavian veins. The jugular is the larger of the two vessels, but the discrepancy in size between it and the subclavian is not so marked as in the diagrams given by Eales of the arrangements in an African foetus. A remnant of the ventral anastomosis connecting the two precavals at their commencement, as depicted in the figures just mentioned, was found in the present specimen. The largest tributaries received after the union of the jugular and subclavian trunks, are the internal thoracic veins, and the azygos veins. The phrenic nerve forms an annulus around the former on the right side. The vena azygos major opens into the right precaval near to the heart. The left precaval receives a hemiazygos draining the upper spaces of its own side, thus differing from the arrangements in the African foetus. The details of the azygos system are discussed below. The subclavian veins receive vertebral, external thoracic and inferior cervical veins, but the vertebral joined the jugular on the right side in this specimen. The thyroid is drained by two veins on the right and one on the left, all opening into the corresponding jugular vein.

The postcaval vein is a very short, wide trunk. It is formed just beneath the diaphragm, by the union of two very large common iliac veins, which ascend from the brim of the pelvis and sit astride the abdominal aorta prior to their union, which occurs immediately anterior to the origin of the coeliac artery from the aorta. The postcaval receives, immediately after its formation, two large urogenital veins which drain the kidneys and testes. Thereafter it receives large tributaries from the adrenals and diaphragm, and also the hepatic veins and the ductus venosus. This arrangement is different from that shown in Eales' African specimen, in which only the two last named vessels opened into the postcaval vein, the others draining into the common iliacs before their union together.

The two common iliacs are formed in the Indian foetus at the brim of the pelvis, by the union of the external and internal iliacs on each side. Each receives an ilio-lumbar vessel from the iliac crest and neighbouring part of the dorsal abdominal parietes, but there is no posterior renal; whilst the segmental lumbar vessels all appear to enter into the formation of the ascending lumbar veins, which, in turn, become the azygos system.

3. The Azygos System of Veins

In this system of veins there are some similarities, but many differences between the Indian and African foetuses. There is some tendency to plexiform arrangement of the medial ends of the intercostal veins before they unite with the azygos system, especially on the left side, but this is not so bewildering as the condition figured in the African foetus by Eales. Possibly this is due to advance in development and the consequent dropping out of some of the interconnecting channels. The whole system is much more symmetrical in arrangement than in the African animal, or even in Man. The system commences, on both sides, on the dorsal abdominal wall in a longitudinal channel, or ascending lumbar vein, as in Man. These vessels are small at first, but rapidly enlarge, especially after piercing the diaphragm. They do not appear to communicate with the iliolumbars. After piercing the diaphragm, the two veins are to be regarded as right and left " azygos " veins. They are of approximately equal size and receive segmental veins from the lower six intercostal spaces of their own side. The left, in addition, receives a large tributary from the thoracic aspect of the diaphragm. The two veins are united, across the bodies of the vertebrae, by two transverse anastomotic channels, one just cranial to the diaphragm, and another two vertebral bodies higher up. Opposite the eleventh thoracic vertebra these two azygos vessels join together and form a wide, median trunk. This receives paired intercostals from the next four spaces, thereafter diverging to the right and receiving contributions only from the spaces of that side. It receives, in this way, vessels from all the remaining right intercostal spaces, with the exception of the three most anterior ones. These are joined together by intervening loops and communicate cranially with the subclavian vein, but they are also connected by a very fine loop with the azygos as it arches over the root of the right lung to join the right precaval. The remaining intercostal veins of the left side join up to form a vena azygos minor anterior (or hemiazygos) as mentioned on p. 57. This proceeds cranially and arches forwards and ventrally to join the dorsomedian aspect of the left precaval vein just after its formation from the left jugular and subclavian trunks.

SUMMARY AND CONCLUSIONS

(1) The Elephant's heart described in the present contribution agrees in all essential particulars with the hearts of adult animals of the Asiatic species. Its study has resulted in the emergence of further

evidence regarding the very primitive nature of the organ, to the extent that it can definitely be stated that, in this advanced foetus, the heart, and related parts of the circulatory system, are in a state of development similar to that found in a human embryo of the fifth week of intrauterine life. Moreover, most of the embryonic characters in the proboscidean heart are known to be retained even in adult life, at least in some degree. Among the primitive features concerned are factors relating to form, shape and structure, and special attention may be directed to (i) the great transverse breadth of the organ relative to its other dimensions, (ii) the relatively large size and globular form of the ventricles, (iii) the apical bifurcation, (iv) certain arrangements in the interior of the right atrium, (v) the absence or incipient nature of the atrial appendages, and (vi) the poor differentiation of the papillary muscles.

Besides these primitive features in the heart itself, a number of others, connected with more distal parts of the circulatory system, demand attention. Such are (i) the close connection of the systemic and pulmonary aortae, (ii) the simple curved form of the "descending" aorta, (iii) the mode of branching from the transverse part of the systemic aorta, (iv) the presence of a left precaval vein, (v) the disposition, etc., of the postcaval vein and (vi) the arrangement of the azygos system of veins.

(2) The atrial artery would appear to be a constant structure on the heart of the Asiatic Elephant, having now been recorded in two adults, as well as in the foetus. There seems to be some variation in its mode of origin, but its distribution is much the same in all cases. Ideally this vessel takes the largest share in the formation of a more or less complete arterial ring which surrounds the roots of the great arterial stems as they emerge from the heart. The ring is completed ventrally, as far as it can be said to be complete, by the arch formed from the infundibular branches of the right coronary and ventral interventricular arteries. These last two vessels were not demonstrable in the foetal heart, but are well developed in the adult. They do not, however, form a complete arch, as they do on the human heart, for they form no precapillary anastomosis.

(3) Numerous differences between the heart and great vessels, especially the latter, of the Indian and African foetuses have been pointed out in the descriptive part of this paper. Some of these would appear to be constant specific differences, in so far as they have been noted previously in adults of the two species. Such, for example, is the difference in the mode of branching of the transverse part of the

aorta. The specific difference, relating to the origin of an inferior thyroid artery from the angle between the two common carotids, mentioned by Eales, does not seem to be borne out by the present specimen. The other, and more numerous, group of differences between the Asiatic and African foetuses, may all be individual variations; although some of them would, on general grounds, seem of greater value than this. But the examination of more material would be preferable before any definite pronouncement is made on them. Examples illustrative of this are (i) the differences in the blood-supply of the thyroid gland and kidneys and (ii) the great differences between the azygos veins of the two forms. As regards the heart, the likenesses between the two foetuses seem to be of far more importance than the differences between them.

REFERENCES TO LITERATURE

CAVE, A. J. E. (1936) *J. Anat.*, LXXI, pp. 124-127
EALES, N. B. (1925) *P. Z. S.*, pp. 445-446
(1926) *Trans. R. Soc. Edin.*, LIV, pt. iii, pp. 491-551
(1928) *op. cit.*, LV, pt. iii, pp. 609-642
(1929) *op. cit.*, LVI, pt. i, pp. 203-246
(1931) *P. Z. S.*, pp. 115-125
HILL, W. C. O. (1936) *J. Anat.*, LXX, pp. 386-398

EXPLANATION TO PLATES

PLATE III

Ventral view of the Heart and Great Arterial Trunks of a foetal Asiatic Elephant

PLATE IV

Dorsal view of the Heart and Great Venous Trunks of a foetal Asiatic Elephant

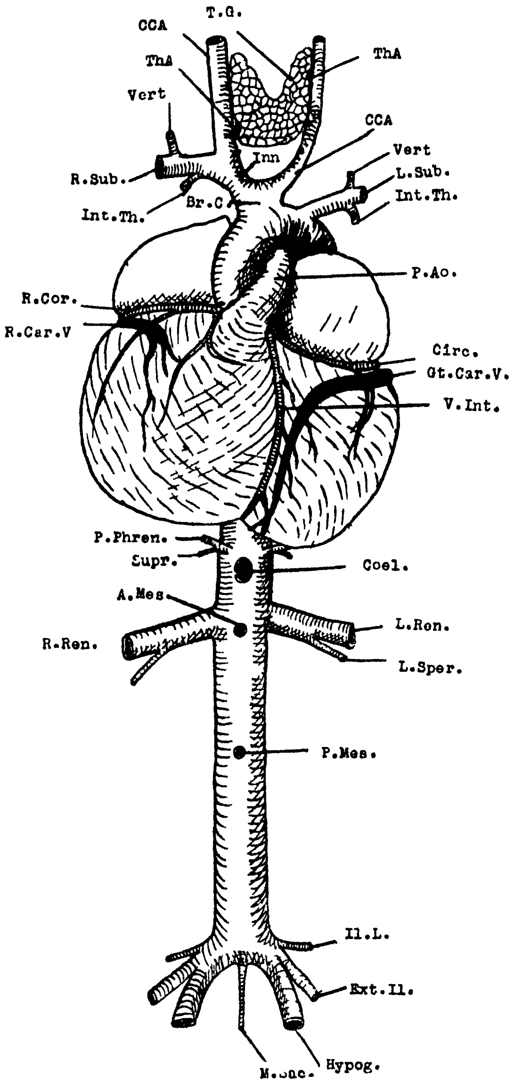
(The left pulmonary veins are not shown on this drawing, the shading on the heart, in both figures, indicates the direction of the superficial muscular fibres.)

Abbreviations used in the above figures

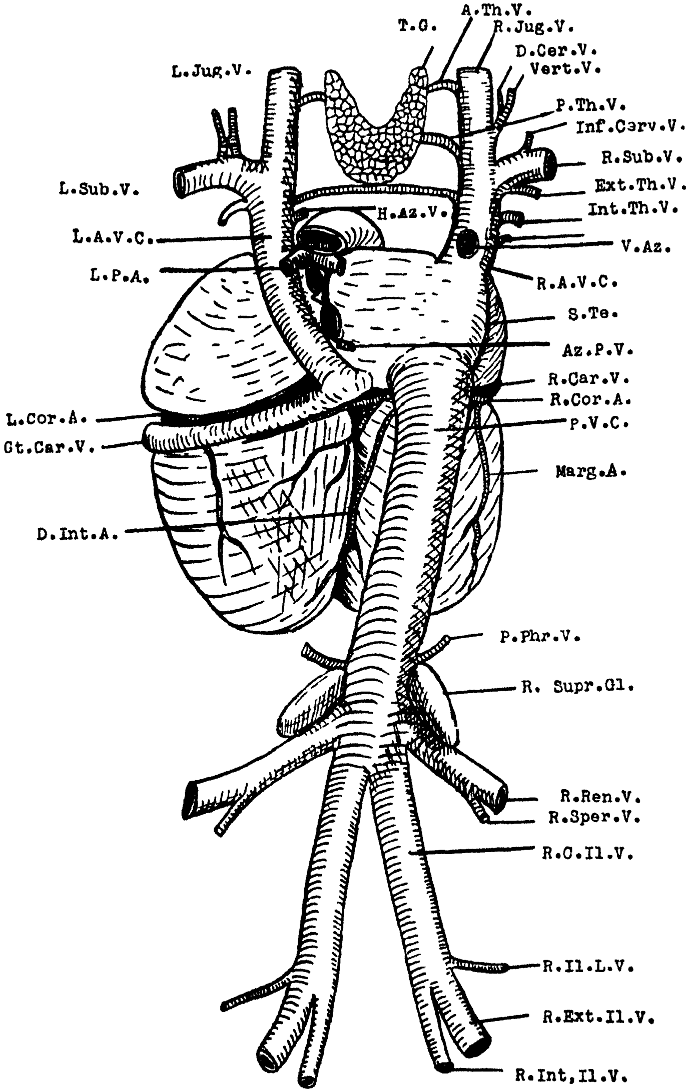
A.Mes.	Anterior mesenteric artery	Ext.Il.	External iliac artery
A.Th.V.	Anterior thyroid vein	Ext.Th.V.	External thoracic vein
Az.P.V.	Vein from azygos lobe of right lung	Gt.Car.V.	Great cardiac vein
		H.Az.V.	Hemiazygos vein
Br.C.	Brachiocephalic trunk	Hypog.	Hypogastric artery
C.C.A.	Common carotid artery	Il.L.	Iliolumbar artery
Circ.	Circumflex branch of left coronary artery	Inf.Cer.V.	Inferior cervical vein
		Inn.	Innominate artery
Coel.	Coeliac artery	Int.Th.	Internal thoracic artery
D.Cer.V.	Dorsal cervical vein	Int.Th.V	Internal thoracic vein
D.Int.A.	Dorsal interventricular artery	L.A.V.C.	Left precaval vein
		L.Cor.A.	Left coronary artery

L.Jug.V.	Left jugular vein
L.P.A.	Left pulmonary artery
L.Ren.	Left renal artery
L.Sper.	Left spermatic artery
L.Sub.	Left subclavian artery
L.Sub.V.	Left subclavian vein
Marg.A.	Marginal branch of right coronary artery
M.Sac.	Middle sacral artery
P.Ao.	Pulmonary aorta
P.Mes.	Posterior mesenteric artery
P.V.C.	Postcaval vein
P.Phren.	Posterior phrenic artery
P.Phr.V.	Posterior phrenic vein
P.Th.V.	Posterior thyroid vein
R.A.V.C.	Right precaval vein
R.Cor.	Right coronary artery
R.Cor.A.	Right coronary artery
R.Car.V.	Right cardiac vein
R.C.Il.V.	Right common iliac vein
R.Ext.Il.V.	Right external iliac vein
R.Il.L.V.	Right iliolumbar vein
R.Int.Il.V.	Right internal iliac vein
R.Jug.V.	Right jugular vein
R.Ren.	Right renal artery
R.Ren.V.	Right renal vein
R.Sper.V.	Right spermatic vein
R.Sub.	Right subclavian artery
R.Sub.V.	Right subclavian vein
R.Supr.Gl.	Right suprarenal gland
S.Te.	Sulcus terminalis
Supr.	Right suprarenal artery
Th.A.	Thyroid artery
T.G.	Thyroid gland
Vert.	Vertebral artery
Vert.V.	Vertebral vein
V.Int.	Ventral interventricular branch of left coronary artery

13—J. N. 67692 (8/37)



Elephas maximus Heart and main arteries of the foetus (ventral aspect)



Elephas maximus. Heart and main veins of the foetus (dorsal aspect)

NOTES

1. The mating of the moth *Phassus purpurascens* Moore

(With One Plate)

In the early morning of March 18th, while walking along a path dividing a tea-field from a steep hill-side jungle near the bungalow at Mousakande, Gammaduwa (alt: 3,350 ft.) in the East Matale Hills, I noticed what I took to be a decayed and twisted wind-blown leaf, hanging from the tip of a bamboo spray overhanging the path. On closer approach, however, I was much surprised to find that the supposed dead leaf was a pair of large moths, hanging *in coitu*. They were a species that I had not hitherto observed and as their resemblance to a dead leaf was extremely realistic, I returned to the bungalow for my camera in order to photograph them.

When first observed, the larger and darker of the pair—the female—was hanging from the tip of one of the terminal leaves of the bamboo spray. Her body was fully extended, her wings closed and her feet attached to the tip of the leaf, while, attached to the extremity of her abdomen, hanging immobile, head-downwards, was the smaller and browner male. The male's wings were also folded close to the body, but they were held at a different angle from those of the female and projected less. His legs were held rigidly at right angles to the axis of his body and projected considerably. He was supported solely by his union with his mate.

In this position they remained, without voluntary movement, swaying gently in the wind. The colour of the female, being dark blackish brown, and that of her mate, being a much lighter shade of brown, and the position which they had taken up, produced a remarkable resemblance to a decayed leaf, twisted to expose part of the underside and stuck, wind-blown, to the bamboo leaf; and this resemblance was much enhanced by the markings and shadings on the wings and bodies and also by the manner in which the male held his legs.

On being closely examined and disturbed, the female crawled slowly higher up the leaf, in order to gain a more secure foothold, but the male continued immobile and remained so while the twig was detached and carried to the bungalow.

The accompanying photograph shows the two moths as discovered:—presumably in the position natural to the species during the act of mating.

As I had not hitherto met with the species, these specimens were forwarded to Mr. G. M. Henry, Entomologist of the Colombo Museum, for identification. He informs me that they are *Phassus purpurascens* Moore, a rare species belonging to the primitive family Hepialidae.

W. W. A. PHILLIPS.

Mousakande, Gammaduwa,
March 27th, 1937.

Photo by W. W. A. Phillips

PHASSUS PURPURASCENS MATING. MOTHS AS FIRST DISCOVERED, PRESUMABLY IN THE POSITION NATURAL TO THE SPECIES

2. A Curious Habit common to Lorisoids and Platyrrhine Monkeys

In view of the interest attaching to the question of the possible diphyletic origin of the monkeys, it may be of some value to report on a curious behavioral complex that does not seem to have been described hitherto, but which, as far as I can ascertain, appears to be found only in the Cebidae and the Lorisoidea. By the American school of thought, these two Primate groups are regarded as phylogenetically related and placed in contrast with the Lemuroidea-Catarrhine association. (*Vide* Hill, W.C.O., 1936, *Ceylon J Sci.* (B), Vol. XIX, pp. 287-314.)

Anyone, who has observed living specimens of any species of the genus *Cebus* in captivity, must have become aware of their nervous temperament, and of the strange habit they display, when frightened, of micturating. Many monkeys micturate and/or defaecate when alarmed, but in *Cebus* the animal invariably micturates on to its own hand, and appears to wash its hands and feet in the outpoured stream of urine. Usually one hand and one foot are placed together and the palmar and plantar surfaces rubbed together whilst the urinary stream is poured over them. Apart from the onset of this bladder-irritability associated with fright, the phenomenon would appear to be the normal method of cleaning the naked palms and soles among these monkeys. Exactly the same occurs in the genus *Saimiri*. I do not know in how many other kinds of American monkeys this phenomenon occurs, but I have not noticed it in Marmosets. It would be interesting to know if it happens in the primitive genus *Aotes*

My chief reason in drawing attention to this peculiar habit, however is to report its occurrence in Lorisoids. Among these the habit occurs exactly as in *Cebus*. It happens less overtly, and perhaps with less frequency, but is nevertheless similarly associated with fright, as on being surprised suddenly. I have noted it in *Loris*, *Nycticebus* and *Galago crassicaudatus panganiensis*. It is done most openly by *Galago* and least by *Nycticebus*. It would be interesting to know if the habit occurs in the Pottos and the smaller Galagos.

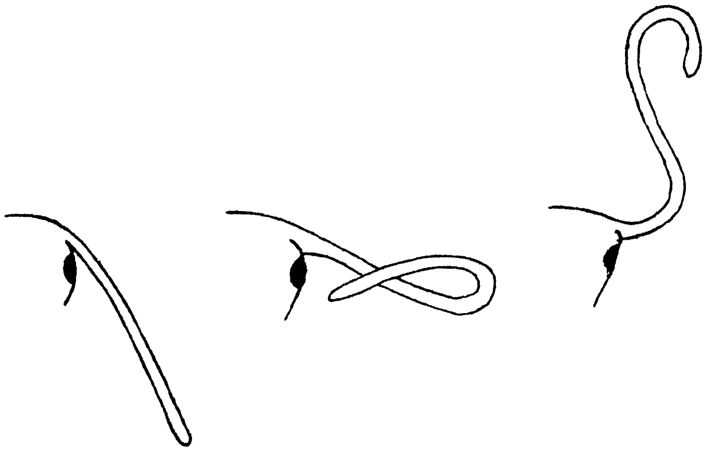
I have examined one living *Tarsius*, but did not observe the habit. As the Marmosets display Tarsioid rather than Lorisoid traits the habit may be absent from both. The habit does not occur in the genus *Lemur* or in any Catarrhine Monkey

W. C. O. HILL.

3. The Mode of carrying the Tail in Leaf-monkeys

(With One Text Figure)

Different species of Leaf-monkeys differ considerably in the mode in which they carry their tails when moving about in the forest. So striking are these differences between forms that have till recently only been regarded as subspecies, that I feel that there must be some germinal basis for such different basic behavioral patterns. My views are supported by other evidence, but the present note is merely intended to record my observations on such species of the Presbytinae as I have had occasion to study.



(a) (b) (c)

Fig. 1. Three modes of tail-carriage in *Presbytinae* (a) *Kasi* and *Trachypithecus*, (b) *Semnopithecus entellus*; (c) *S. priam*

1. *Kasi*. The members of this genus would appear to be the most primitive of the group. They carry their tails hanging down straight behind them, and seem to use them but little in balancing. I have noted this in all the races of *K. vetulus* and in *K. johnii*.

2. *Trachypithecus*. These would appear to agree with *Kasi*. I have only examined two species, *T. obscurus* and *T. cristatus*, both in captivity. They show no inclination to carry their tails in an unusual manner.

3. *Semnopithecus*. All the members of this group have been treated (Pocock 1928) as subspecies of one form, *S. entellus*. I have recently (1937 *a* and *b*) given morphological reasons for not so regarding

all of them. This view is confirmed by the present observations on behaviour. *S. entellus* of Bengal carries its tail in a single loop, the loop being held out behind or vertically, or even against one side of the body. This is illustrated in McCann's (1933) photographs of wild examples, and has been confirmed by me on captive animals.

S. priam is one of the most elegant members of the group and adds to its elegance by the manner of tail-carriage, as must be familiar to all who have traversed the roads in the North-Central Province of Ceylon, where this monkey abounds. The tail is carried aloft in the form of a letter S.

4. *Presbytis.* Of this genus I have only seen specimens of *P. melalophus*, the handsome Black-crested Monkey of Sumatra. I have seen the normal red phase and also the black mutant, all, however, in captivity. The tail in all these was carried in the same position as in *Kasi* and *Trachypithecus*.

W. C. O. HILL.

REFERENCES TO LITERATURE

HILL, W. C. O. 1937 (a).—*Ceylon J. Sc.* (B) XX, pp. 211-251

1937 (b) *P. Z. S.* Ser. B, pt. 2, pp. 205-216

MCCANN, C. 1933.—*J. Bombay N. H. Soc.*, XXXVI, pp. 618-628

POCOCK, R. I. 1928.—*J. Bombay N. H. Soc.*, XXXII, pp. 472-504

CEYLON J. SCI. (B) VOL. XXI, PT. 1. (*February 10, 1938*)

PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1934-1935 SESSIONS

Twenty-Second Annual General Meeting.

The Twenty-second Annual General Meeting was held on the 13-II-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President, Mr. D. R. R. Burt, took the Chair, and there were eighteen members and six visitors present.

The minutes of the previous general meeting were read and confirmed.

The Honorary Secretary's Report and the Honorary Treasurer's Statement which were in the hands of the members, were adopted.

The President announced that His Excellency Sir R. E. Stubbs had kindly consented to become the Patron of the Society, and Sir Solomon Dias Bandaranaike, the Vice-Patron. The President called upon Mr. W. E. Wait the Council's nominee for the office of President for the year 1934, to take the chair. The new President proceeded to put to the house the names of the other office-bearers nominated by the Council. There being no other nominations, the following were elected office-bearers for 1934:—

President.—Mr. W. E. Wait.

Vice-Presidents.—Prof. F. O'B. Ellison, Mr. G. M. Henry, Mr. E. C. T. Holsinger, Dr. S. E. Fernando, and Mr. D. R. R. Burt.

Honorary Secretary.—Mr. P. Kirtisinghe.

Honorary Treasurer.—Mr. A. H. Malpas.

Council.—Prof. N. G. Ball, Mr. W. W. A. Phillips, Mr. L. G. O. Woodhouse, Mr. P. E. P. Deraniyagala, Rev. Fr. M. J. Le Goc, O.M.I., and Mrs. W. Dalton.

The President said that there were no nominations of a Student Member to the Council, and it was decided to leave it to the Secretary to arrange for nominations at the next general meeting. Messrs. W. O. Edema and P. O. Edema, proposed by Mr. L. G. O. Woodhouse, were elected members of the Society. The President then asked Prof. W. C. O. Hill to demonstrate his specimens. Prof. Hill exhibited live specimens of the Coney (*Hyrax*) and a Madagascar Lemur and described the characters of each of them briefly.

Mr. D. R. R. Burt was then called upon to deliver his lecture on " The Distribution of Animals in Ceylon ".

Mr. Burt said:—There are two methods of approach in the study of animal distribution. The first method is to mark the limits of distribution of the animals existing at the present time and to compare this with that of their ancestors from a study of fossil remains. The second is the ecological method or the study of an animal in relation to its environment. It is the environment which changes the form of the animal, and to determine the adaptional significance of the various characters of an environment, one has to analyse the functional relation between a particular character and a particular environmental feature by experimental methods in the laboratory.

Ceylon is a part of what is known as the Oriental or Indo-Malayan Region, one of the larger zoo geographical regions of the world. This is divided into sub-regions and those of India, Burma and Ceylon, concern us most. At the present time, Ceylon is separated from India by a considerable extent of deep water, except across Adam's Bridge, Palk Strait and the Pedro Banks, which are comparatively shallow. It is not inconceivable to imagine a land connection between Ceylon and India which would be necessary for the continuous distribution of animals in Ceylon and in the Peninsula. The climate of the intervening land must have differed considerably from that obtaining to-day. The Laccadives, Maldives, Chagos Archipelago and Diego Garcia mark the peaks of a submarine range of mountains extending for about 1,400 miles, and rising from a depth of 2,000 fathoms. At one time, this range was above sea-level and a very great subsidence must have taken place but not within recent times. Although we cannot assume a direct connection between the Malabar Coast and the Ceylon hill tract in recent times, we know that the last glacial period must have caused great changes in the climate, and the Carnatic once possessed a damp climate and was covered with forests like those of Ceylon and the Malabar Coast of to-day. Other evidence of the relation of Ceylon to India is obtained from the geological record. In Miocene times the barrier of water separating us from India was much wider than now. Prior to this period there must have been a land connection or a narrow barrier.

On considerations of temperature, elevation and rainfall, Ceylon can be divided into the following climatic zones :—(i) a low-country dry zone including the northern part of the Island and extending south between the hills and the east coast; (ii) two narrow arid belts along the north-west and south-east coasts; (iii) the central hill wet zone; and (iv) the wet forest low-country zone to the south-west of the central mountain cluster. The boundaries of these zones are not marked off sharply, but it is surprising to find many different races of animals confined to one or other of them and merging insensibly from one subspecies into another on the borders of these zones. A few examples from the mammals of the Island illustrate this. Of the lorises in Ceylon, *Loris tardigradus tardigradus* occurs in the south-west wet zone; *L. t. grandis* in the central hill zone and *L. t. nordicus* in the north low-country dry zone. The low-country wet zone loris is the smallest, while *nordicus* and *grandis* are of about the same size. The Wanderoo monkeys are also distributed according to regional climatic characters. *P. v. vetulus*, the Black Wanderoo, is confined to the south-west wet zone in the low-country, while north of this region, although still in the wet lowland zone, is found *P. v. nestor*. *P. v. monticola* is confined to the higher reaches of the mountains, while *P. v. philbricki* is found north of the Mahaweliganga where it runs east to west in the valley between the Matale hills and the central hills and also north of this region in the drier low-country parts. *P. vetulus* is absent from the north-western third of the Island where its place is taken by the Madras Langur, *Pithecus priam thersites*.

There are two civets of the genus *Paradoxurus* in Ceylon. The Indian Toddy cat, *P. hermaphroditus*, is common throughout the whole Island, while the Golden Palm Civet, *P. zeylonensis* is peculiar to Ceylon, and, like most peculiar animals, is confined to the wet zone being found there both in the low-country and in the hills. *Herpestes flavidens* is a Mongoose peculiar to Ceylon. Its subspecies, *H. f. flavidens* is common in the central hill zone; *H. f. phillipsi* ranges in the eastern Matale hills; *H. f. maccarthiae* is confined to the low-country dry zone.

Ratufa macroura, the Long-tailed Giant Squirrel, exists in three geographical races. The hill race is the largest, the low-country wet zone form is intermediate. The tail length is actually and relatively shorter in the hill race than in the race from the intermediate zone while it is longest in those from the low-country dry zone. The sub-species of the Palm Squirrel (*Funambulus palmarum*) show similar differences and also a colour difference between the sub-species from wet and dry regions; the wet zone forms being dusky in hue, while the dry zone forms are lighter. The distribution of the sub-species of the jungle squirrel (*Funambulus layardi*) and the sub-species of rats peculiar to Ceylon exhibits the same features.

As among the mammals, the birds may be separated into those which are found both in India and Ceylon; those which are peculiar to the Island but which show affinities to species found in the Malabar tract; and, thirdly, those which differ from Indian forms but with near allies further afield. As with the mammals, the peculiar birds are restricted to the wet zone, particularly to the hills.

The reptiles characterize the Ceylonese regions even more than the higher vertebrates. Among the Amphibia the species peculiar to the Island are restricted to the wet regions as with the peculiar species of other groups.

Amongst the Invertebrata one finds a curious and remarkable feature in the distribution of the Earthworms. *Megascolex* and *Perichaeta* are both found in the Indo-Malay region. *Megascolex* is also found in Africa and Australia, while *Perichaeta* occurs in South America and Australia. Their distribution thus lends colour to the view that at one time South America, Africa, India, Malaya and Australia were part of a large continuous land surface.

A consideration of the differences in the morphological characters of the geographical races of a species in the light of differences in climate involves an analysis of all the climatic factors affecting an animal. A simple relation is known to exist between the temperature of a mammal and the size of its body. The temperature of a mammal, however, varies according to age, sex, race, external temperature, moisture, food, elevation and light. The efficiency of the temperature-regulating mechanism varies from one group to another; and, while it is almost perfect in the Primates, it is not nearly so well evolved in furry animals like the Rodents which lack sweat glands, and which depend on the stimulation of their *arrectores pilorum* muscles for heat loss. Przibram in Vienna found, as did Sumner in America, that at lower external temperatures rats and mice had lower body temperatures. The internal temperature of an animal affects its metabolic rate which, in turn, determines the size of the animal. The relative lengths of its appendages, legs, tail, ears, etc., will also be controlled by external temperature. Thus rats and mice kept at a low temperature have larger bodies and shorter tails than those kept at a higher temperature. Humidity also accentuates the effect of temperature in so far as animals in a hot, moist, climate have a higher body temperature than those in a hot dry climate, while conversely, those in a cold, dry, climate have a higher temperature than those in a cold, wet, climate. These are but two of the climatic factors which change from one locality to another. Light is richer in ultra-violet rays at higher altitudes, and, while light alone has a stimulating effect on growth, yet, in the presence of moisture, it has the opposite effect.

On grounds such as these one may attempt to explain the differences in the geographical races of animals found in Ceylon. Climate is not a simple matter and the effect of it on the organism is the sum total of the effects of all its different constituents.

particular character and a particular environmental feature by experimental methods in the laboratory.

Ceylon is a part of what is known as the Oriental or Indo-Malayan Region, one of the larger zoo-geographical regions of the world. This is divided into sub-regions and those of India, Burma and Ceylon, concern us most. At the present time, Ceylon is separated from India by a considerable extent of deep water, except across Adam's Bridge, Palk Strait and the Pedro Banks, which are comparatively shallow. It is not inconceivable to imagine a land connection between Ceylon and India which would be necessary for the continuous distribution of animals in Ceylon and in the Peninsula. The climate of the intervening land must have differed considerably from that obtaining to-day. The Laccadives, Maldives, Chagos Archipelago and Diego Garcia mark the peaks of a submarine range of mountains extending for about 1,400 miles, and rising from a depth of 2,000 fathoms. At one time, this range was above sea-level and a very great subsidence must have taken place but not within recent times. Although we cannot assume a direct connection between the Malabar Coast and the Ceylon hill tract in recent times, we know that the last glacial period must have caused great changes in the climate, and the Carnatic once possessed a damp climate and was covered with forests like those of Ceylon and the Malabar Coast of to-day. Other evidence of the relation of Ceylon to India is obtained from the geological record. In Miocene times the barrier of water separating us from India was much wider than now. Prior to this period there must have been a land connection or a narrow barrier.

On considerations of temperature, elevation and rainfall, Ceylon can be divided into the following climatic zones :—(i) a low-country dry zone including the northern part of the Island and extending south between the hills and the east coast; (ii) two narrow arid belts along the north-west and south-east coasts; (iii) the central hill wet zone; and (iv) the wet forest low-country zone to the south-west of the central mountain cluster. The boundaries of these zones are not marked off sharply, but it is surprising to find many different races of animals confined to one or other of them and merging insensibly from one subspecies into another on the borders of these zones. A few examples from the mammals of the Island illustrate this. Of the lorises in Ceylon, *Loris tardigradus tardigradus* occurs in the south-west wet zone; *L. t. grandis* in the central hill zone and *L. t. nordicus* in the north low-country dry zone. The low-country wet zone loris is the smallest, while *nordicus* and *grandis* are of about the same size. The Wanderoo monkeys are also distributed according to regional climatic characters. *P. v. vetulus*, the Black Wanderoo, is confined to the south-west wet zone in the low-country, while north of this region, although still in the wet lowland zone, is found *P. v. nestor*. *P. v. monticola* is confined to the higher reaches of the mountains, while *P. v. philbricki* is found north of the Mahaweliganga where it runs east to west in the valley between the Matale hills and the central hills and also north of this region in the drier low-country parts. *P. vetulus* is absent from the north-western third of the Island where its place is taken by the Madras Langur, *Pithecus priam thersites*.

There are two civets of the genus *Paradoxurus* in Ceylon. The Indian Toddy cat, *P. hermaphroditus*, is common throughout the whole Island, while the Golden Palm Civet, *P. zeylonensis* is peculiar to Ceylon, and, like most peculiar animals, is confined to the wet zone being found there both in the low-country and in the hills. *Herpestes flavidens* is a Mongoose peculiar to Ceylon. Its subspecies, *H. f. flavidens* is common in the central hill zone; *H. f. phillipsi* ranges in the eastern Matale hills; *H. f. maccarthiae* is confined to the low-country dry zone.

Ratufa macroura, the Long-tailed Giant Squirrel, exists in three geographical races. The hill race is the largest, the low-country wet zone form is intermediate. The tail length is actually and relatively shorter in the hill race than in the race from the intermediate zone while it is longest in those from the low-country dry zone. The sub-species of the Palm Squirrel (*Funambulus palmarum*) show similar differences and also a colour difference between the sub-species from wet and dry regions; the wet zone forms being dusky in hue, while the dry zone forms are lighter. The distribution of the sub-species of the jungle squirrel (*Funambulus layardi*) and the sub-species of rats peculiar to Ceylon exhibits the same features.

As among the mammals, the birds may be separated into those which are found both in India and Ceylon; those which are peculiar to the Island but which show affinities to species found in the Malabar tract; and, thirdly, those which differ from Indian forms but with near allies further afield. As with the mammals, the peculiar birds are restricted to the wet zone, particularly to the hills.

The reptiles characterize the Ceylonese regions even more than the higher vertebrates. Among the Amphibia the species peculiar to the Island are restricted to the wet regions as with the peculiar species of other groups.

Amongst the Invertebrata one finds a curious and remarkable feature in the distribution of the Earthworms. *Megascolex* and *Perichaeta* are both found in the Indo-Malay region. *Megascolex* is also found in Africa and Australia, while *Perichaeta* occurs in South America and Australia. Their distribution thus lends colour to the view that at one time South America, Africa, India, Malaya and Australia were part of a large continuous land surface.

A consideration of the differences in the morphological characters of the geographical races of a species in the light of differences in climate involves an analysis of all the climatic factors affecting an animal. A simple relation is known to exist between the temperature of a mammal and the size of its body. The temperature of a mammal, however, varies according to age, sex, race, external temperature, moisture, food, elevation and light. The efficiency of the temperature-regulating mechanism varies from one group to another; and, while it is almost perfect in the Primates, it is not nearly so well evolved in furry animals like the Rodents which lack sweat glands, and which depend on the stimulation of their *arrectores pilorum* muscles for heat loss. Przibram in Vienna found, as did Sumner in America, that at lower external temperatures rats and mice had lower body temperatures. The internal temperature of an animal affects its metabolic rate which, in turn, determines the size of the animal. The relative lengths of its appendages, legs, tail, ears, etc., will also be controlled by external temperature. Thus rats and mice kept at a low temperature have larger bodies and shorter tails than those kept at a higher temperature. Humidity also accentuates the effect of temperature in so far as animals in a hot, moist, climate have a higher body temperature than those in a hot dry climate, while conversely, those in a cold, dry, climate have a higher temperature than those in a cold, wet, climate. These are but two of the climatic factors which change from one locality to another. Light is richer in ultra-violet rays at higher altitudes, and, while light alone has a stimulating effect on growth, yet, in the presence of moisture, it has the opposite effect.

On grounds such as these one may attempt to explain the differences in the geographical races of animals found in Ceylon. Climate is not a simple matter and the effect of it on the organism is the sum total of the effects of all its different constituents.

One Hundred and Twenty-third General Meeting.

The One Hundred and Twenty-third General Meeting was held on 12-III-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of twenty-one members and visitors. The minutes of the previous meeting were read and confirmed.

Mr. D. Obeyesekera, proposed by Dr. S. E. Fernando, was elected an ordinary member of the Society, and Mr. K. Satchithananda, proposed by Mr. L. J. D. Fernando and seconded by Mr. S. E. Dias, was selected to serve in the Council of the Society as the representative of the Student Members.

Mr. G. M. Henry exhibited two rare specimens of a centipede and a spider.

Mr. L. G. O. Woodhouse then delivered his lecture on " Ceylon Butterflies ". Mr. Woodhouse said that Ceylon, for a tropical country, is comparatively poor in butterflies. Of the 14,000 species known throughout the whole world, about one-tenth come from India, Burma and Ceylon, and of this only 233 species are from Ceylon. But the difference in size, shape and the glorious shades of colour are astonishing. The lecturer then proceeded to show, with the help of the epidiascope, his preparations of the wings of over 35 species of Ceylon butterflies. He also discussed the migrations of butterflies. At the conclusion of the lecture, Mr. G. M. Henry and Mr. E. C. T. Holsinger spoke in appreciation of Mr. Woodhouse's new method of preparation of the wings of butterflies.

One Hundred and Twenty-fourth General Meeting.

The One Hundred and Twenty-fourth General Meeting was held on 10-VII-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of eighteen members and visitors. After the minutes of the previous meeting were read and confirmed, the President called upon Prof. R. Marrs to deliver his lecture on " Kant and the Biological Sciences ".

At the conclusion of this interesting lecture, the President proposed a hearty vote of thanks to Professor Marrs which was carried with acclamation.

One Hundred and Twenty-fifth General Meeting.

The One Hundred and Twenty-fifth General Meeting was held on 11-IX-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of twenty-nine members and visitors. Mr. Wait then delivered his presidential address on Darwin's " Origin of Species ".

One Hundred and Twenty-sixth General Meeting.

The One Hundred and Twenty-sixth General Meeting was held on 16-X-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of twenty-two members and visitors. After the minutes of the previous meeting were read and confirmed, Mr. P. E. P. Deraniyagala delivered his lecture on " The Turtles' Shell ". The lecture was illustrated by a large number of drawings, and various types of turtles' shells were exhibited.

One Hundred and Twenty-seventh General Meeting.

The One Hundred and Twenty-seventh General Meeting was held on 13-XI-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of seventy-three members and visitors. After the minutes of the previous meeting were read and confirmed. Prof. F. O'B. Ellison delivered his lecture on " Eyes ". The lecturer began by tracing the evolution of the eye from the simple pigment spot of *Euglena* and its allies through the various organs for the perception of light in the separate phyla of the animal kingdom, and described the structure and mode of function of the compound eyes of the Arthropoda and the well developed eye of the Cephalapoda. He explained how the Cephalapod eye differs from that of the Vertebrates. He then discussed some forms of animal life from the depths of the ocean where practically no light enters, and showed that they are either blind or that they possess very large eyes and phosphorescent organs. In conclusion, he demonstrated some examples of optical illusion.

One Hundred and Twenty-eighth General Meeting.

The One Hundred and Twenty-eighth General Meeting was held on 11-XII-1934, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of twenty members and visitors. After the minutes of the previous meeting were read and confirmed, Prof. F. O'B. Ellison showed two lantern slides of photographs taken by him with the lenses of a beetle's eye.

Mr. Philip Fowke then delivered his lecture on " Trout Culture in Ceylon ".

One Hundred and Twenty-ninth General Meeting.

The One Hundred and Twenty-ninth General Meeting was held on 15-I-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. In the absence of the President, the chair was taken by Mr. D. R. R. Burt, and there was an attendance of thirty-three members and visitors.

Prof. W. C. Osman Hill next delivered his lecture on " Primitive Primates ".

The Primates are difficult to define as they possess characters which are also possessed by other orders of mammals. In the Primates, however, there is a combination of characters, which, though occurring individually in other types, is never in the same combination as in the Primates.

It follows that among the more generalized members of the order there are forms which it is difficult to assign to their correct position in the mammalian scale. Some would debar the Lemurs from Primate rank entirely. Others would include such primitive forms as the Tupaioids in the Primate Order.

Undoubtedly the Tupaioids are closely related to the forms from which the true Primates sprang in the early days of mammalian life on earth. They show some extremely generalized mammalian traits, including some which are usually coupled with a marsupial type of organization.

The earliest Primates must have been but little more advanced than the Tupaioids, but, as far as present knowledge goes, it would appear that these forms early differentiated into a number of distinct evolutionary trends, and these have remained separate ever since. Among them must be mentioned the Tarsioids, the Lorisoids, the Cheiromyoids (Aye-Ayes) and the Lemuroids proper. The last-named have undoubtedly been separated from the Lorisoids for a considerable time. The Lorisoids are in many respects more nearly related to the Tarsioids than the Lemuroids.

The early Primates migrated from a dispersal centre in the Siwalik region of the Himalayas. An early Lorisoid migration took place into Africa giving rise to Pottos and Galagos. The Lemuroids also had an African branch, but this was soon cut off in Madagascar, in which Island they were left to pursue their evolutionary trends unhindered. The Tarsioids were represented in early times both in America and Europe, and there is sufficient evidence to believe that they were ancestral to the Catarrhine Monkeys and Man. It is distinctly possible that the Platyrrhine Monkeys are the descendants of a Lorisoid stock which was separated off in South America when that continent severed its former connection with Africa. The Marmosets, however, show some Tarsioid affinities. In the more peripheral parts of Asia such as Ceylon, Malaya, Java, Borneo, and the Philippines are to be found the last relics of the most primitive types of Lorisoids (*Loris* and *Nycticebus*) and also the only living representative of the Tarsioids (*Tarsius*).

The following living Primates were on exhibition:—

Galago crassicaudatus panganiensis (Tanganyika, East Africa).
Lemur fulvus (Madagascar).
Hapale jacchus (Brazil).
Saimiris sciurea (Brazil).

Twenty-third Annual General Meeting.

The Twenty-third Annual General Meeting was held on 19-II-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there were fourteen members and visitors present. The minutes of the previous meeting being read and confirmed, the following office-bearers were elected for the year 1935:—

Patron.—His Excellency Sir R. E. Stubbs, G.C.M.G.
Vice-Patron.—Sir Solomon Dias Bandaranaike, K.C.M.G.
President.—A. H. Malpas, Esq.
Vice-Presidents.—E. C. T. Holsinger, Esq., Dr. S. E. Fernando, D. R. R. Burt, Esq., Dr. A. Nell, Prof. W. C. O. Hill.
Honorary Secretary.—D. C. Gunawardena, Esq.
Honorary Treasurer.—P. Kirtisinghe, Esq.
Council.—Prof. F. O'B. Ellison, Prof. N. G. Ball, P. E. P. Deraniyagala, Esq., Very Rev. Fr. M. J. Le Goc, O.M.I., W. W. A. Phillips, Esq., L. G. O. Woodhouse, Esq., Dr. P. C. Sarbadhikari.

New members elected were—

Mr. and Mrs. D. J. Unwin.—Ordinary Members.
Dr. H. C. P. Gunawardena.—Ordinary Member.
Mrs. H. Millen.—Ordinary Member.
Mr. M. J. Tambimuttu.—Student Member.

Dr. A. Nell then delivered his lecture on "Plants, etc., mentioned in the Mahavansa". Nearly every plant recorded in the Mahavansa had been identified with some certainty. There were numbers of workers on the subject and revisions were not uncommon. Dr. Nell, with his knowledge of the country, attempted to make some corrections but did not claim any finality for his identifications. The lecturer referred among others to the ancient Bo-tree at Anuradhapura (*Ficus religiosa*), which was brought from Gaya (India), about 240 B.C. The Sal tree (*Shorea robusta*) was connected with the Buddha's birth and death. The following trees were commonly grown in gardens and parks:—Coconut, Areca, Palmyrah, the Tamarisk (*Tamarix gallica*), Embul-Bakmee (*Anthocephalous cadamba*). The 73rd chapter of the Mahavansa, the best chapter of all, mentioned 20 trees in a park called Nandana. Among the fragrant flowers were Lotus, Geta piccha, (*Jasminum Sambac*) Olu or Water lily with white crimson, yellow, violet and blue flowers.

The first mention of the mango was in the middle of the third Century, B.C., in the fabulous account of the devas bringing it from the Himalayas as gifts to Asoka. When the missionary priest Mahinda catechized King Devanampiyatissa (circa 247-207 B.C.), he made the mango tree his illustration.

Dr. Nell argued as follows for the presence of cotton trees in ancient Ceylon. The " Kathina " offerings of the Buddhists, of which at least six notable occasions are mentioned in the Mahavansa, have a ritual of their own. The cotton has to be plucked off the bush, spun into yarn; the yarn woven into cloth; the cloth dyed, cut into seven pieces and sewn into a monk's robe—all within the short period of a day and a night. It was reasonable, therefore, to infer that cotton was widely grown and that spinning and weaving were customary and habitual occupations with a large section of the common people. Besides, the philosophers who accompanied Alexander the Great, when he came to India in 520 B.C., were surprised to find people wearing clothes made of some wool " growing on trees ". This wool was cotton.

In the discussion which followed, the Secretary referred to the early work of J. M. Senaveratna and of T. Petch, E. Senaratne and A. H. G. Alston of Peradeniya. The problem of identification was difficult, as these early workers did not possess a knowledge of both Botany and Pali and Sanskrit. He suggested that the Society should form a Committee of Orientalists and Botanists and carry on the work of identification. Mr. E. Senaratne informed the house that they at Peradeniya, had indexed 90 per cent. of the identified names.

Prof. Ellison referred to the omission by Dr. Nell of the Temple flower tree (*Plumeria acutifolia*), which was found in nearly all temples and shrines in this country. Dr. Nell in reply stated that the Temple flower was introduced from Mexico to China in the 11th or 12th Century and came to Ceylon about the 15th Century.

One Hundred and Thirty-first General Meeting.

The One Hundred and Thirty-first General Meeting was held on 19-III-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President took the chair and there was an attendance of thirty-four. The minutes of the previous meeting having been read and confirmed, Mr. P. Kirtisinghe delivered his lecture on " Some Products from the Sea ". He referred to the economic values which may be derived from the " teeming life in the ocean " and laid special emphasis on fish and fishing. This industry could be much improved, as it has been done in other countries, by the adoption of modern methods and the education of public opinion. The lecture was well illustrated.

One Hundred and Thirty-second General Meeting.

The One Hundred and Thirty-second General Meeting was held on 16-VII-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President took the chair and there was an attendance of fifty-one members and visitors.

The minutes of the last meeting being read and confirmed, Messrs. V. Claasz and K. M. Mehta, were elected Ordinary Members of the Society.

The Secretary exhibited a Mangrove plant from a lagoon in Chilaw. The plant was not identified. Dr. S. E. Fernando commented on some specimens of intestinal Coleoptera, (*Onthophagus bifasciatus*). Their occurrence in children is well known.

The Sinhalese refer to it as ' *Kurumini Mandama* ',—Beetle rickets. The specimens were passed round. Prof. Ellison offered remarks. More data was necessary to establish definitely the intestinal nature of these Coleoptera.

The main business of the day was a lecture by Mr. E. C. T. Holsinger on " The Dwellers of the Soil ". The lecture was well illustrated. Mr. Holsinger referred to the active community of living animals and plants in the soil. The fertility of the soil was increased by heating it before tilling. This was an ancient practice, but had received scientific explanation only in recent years. There was thus a new conception of the soil and soil analysis should include not merely a chemical analysis but a microbiological analysis as well.

One Hundred and Thirty-third General Meeting.

The One Hundred and Thirty-third General Meeting was held on 10-IX-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

In the absence of the President, the chair was taken by Mr. D. R. R. Burt, and there was an attendance of twenty-seven members and visitors. The minutes of the last meeting having been read and confirmed, Dr. R. Child of the Coconut Research Scheme, delivered a very interesting lecture on " Vitamins ".

He began by tracing the development of the history of vitamins in the past fifteen years and proceeded to deal with the chemical method of attack on different vitamins. He referred to the incidence in Ceylon of the condition known as " sore mouth " and " toad skin ", and mentioned the work of Dr. Nicholls in the asylums and in the poor Vernacular Schools. Two-thirds of the numerous cases of blindness are to be ascribed to vitamin ' A ' deficiency.

Mr. E. C. T. Holsinger, Dr. F. O'B. Ellison and Mr. P. Kirtisinghe offered remarks. Dr. Child suitably replied.

The Chairman said that the absence of rickets in Ceylon to any great extent might be due not only to the fact that children were exposed to the sunlight, but because the people were not in a position to afford dried milks, which were deficient in vitamin ' D '. The children were naturally fed and natural milk contained a good percentage of calcium.

One Hundred and Thirty-fourth General Meeting.

The One Hundred and Thirty-fourth General Meeting was held on 8-X-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of forty-one members and visitors.

The minutes of the last meeting which were read by Mr. L. de Fonseka, in the absence of the Secretary, were confirmed.

Prof. W. C. Osman Hill then delivered a very interesting lecture on " Anthropoid Apes ". The lecture was well illustrated, and Prof. Hill had before him for the inspection of the audience a variety of specimens to illustrate the points he was dealing with in the course of his lecture. The lecturer defined Anthropoid Apes as " large, tailless Catarrhine Primates, distinguished from Man by more complete hairy coat and by presence of a big toe which arises from the inner margin of the foot instead of in line with the other toes ". The earliest known is *Propliopithecus* of the Oligocene period, discovered in the Fayûm deposits of Upper Egypt. This was smaller than a Gibbon, but was definitely in advance of the monkey.

Next came *Dryopithecus*, a large tree ape as big as a Chimpanzee and with dental characters approaching the human even more closely than those of modern large apes.

This was a Miocene form, and various species are known from Europe and from the Siwalik Hills in the Punjab. Several other fossil apes are known from these latter deposits (e.g., *Palaeopithecus* and *Sivapithecus*) as well as a jaw indistinguishable from that of a modern Orang-utan (*Pongo*).

It is believed that the Siwalik area was one of active Primate evolution and dispersal. With the upheaval of the Himalayas and the occurrence of glaciation, migrations took place, and one of the latest of these was responsible for the migration (*a*) of *Dryopithecus* into Europe, (*b*) the ancestors of the Chimpanzee and Gorillas into Tropical Africa, and (*c*) the Gibbons and Orangs into Malaya.

Australopithecus, originally described as an Ape-man, is now known to have been an immature Ground Ape allied to the Gorilla, but of pigmy proportions and definitely less arboreal, and, therefore, approaching Man more closely than the existing Gorilla. Of the Gorillas, the highland from (*G. beringei*) is more terrestrial than the lowland animal, and has, as a result, evolved the most human foot of any living anthropoid.

The Chimpanzees have evolved into local races comparable to the races of human beings. These are characterized by pigmentary and hairy characters. Some Chimpanzees, like humans, go bald with age: others are black-faced and bearded, whilst some are white-faced or beardless. The most interesting is the black-faced Pigmy Chimpanzee (*Pan paniscus*) recently discovered on the south of the River Congo where Chimpanzees had previously not been suspected to occur.

Orangs are confined to Sumatra and Borneo. The Sumatran Orang is larger than the Bornean. Orangs have poor or no brow ridges, cheek pads, beards, and a shaggy coat of red hair. They are essentially arboreal, with long arms and short, weak legs.

Gibbons form a group of about a dozen kinds, scattered over East Bengal, Burma, Siam and Malaya. They have perfected arboreal progression and in so doing have departed from the line which led to the emergence of Man and the heavier anthropoids.

It is clear on geological as well as other grounds that Man and the Apes have developed *pari passu*, both having existed as such from Pliocene times. Gibbons and Chimpanzees little differing from modern types were already in existence in East Africa, at a time when modern types of Man had also been evolved. The apes are to be regarded rather as brothers of Man. No modern ape could possibly be regarded as Man's ancestor. Both are derivable from a common ancestor, which possessed generalized characters not definitely human nor definitely anthropoid in its modern sense. *Propliopithecus* could have been close to this hypothetical ancestor.

One Hundred and Thirty-fifth General Meeting.

The One Hundred and Thirty-fifth General Meeting was held on 12-XI-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President took the chair and there was an attendance of thirty-three members and visitors.

The minutes of the previous meeting were read and confirmed.

Miss A. K. Joshua, B.Sc. (Lond.), was elected an Ordinary Member of the Society.

The President then called upon Prof. N. G. Ball to deliver his lecture on "Vegetation in Ceylon". Prof. Ball showed a number of very interesting photographs taken by himself and coloured in natural colours by Mrs. Ball, illustrating the type of vegetation to be found in different parts of the Island. The photographs emphasized the fact that vegetation varied in different parts of the Island according to local climatic conditions. Those that could adapt themselves to live in those regions survived and the rest were eliminated. If often happened that two places had similar climates, but differed in the actual specimens they presented. There were perhaps no places in the tropics, which could show so many varieties of plant life in such a small area.

At the conclusion of the lecture, remarks were offered by the President and Prof. F. O'B. Ellison. The lecturer suitably replied.

One Hundred and Thirty-sixth General Meeting.

The One Hundred and Thirty-sixth General Meeting was held on 10-XII-1935, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President occupied the chair and there was an attendance of fifty-six members and visitors.

After the minutes of the previous meeting were read and confirmed, Mr. L. G. O. Woodhouse delivered his lecture on " The Meaning of Colour and Adornment in Butterflies." Mr. Woodhouse expounded the theory of Major Hingston that colours in butterflies were more to terrify rivals or enemies rather than to attract males, as Darwin had explained. The lecture was very well illustrated. In the discussion which ensued, Messrs. R. H. Bassett, D. R. R. Burt, Prof. Ellison and Mr. P. Kirtisinghe took part.

All blocks illustrating this Part by courtesy of the Survey Department, Ceylon.

PRINTED AT THE CEYLON GOVERNMENT PRESS, COLOMBO.

CEYLON J. SCI. (B) VOL. XXI, PT. 2. (*February 10, 1939*)

The Phenomenon of Spontaneous Fission in *Laomedea*[1] (*Obelia*) *spinulosa* Bale, var. *minor* Leloup in Colombo Harbour

BY

S. JONES, B.A., M.Sc.
Department of Agriculture and Fisheries, Travancore

(With Two Text Figures)

INTRODUCTION

While examining living colonies of *Laomedea spinulosa minor*, a common hydroid in Colombo Harbour, certain peculiar structures were noticed which, on closer study, proved to represent a case of spontaneous fission, a mode of reproduction recorded in a number of hydroids from European waters. From the literature available, this appears to be the first record of spontaneous fission observed in the tropics. Its occurence, side by side with metagenesis, in a large number of forms in different regions of the world, is of biological interest.

HISTORICAL RÉSUME

Spontaneous fission was first recorded by Allman (1871) who observed the formation, liberation, and subsequent development of the frustule into a Colony in a thecaphore hydroid, which he named ' *Schizocladium ramosum* ', basing the generic character upon this phenomenon and stating at the same time the close resemblance of the form in question to *Obelia dichotoma*. When Allman observed this phenomenon he failed to find any gonosome, which made him mention that " it is quite possible that in ' *Schizocladium ramosum* ' spontaneous fission never occurs simultaneously with true sexual generation " (Allman 1872). He observed a slightly different type of fissiparous multiplication in *Corymorpha nutans*, a non-colonial athecaphore hydroid.

[1] Most of the forms mentioned under the genus *Laomedea* in this paper were described under *Obelia* (subgenus) by many former workers.

2——J. N. 76094-505 (7/38)

Hincks (1872) observed the same mode of reproduction in *Laomedea neglecta* and dispelled the idea of Allman that the capacity to develop fission frustules is a specific character. He considered it common among hydroids and gave credit to Allman for the discovery of a new and interesting mode of reproduction in this group.

Mereschkowsky (1878) observed spontaneous fission in *Obelia flabellata* (=*Laomedea longissima*) and attributed the formation of the frustules to the increase in salinity of the water in which he kept the specimens. He considered this phenomenon akin to encystation, to tide over unfavourable conditions, in some Protozoa. In this case " not only for the preservation of the individual, but also for propagation."

Billard (1904) recorded his own observations on spontaneous fission in three forms, *Laomedea longissima*, *Laomedea geniculata*, and *Leptoscyphus tenuis* which he described under ' Scissiparite secondaire avec propagules simples '. He identified " *Schizocladium ramosum* " of Allman with *Laomedea longissima* and disagreed with Hartlaub[1], who considered it to be synonymous with *Laomedea geniculata*. He was of the opinion that frustules are induced to form by the movement of the water. Under ' Scissiparite avec propagules complexes ' he described *Laomedea angulata*, *Halecium sessile*, and *Plumularia halecioides*. In *Laomedea angulata* he found an intermediate condition where the stolon under certain conditions is converted into a frustule, whereas in *Halecium sessile* and *Plumularia halecioides* complete fission does not take place. He considered spontaneous fission and stolonization as closely related phenomena. In 1911 Billard again recorded a case of spontaneous fission in an athecaphore hydroid, *Perigonimus repens*.

Kramp (1916) recorded observations on *Laomedea geniculata* and *Laomedea longissima* and came to the conclusion that spontaneous fission is not due to the strong motion of water as suggested by Billard or to an increase in salinity as opined by Mereschkowsky, but to food deficiency.

Lastly, is the account of Lwoff (1925) in which he recorded observations on a species of *Perigonimus*. Brief as this account is, it is of interest as he shows that spontaneous fission can to some extent be considered a normal phenomenon. He found no evidence supporting the explanation of previous workers for the formation of frustules, as these were produced by well fed colonies in still water. He referred to the interesting experiments of Child (1923 and 1925) who by the

---

1 1902. *Biolog. Centralbl.* IX. as referred by Billard.

addition of different chemicals induced the formation of frustules. In *Perigonimus*, Lwoff found no gonophore but observed the capacity of the same ramulus to produce more than one frustule by successive budding.

OBSERVATIONS

The following observations were made during the month of June, 1937, on specimens collected within six feet of low tide water level from the Fisheries Department Jetty at Kochchikkade, Colombo Harbour. The Jetty is wind swept and close to the coal wharfs; on account of which there is considerable amount of coal dust and débris. The specimens were immediately brought in clean sea water to the Fisheries Laboratory, Colombo Museum, and examined.

In the local form both gonosome and frustules are sometimes present, at other times only one or the other of these. Frustules are developed from buds at the free distal end of the colony (Fig. 1). In the first instance a bud arises which is distinguished with difficulty from that which forms an ordinary trophozooid (Fig. 1, 1 e). This bud, instead of developing a hydrocephalus at the distal end, becomes elongated (Fig. 1, 1 c, d). It has the typical 'hydroid' structure with the external perisarc, internal coenosarc, and central coelenteric cavity in which the constant movement of granules can be clearly observed. A series of annulations now arise in the perisarc at the base of the bud. This is the beginning of the formation of the frustule. Further development is rapid. The annulations penetrate deeper and deeper with consequent constriction of the coenosarc (Fig. 1, 1 c, d 2). Meanwhile food material has been stored to capacity and at this stage no movement of the granules in the coelenteric cavity can be seen.

The coenosarcal connection from the hydrocaulus to the frustule is soon completely lost and the latter becomes a long rod-like structure, round at the tip but tapering below, and connected to the parent colony by the chitinous tube of perisarc (Fig. 1, 1 b). The tapering lower portion, the place of lesion, gets rounded off so as not to exhibit any visible difference from the other end (Fig. 1, 1 a). The healed up portion secretes a thin layer of chitin, thus sealing up the whole structure. The actual length of the frustule varies from 0.2 mm. to 0.5 mm. or a little more, though the diameter does not vary to any appreciable extent. Even after the isolation of the frustule, the chitinous tube of perisarc continues to elongate, sometimes to an extent of about 5 mm. The frustules appear to the naked eye as tiny white rods swaying in the water.

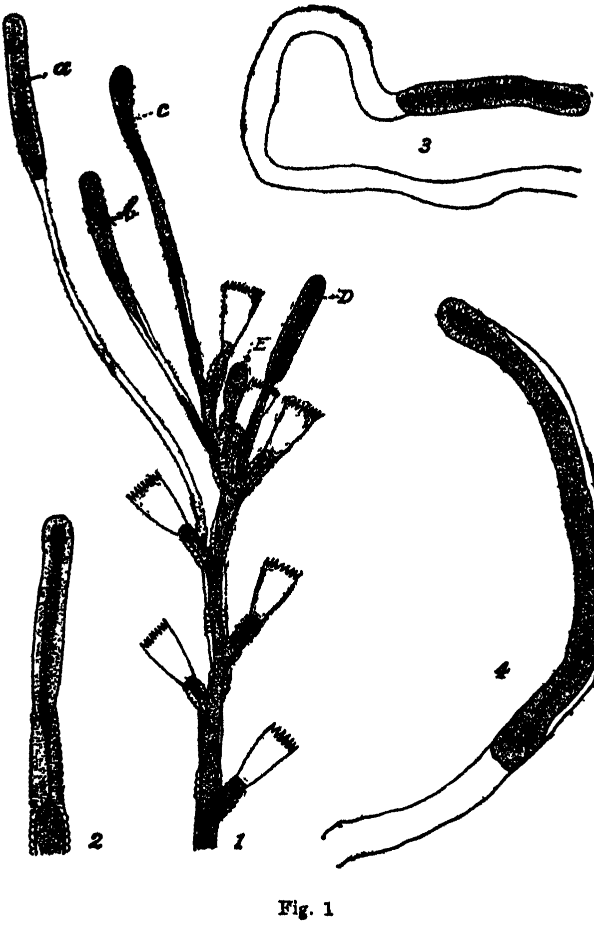


Fig. 1

(1) Terminal portion of a colony of *Laomedea spinulosa minor* showing the frustules in the various stages of development. (Hydranths are not shown.) (*a*) A fully formed frustule; (*b*) A frustule immediately after the isolation of coenosarc; *c* and *d* frustules in formation; (*e*) A small bud which may grow either into a hydranth or a frustule × 105

(2) A frustule in formation showing the nature of the annulations of the perisarc at the base × 130

(3) A frustule resting at the bottom of the dish × 130

(4) A frustule (primary stolon) after 24 hours × 130

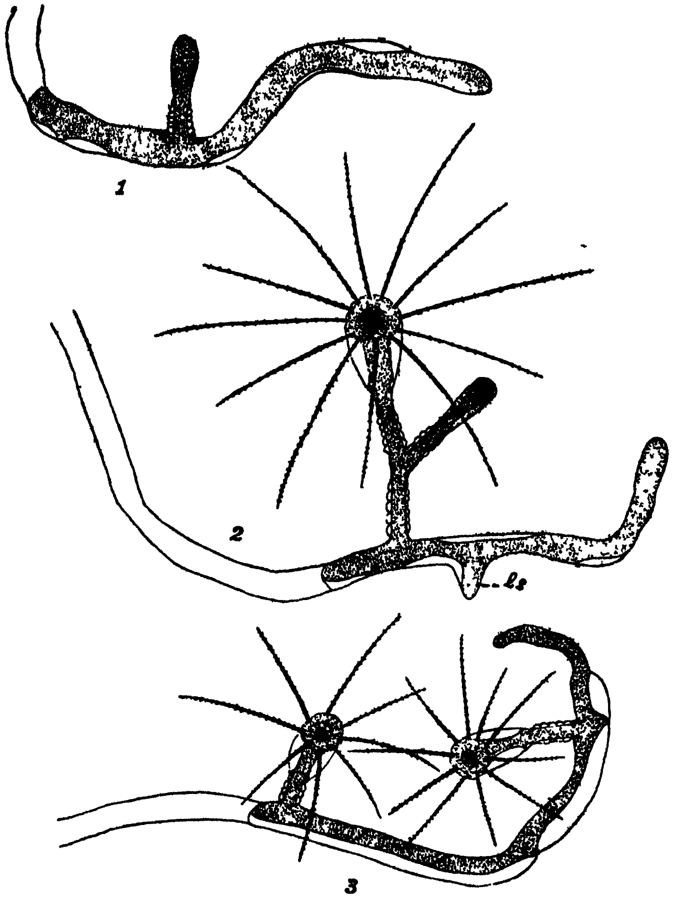


Fig. 2

(1) The primary stolon showing the first bud that develops into the primordial hydranth—about 36 hours old × 130

(2) The primordial hydranth with the first lateral bud—about 60 hours old × 130 ls = lateral stolon

(3) Two primary hydranths from a single stolon—about 48 hours old × 130

The motion of the water snaps the chitinous tube and they are freed. If the water is still, the frustules, the specific gravity of which do not differ very much from that of the sea water, gradually sink down.

In the Laboratory, the fission products were kept in small dishes within large vessels containing sea water and their further development was watched. The frustule sinks down and there is a resting period of very short duration (Fig. 1, 3). Then the tip becomes attached to the glass surface by the aid of a secretion and creeps forward just in the manner of the ordinary stolon. Meanwhile the coelenteric cavity, which was till now indistinct, shows itself by the presence of granules in motion. The creeping process of the stolon is very slow and the primary stolon gets established within the first twenty-four hours. (Fig. 1, 4). This then stops growing and develops a bud (Fig. 2, 1) which forms the primordial hydranth before it is forty-eight hours old. By this time the coenosarc of the stolon has become considerably shrunken as much of it has been expended in the formation of the hydranth. Billard says that the coenosarc from the whole hydrorhiza, and sometimes even from the stalk, will be withdrawn. Kramp has never seen such an inordinate reduction of the coenosarc and my observations tally with Kramp's.

Further growth depends on the availability of food to the first hydranth. If food is abundant lateral stolons are developed and the primary stolon itself begins to elongate. From the stalk of the first hydranth buds are produced one by one, thus giving rise to a colony. The first lateral bud has been seen to develop in the specimens kept in the aquarium within seventy two hours after the liberation of the frustule (Fig. 2, 2). If food is scarce the first hydranth is withdrawn, no lateral stolons are developed and a fresh hydranth is formed. The animal dies on further starvation. Usually a single primary hydranth is developed, but rarely two. In such cases, the hydranths are smaller with fewer tentacles (Fig. 2, 3).

DISCUSSION

It is evident that spontaneous fission, or ' schizocladism ' as Hincks puts it, is of very common occurrence among the hydroids, more especially among the thecaphores. Now the most important question is whether it is a normal phenomenon or an induced one. Various explanations have been given by the different observers. Mereschkowsky attributes it to an increase in salinity. Billard considers it to have been brought about by the constant motion of the water, whereas Kramp is of opinion that it is induced by hunger. Allman, who first saw this phenomenon, considers it to be a specific character. Hincks, who had only very little data, merely regarded it as a new mode of reproduction which might have a wide range among hydroids.

From the above account we find that, though the weight of opinion is in favour of considering this phenomenon to have been brought about by abnormal circumstances, no one has ever been able to show definitely the determining factor. When frustule-bearing colonies were examined from the Colombo Harbour, monsoon rains were in full swing and there was naturally a decrease in salinity contrary to the suggestion of Mereschkowsky. So the view that increase in salinity is the cause for the formation of frustules does not in my opinion hold good, at least in the Colombo form. Similarly with regard to the opinion of Kramp who attributes it to a scarcity of food. I have had the opportunity of making plankton collections from the locality and it has been definitely found that there is an abundance of micro-organisms suitable for the hydroids to consume if they care to. The other remaining factor is the motion of the water. One cannot deny the fact that there is motion in the water; but this every organism, unless it is an inhabitant of the deeper zones, has to withstand and the condition cannot be considered in the true sense abnormal. Also, as Kramp says, a certain amount of motion is necessary for the liberation of the frustules. These have been produced in still water in the laboratory. The question is, why should both medusae and frustules be liberated at the same time under normal conditions. Even here in some instances certain colonies show only one mode of reproduction and the rest the other. Considerable experimental research work has to be done before it is possible to arrive at any satisfactory explanation. In this connection, a perusal of the work of Lwoff (1925) and of Child (1923 and 1925) will be of much interest. The experiments of Hallez (1905), according to Kramp, are so " brutal " that no evidence can be utilized from his results.

What we know at present is that, in some cases, frustulation and metagenesis occur together, whereas in others either of them at a time.

If frustulation is a natural phenomenon, it will be interesting to find out the particular advantage this has over metagenesis. Is it merely another mode of reproduction simpler than metagenesis—perhaps the vestige of a more archaic type of reproduction—without all the disadvantages of a complicated life cycle? The repeated production of frustules by the same ramulus in *Perigonimus* sp. observed by Lwoff cannot be without significance.

The study of stolonization (Billard 1904, Philbert 1935) in this form has been taken up to see its relation to spontaneous fission.

SUMMARY

1. The phenomenon of spontaneous fission or frustulation in *Laomedea* (*Obelia*) *spinulosa* Bale var. *minor* Leloup has been studied.

2. A fission frustule is developed from an ordinary bud which first becomes elongated, followed by a series of deep annulations of the perisarc formed at the base.

3. The coenosarc at the base becomes constricted till the distal end becomes isolated from the hydrocaulus (but connected by the chitinous tube of perisarc).

4. The place of lesion heals up and becomes rounded where a layer of chitin is secreted and the frustule looks like a cylindrical rod, both ends rounded.

5. The frustule becomes detached from the colony by motion of the water, sinks and grows into the primary stolon.

6. From the primary stolon a bud is developed (rarely two) which forms the primordial hydranth and which by subsequent budding gives rise to a colony.

7. The various views regarding spontaneous fission in hydroids are discussed.

I am much indebted to Mr. A. H. Malpas, the Director of the Colombo Museum and Marine Biologist to the Government of Ceylon, and to Mr. P. E. P. Deraniyagala, the Acting Director and Marine Biologist, for the facilities given to me for making these investigations. My thanks are also due to Mr. J. H. de La Haule Marrett, the Ethnologist to the Government of Ceylon, for the translation of certain French passages.

REFERENCES TO LITERATURE

ALLMAN, G. J. 1874—On a mode of Reproduction by spontaneous fission in the Hydroida. *Quart. Journ. Micr. Sci. N. S.* XI

idem 1872—" A Monograph on Gymnoblastic or Tubularian Hydroids. " *Ray Society, London*, I

BILLARD, A. 1904—Contribution a'l'étude des Hydroides. (Multiplication, régénération, greffes, variation) *Ann. Sci. Nat. Zool.* Ser. 8, XX

idem 1911—Note sur un nouveau cas de scissiparite chez les Hydroides. *Bull. Mus. d'Hist nat.*

CHILD, C. M. 1923—The axial gradients in Hydrozoa V. Experimental axial transformation in Hydroids. *Biol. Bull.* 45

idem 1925—The axial gradients in Hydrozoa VII. Modification of development through differential suceptibility, *ibid* 48

HALLEZ, P. 1905—Rhiotropisme de quelques Hydroides monosiphonés et des Bugula—*Comptes Rendus des Séances de l'Acad. des Sciences Paris*, 141

HINCKS, T. 1872—Contribution to the History of the Hydroida *Ann. Mag. Nat. Hist.* Ser. 5, I

KRAMP, P. L. 1916—Spontaneous Fission in Hydroids *Vidensk. Meddel. Dansk natur. Forsch, Copenhagen*, 67

LWOFF, A. 1925—Reproduction D'un Hydraire Gymnoblaste Par Pousées Repetées de propagules apartir D'un même Rameau propagulaire. *Bull. Coc. Zool. Paris*, 50, No. 10

MERESCHKOWSKY, C. 1878—Studies on the Hydroida. *Ann. Mag. Nat. Hist.* Ser. 5, I

PHILBERT, M. 1935—Le phénomène de stolonization chez trois espèces d'Hydraires fixes sur des posidonies en Mediterranée. *Bull. L'Inst. Ocean. Monaco* No. 665

8—J. N. 76094 (7/38)

CEYLON J. SCI. (B) VOL. XXI, PT. 2. (February 10, 1939)

The Oesophagus of the Earthworm *Pheretima peguana* (Rosa)

BY

P. KIRTISINGHE, B.Sc.

Demonstrator in Zoology, University College, Colombo

(With Four Text Figures)

For purposes of the study of the circulatory system of the earthworm *Pheretima peguana*, serial sections, both transverse and horizontal, were made through the anterior region of this worm. Besides the purpose for which they were made, these sections served (*a*) to show the presence of certain secretory glands in the oesophagus, which as far as can be ascertained, has not been previously noted and (*b*) to enable further observations to be made on the condition of the so-called " calciferous gland " of this worm.

The worms were kept in moist blotting paper until their gut contents were evacuated, gradually narcotised with 90 per cent alcohol as recommended by Bahl (1926) and then fixed in Bouin's fluid. Sections were stained with Delafield's haematoxylin or in Haidenhain's haematoxylin and counterstained with eosin.

The alimentary canal of this worm is differentiated into buccal cavity, pharynx, oesophagus with gizzard, and intestine. The oesophagus extends from the fifth to the end of the fourteenth segment and is provided with a gizzard in the eighth segment. The wall of the oesophagus anterior to the gizzard is made up of a layer of epithelium, a layer of reticular tissue beneath the epithelium, a thick layer of circular muscles, a very thin layer of longitudinal muscles and, outside that, the peritoneum. In the gizzard, the layer of reticular tissue is suppressed, the circular muscles become hard and compact and the lumen of the gizzard lined by a chitinoid membrane. The reticular tissue between the epithelial and circular muscle layers is again present in the ninth and tenth segments, gradually diminishing in thickness until, in the eleventh segment and backwards, its place is taken by fairly large blood sinuses, the general blood sinuses of the gut. The circular muscle layer in the ninth segment, though not so thick and compact as in the gizzard, is still considerable, but it too shows a gradual reduction in thickness hindwards, until in the eleventh segment it is reduced to a very narrow layer, which condition it retains throughout the intestine.

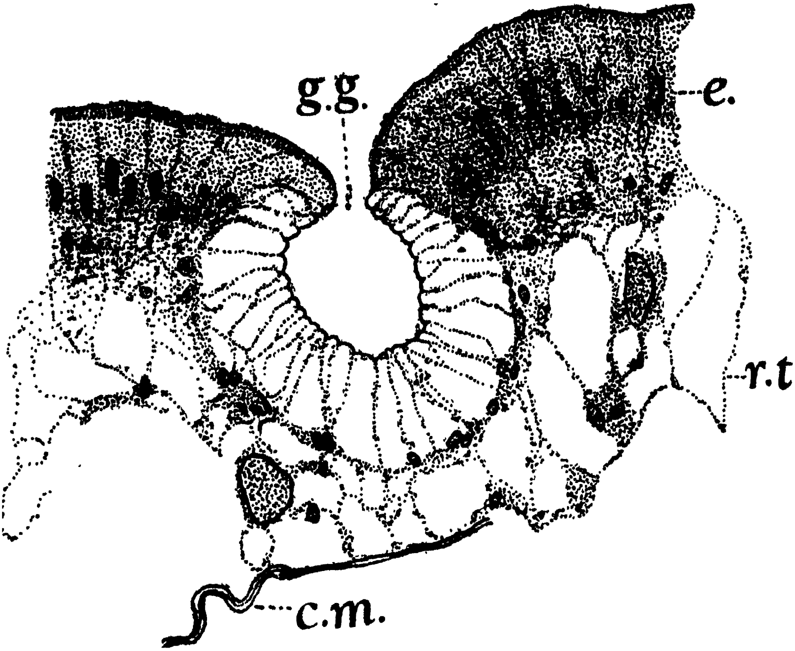


Fig. 1. Transverse section through portion of oesophagus passing through a gastric gland
c.m. circular muscles; e. epithelium of oesophagus; g.g. gastric gland. × 970

A number of spherical glands is to be seen embedded in the oesophageal epithelium of the ninth and tenth segments. These glands are conspicuous in stained sections as clear areas, for they remain practically unstained. They are fairly numerous in the ninth segment, occur in smaller numbers in the tenth and are not found further back. They measure about 40μ in diameter and possess a central cavity opening into the lumen of the oesophagus by a small aperture (Fig. 1). The cells forming the walls of the glands are continuous with the epithelial cells of the oesophagus and appear to have been derived from them. There cannot be any doubt that these glands are secretory. Their presence enables us to differentiate this part of the gut as a stomach region functionally.

Stephenson and Prashad (1919) have shown that in *P. hawayana* the oesophagus is swollen segmentally in segments ten to thirteen and constricted intersegmentally, and that in these segments the epithelium is thrown into well marked transverse folds. These folds are said to represent a very simple form of calciferous gland. Although these authors described a system of transverse blood channels in the oesophageal wall, they were unable to depict the blood supply within the epithelial folds " . . . owing to the fact that this portion of the alimentary canal does not retain its blood supply after fixation ". The results I have obtained in this respect with *P. peguana* are quite otherwise. In all my sections, this blood supply is so well retained, that I have here briefly attempted to supplement Stephenson and Prashad's account with drawings of the actual blood supply to the folds of the " calciferous gland " in *P. peguana*, as well as to show that the condition of the gland in this worm is an advance on that in *P. hawayana*, in that the number of folds of the epithelium is greatly increased in each segment.

In *P. peguana* the oesophagus is swollen in segments twelve and thirteen and constricted intersegmentally, the transverse folds of the oesophageal epithelium being very prominent in these two segments (Fig. 2). The oesophagus in the twelfth segment may assume a flask shape by the extension, into this segment, of the seminal vesicles which press on its sides anteriorly. Except in the anterior portion of the twelfth segment, the lumen of the oesophagus remains a large cavity. As in *P. hawayana* the folds of the oesophageal epithelium are of two kinds; a longer kind—the lamellae—and alternating more or less regularly with these, a shorter kind—the ridges. But whereas in *P. hawayana* these folds number only about a dozen per segment, in *P. peguana* they are strikingly more numerous being about sixty in each segment.

This region of the oesophagus is supplied with blood from the lateral oesophageal vessels. These vessels here lie close against the wall of the oesophagus and blood passes directly from them into a series of transverse channels formed by the enlargements of the sinuses at the bases of the epithelial folds—the basal sinuses. From these channels, blood enters the peripheral sinus and also extends into the axial space between the two layers of epithelium of the folds. Some of this blood may pass backward in the general gut sinus, but most of it is discharged into the supra-intestinal vessel with which the transverse channels are in communication. These transverse channels are externally visible on the wall of the oesophagus on opening up a freshly killed

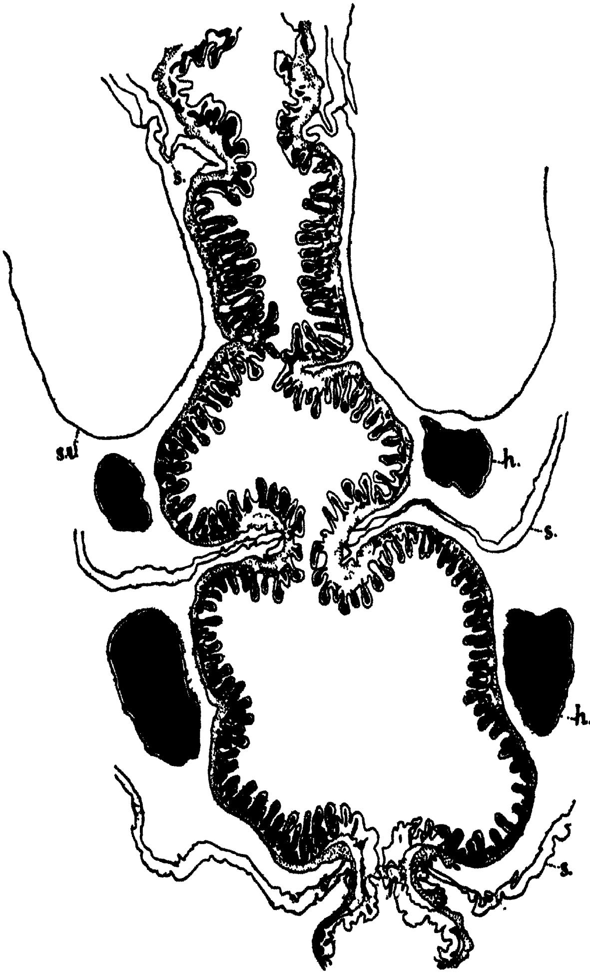


Fig. 2. Horizontal section through oesophagus in twelfth and thirteenth segments
h. heart, s septum, s.v. seminal vesicle × 40

worm. In *P. peguana*, the supra-intestinal vessel first makes its appearance in the eleventh segment and extends through the twelfth and thirteenth segments. It communicates with the ventral vessel by a pair of intestinal " hearts " in the eleventh segment and by the latero-intestinal " hearts " in the twelfth and thirteenth segments. It is generally double throughout its length except where it joins the " hearts " of the twelfth and thirteenth segments. Fig. 3 represents a transverse section of the oesophagus immediately behind the heart in the twelfth segment. The supra-intestinal vessel is here still a single vessel.

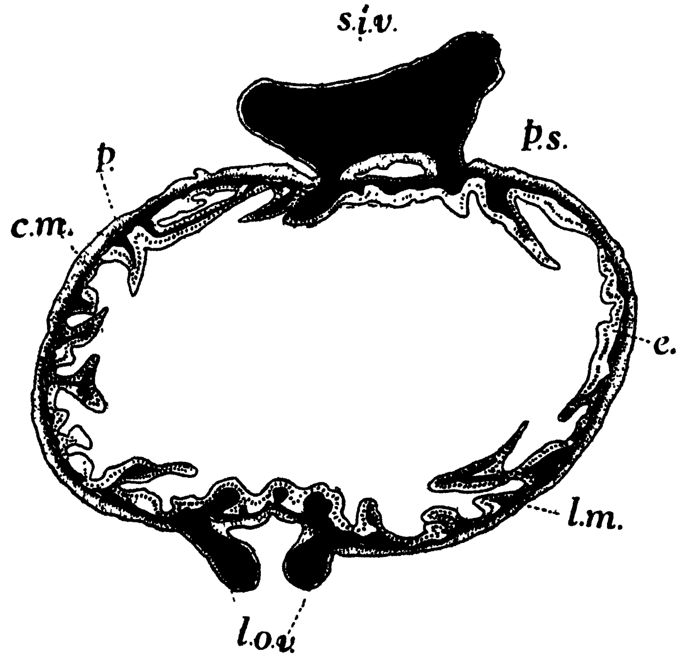


Fig. 3. Transverse section through the oesophagus in twelfth segment

c.m. circular muscles, e epithelium of oesophagus, l.m. longitudinal muscles; l.o.v. lateral oesophageal vessel, p peritoneum, p.s. peripheral sinus; s.i.v. supra-intestinal vessel × 66

The columnar cells of the epithelium, in this region of the oesophagus, are not provided with rodlets or cilia and in other respects of their detailed structure are identical with what has been described by Stephenson and Prashad for *P. hawayana*, except that the axis of the folds of the epithelium is clearly divided by a blood sinus (Fig. 4).

The differentiation of the alimentary canal into a stomach region has only rarely been definitely established among the Oligochaeta. According to Stephenson (1930), in several species of *Pristina* (Naididae), there is a stomachal dilation in which epithelial cells are found with an intracellular lumen, and in the genus *Fridericia* (Enchytraeidae), in a few segments at the beginning of the intestinal region, there are " chylus cells " with an intracellular canal opening into the lumen

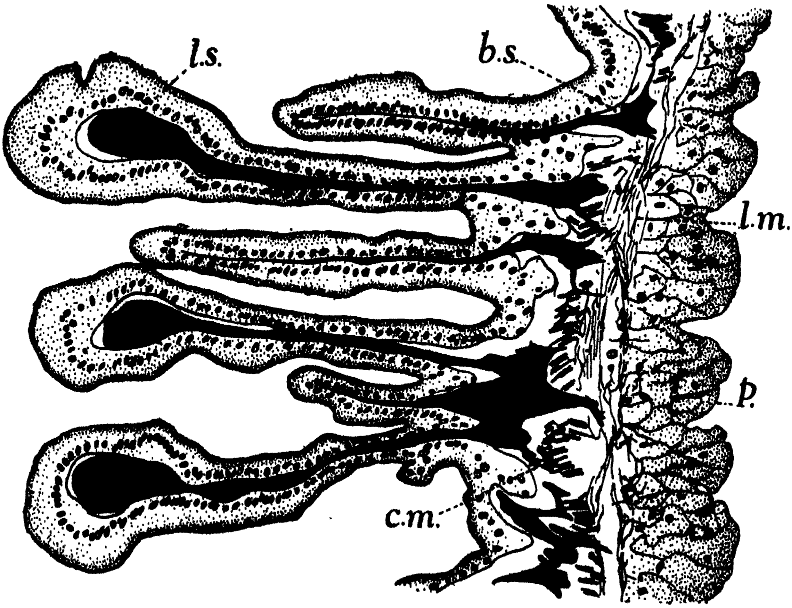


Fig. 4. Portion of horizontal section through oesophagus in thirteenth segment

b.s. basal sinus; c.m. circular muscles; l.m. longitudinal muscles; l.s. lamellar sinus; p. peritoneum × 360

of the intestine. In *Agriodrilus vermivorus*, Michaelson (1926) has described a number of fine canals opening into the anterior portion of the intestine, but it is not known whether they are intercellular or intracellular. So that the glands described above as gastric glands in *Pheretima peguana* are the only intercellular glands known opening into what may be called the stomach region of an Oligochaete worm. This of course leaves out of consideration the oesophageal diverticula of uncertain function in a number of worms and the calciferous glands, which according to the latest worker on the subject (Robertson have no role in the digestion or absorption of food.

REFERENCES TO LITERATURE

BAHL, K. N. 1926.—*Pheretima. Ind. Zool. Memoirs 1.* Lucknow

MICHAELSON, W. 1926.—*Agriodrilus vermivorus* aus dem Baikal-See, ein Mittelglied zwischen typischen Oligochäten und Hirudineen. *Mitt. zool. Mus. Hamburg*, S. 42

ROBERTSON, J. D. 1936.—The Function of the Calciferous Glands of Earthworms. *Journ. Exp. Biol.* Vol. XIII, pp. 279-297

STEPHENSON, J. 1930.—*The Oligochaeta.* Oxford pp. 92-118

STEPHENSON, J. and B PRASHAD, 1919.—The Calciferous Glands of Earthworms. *Trans. Roy. Soc. Edinb.* Vol. 52, pp. 460-462

CEYLON J. SCI. (B) VOL. XXI, PT. 2. (*February 10, 1939*)

Five New Species of Pseudophaneroptera Brunner (Insecta, Tettigoniidae) from Ceylon

BY

G. M. HENRY, F.R.E.S.
Assistant in Systematic Entomology, Colombo Museum

(With One Text Figure and Three Plates)

The genus *Pseudophaneroptera* was erected by Brunner von Wattenwyl in 1878 (*Monographie der Phaneropteriden* p. 107) for the accommodation of a species from Ceylon, *P. turbida*. Later (1891, *Verh. zool.-bot. Ges. Wien* XLI Band, Additamenta zur Monographie der Phaneropteriden, p. 53), he added a species from Deli in Sumatra, *P. major*. These two are the only described species, but a number of new ones have come to light in Ceylon, five of which are described in this paper.

It may be of interest to record the fact that no species of *Pseudophaneroptera* appears among the extensive collections of Orthoptera made by the British Museum—Colombo Museum Expeditions conducted by me in South India in 1936, 1937 and 1938 although much of the country collected in was very similar to the habitats of Ceylonese members of the genus. Should further collecting in South India confirm its absence there, and should *P. major* Brunner from Sumatra prove to be indeed congeneric with the Ceylonese forms, this genus will add an interesting item to the known links between the faunae of Ceylon and Sumatra.

The genus may be recognized by the following combination of characters:—general habitus of *Letana* (=*Pyrrhicia* Stal and Brunner) which it closely resembles in most features, but is readily separated by the possession of well-marked lateral carinae on the pronotum. These carinae distinguish it from all its near relatives. The fore-tibial auditory organs are open on both sides. Distal to the auditory organ, the tibia narrows rather suddenly dorso-ventrally (see Plate VIII. fig. 8), as in *Letana*, and is unarmed and more or less rounded dorsally. (Brunner makes the anteriorly-rounded, unsulcate nature of the fore tibia the main point of difference between his group Pseudophaneropterae and the Ducetiae, Pyrrhiciae, &c. This feature is however, not of great importance, for in several of the new species described below, although they are obviously Pseudophaneropterae, a trace of a dorsal sulcus on the fore tibia is present for a short distance distal to the auditory region. The lateral carina on pronotum seems to me a far more satisfactory ' key character ' than the non-sulcate fore tibia). There is no fore-coxal spine. All knee lobes bear a spine, or at least a minute, pointed tooth; the dorso-median apex of the femora is truncate, not, as in *Himerta*, produced. The tegmina are closely reticulated, almost parallel-sided distal to the stridulatory area, and rounded at the tip. The wings are longer than the tegmina and are reticulated in a similar manner in the portion that is not covered by the latter. The male subgenital lamina bears no articulated styles.

Amongst other features, the species of this genus known to me show the following general tendencies: a rather glaucous green coloration; the fore femora and tibiae tend to be suffused with castaneous, in contrast with these parts in the mid legs which are green; the ventral sulcus in the fore femur is always black, in the basal half at least; the eyes in life are green or yellow in the ventral half, some shade of brown or purple dorsally, with a dark equatorial zone separating the two colours; the head, body and limbs are more or less thickly sprinkled, especially dorsally, with small dark crimson specks; the vannal veins of the posterior wings are pink; the stridulatory area of the male left tegmen is generally lighter in colour than the rest of the tegmen and surrounded by a black or crimson line, forming a conspicuous oval patch; the basal portion of the female right tegmen, where covered at rest by the left tegmen, shows a feebly developed structure—presumably stridulatory in function—consisting of rows of bristled tubercles set on veinules with small vibratory membranes between them. This structure is closely similar in its main features to that described elsewhere in this volume (see p. 183) in *Psyra ceylonica* ♀, but is less developed than in that species.

KEY TO THE SPECIES OF PSEUDOPHANEROPTERA

1. Wings yellow (?-veined) ;[1] Sumatran species ... *major* Brunner
2. Wings pink-veined; Ceylonese species
3. Tegmina longer than abdomen; male cerci lacking minute black spinules ... 5

[1] Brunner states (*Verh. zool.—bot. Ges. Wien*, 1891, Additamenta Monog. Phaneropt. p. 52) that the pronotum of *P. major* has a median carinula, and that the posterior margin is slightly emarginate. On examining the extensive material detailed below I am forced to the conclusion that neither of these characters is, in this genus, of taxonomic importance; in several species, individuals occur in which either of them is more or less developed, while in other individuals both may be quite absent: for instance, one of the melanistic females of *P. ramicerca*, sp. nov. described below (p. 106) shows both these features distinctly, while another female and a male collected by me at the same place and period, and unquestionably conspecific with the other, have no emargination and only a trace of the median carinula; while yet other specimens show no trace of either.

4. Tegmina shorter than abdomen (*i.e.*, when the latter is normally extended); ma'e cerci furnished with minute black spinules ... 11

5. A black line ventral to lateral pronotal carinae ... 7

6. No black line ventral to lateral pronotal carinae ... *malpasi*, sp. nov.

7. Larger; pronotum 4 mm. long or more; male cerci short and bulbous ... *grandis*, sp. nov.

8. Smaller; pronotum well under 4 mm. long; male cerci not short and bulbous ...

9. Male cercus strongly expanded distally and concave below at tip, with short internal hook ... *turbida* Brunner.

10. Male cercus not strongly expanded distally or concave below at tip, and with long internal spine ... *phillipsi*, sp. nov.

11. Male cercus 3 pronged; with two sclerotized plates anterior to subgenital lamina ... *ramicerca*, sp. nov.

12. Male cercus flipper-shaped; lacking sclerotized plates anterior to subgenital lamina ... *pinnicerca*, sp. nov.

Pseudophaneroptera turbida Br. W.

(Plate VI figs. 8-10)

I had the privilege of examining the type series of this species in 1935 at the British Museum (Natural History). They were kindly loaned from the Berlin Museum by Dr. W. Ramme, at the request of Dr. Uvarov, for my examination, and my grateful thanks are due to these gentlemen for their co-operation. Unfortunately, the specimens arrived after I had packed up for returning to Ceylon and I had neither time nor necessary apparatus for their proper examination. However I made pencil drawings of the male genitalia from which the figures 8, 9 and 10 given in Plate VI have been prepared. The type series consists of two males and a female all labelled ' Typus ' and numbered 3179. They are not labelled with precise localities but were collected by Nietner somewhere in Ceylon.

In general structure and size this species closely resembles the following (*P. phillipsi*, sp. nov.), but is easily separated by the shape of the male cerci (Plate VI, fig. 8.), which are distally very broad, somewhat flattened dorso-ventrally, and rather deeply concave ventrally. The supra-anal plate and subgenital lamina, too, are different (Plate VI, figs. 9 and 10). Females of these species are difficult to discriminate with certainty and it may, eventually, be found that they are only entitled to rank as subspecies of one form, but until the distribution of both is worked out it is better to treat them as full species. *P. malpasi*, sp. nov. (p. 102) is also closely related but has shorter tegmina and wings.

Measurements.—For purposes of comparison with *P. phillipsi*, sp. nov. and *P. malpasi*, sp. nov., described below, I give the measurements of one of Brunner's males and his female specimen re-measured by myself.

Measurements.	♂ mm.	♀ mm.
Length of body*	12.0	17.0
Length of pronotum	3.0	3.0
Breadth of pronotum (between lateral carinae	2.2	2.4
Length of tegmen	16.5	17.5
Breadth of tegmen*	3.0	? (folded)
Length of wing	21.2	23.4
Length of hind femur	14.0	15.3
Length of ovipositor	—	4.1

This paper was already in typescript and ready for the press when I was fortunate enough to capture a male of *P. turbida* at West Haputale Estate, below the south-eastern border of the Horton Plains, at an elevation of 6,000 feet. It was sitting on the upper surface of the leaf of a herbaceous plant in a strip of jungle, at a height above the ground of about 18 inches, on 8-viii-37 and was brought alive to Colombo and specimenized two days later.

Although the measurements of this specimen are a little greater than those given above for Brunner's male specimen they differ from the latter fairly consistently, and the structure of the genitalia leaves me in no doubt that it is *P. turbida* and also that the latter species is definitely distinct from *P. malpasi*, sp. nov., described below, of which a number of specimens were collected at the same period in the jungles above the Estate and from 500 to 800 feet higher (see below, p. 104).

The living coloration of this specimen was as follows:—Glaucous green. Eyes pale purple dorsally, green ventrally, the two colours being separated by a dark brownish-purple 'equatorial' zone. Ocelli nearly colourless, a dark crimson spot above each. Labrum pale whitish green. Antennae: two basal segments green, marbled with brown and black; flagellum green at base, rapidly darkening to black.

Pronotum dark green dorsally, with a narrow, pale-green, medial line. Posterior lobe partly suffused with black and dark, dull crimson. Lateral carinae pale yellow with a black line immediately below them. Lateral lobes lighter green than dorsum. Pronotum thickly speckled with blackish-crimson specks.

Fore coxae and trochanters yellow-green. Fore femur, in proximal half, russet pink, shading into green distally; a small, diffuse, black,

* In the case of all species described in this paper these measurements are approximate only—in the first owing to post-mortem shrinkage and in the second to the natural curvature of the tegmina. The latter are measured at the widest part distal to the stridulatory area.

linear spot on its dorsum at one-third from base. Ventral sulcus black proximally for more than half its length. Fore tibia green except auditory organ which is russet with a black dorsal area, tympanal membrane black.

Mid legs green. Hind femur whitish-green externally, darker green dorsally. Hind tibiae green. All the femora speckled with dark crimson. All the tarsi translucent brownish-yellow with a pair of black spots at base of third joint; fourth joint shading to a subapical black ring; claws dusky.

Tegmina glaucous green with a milky suffusion in the costal half, and macular black submarginal, and brown marginal, sutural lines. The stridulatory area of the left tegmen is pale greenish-ochraceous, black proximally and distally. The wings are hyaline, with pink veins in the vannal area, green in the anterior and apical portions.

The abdomen is green, thickly speckled with dark crimson dorsally and suffused with opaque white ventrally. The cerci are glaucous green proximally, yellow-green at apex.

In the preserved specimen these colours have altered to some extent, and unfortunately it proves to be somewhat teneral, as the body has shrunken and distorted a little in the process of drying, and one of the cerci has shrivelled.

Pseudophaneroptera phillipsi, sp. nov.

(Plate VI, figs. 1-4)

Closely related to the genotype (*P. turbida* Br.) but differing in the shape of the male genitalia.

Genitalia (male). These are as shown in Plate VI, figs. 1-4. The cerci are cylindrical and terminate in a long, sharp, inwardly-directed spine; the subgenital lamina is shorter and much broader than in the next species (*P. malpasi*, sp. nov.), broadly emarginate distally and with a distinct, downwardly-projecting median tooth (in some specimens the lamina is flatter, not so ventrally concave as in the specimen shown in fig. 3, which is probably somewhat contracted in drying).

The female genitalia show little appreciable difference from those of *P. turbida* and those of the following species, *P. malpasi*, sp. nov.

Coloration. Green; a diffuse crimson-black spot on outer aspect of the basal antennal joint; flagellum of antennae green proximally, shading rapidly to black; a narrow black line along ventral side of lateral carina on pronotum; a small, diffuse, crimson-black mark at each lateral angle of posterior lobe of pronotum; the ventral sulcus on fore femur black in its proximal half; the auditory area of fore tibia dull crimson; the tympanal lobe of left tegmen (in the male) black and dull crimson proximally and distally, pale green on the disc; a black line, consisting of inter-venular spots, extends along the sutural border of each tegmen; the whole body and the femora more or less speckled with minute spots of dull crimson. The veins in the vannal area of the wings are crimson.

Measurements.	♂	♀
	mm.	mm.
Length of body	12.0 to 12.3	16.5 to 19.8
Length of pronotum	3.0	3.1 to 3.4
Breadth of pronotum (between lateral carinae)	2.0 to 2.2	2.25 to 2.3
Length of tegmen	15.0 to 15.5	17.5 to 19.0
Breadth of tegmen	3.0	3.7 to 4.0
Length of wing	19.5 to 21.0	22.0 to 25.0
Length of hind femur	12.5 to 14.0	14.8 to 16.0
Length of ovipositor	—	4.5 to 5.0

Material examined. Two males and one female from Woodside, Urugalla (one ♂ and one ♀ of these are in the British Museum, the other ♂, 9-iv-1923, is in the Colombo Museum); twenty-four males and twelve females from Mousakande, Gammaduwa, captured in the following months: February, March, July, September, October, November, December—1929 to 1936 by Mr. W. W. A. Phillips, in whose honour the species is named. I designate as type a male from Mousakande, Gammaduwa, 14-x-1932. With a series of paratypes of both sexes it will be deposited in the British Museum (Natural History).

Pseudophaneroptera malpasi, sp. nov.

(Plate VI, figs. 5-7)

Very close to the last species, and also to *P. turbida*, but differing in measurements and in the male genitalia. The capture of a series of specimens after this paper was ready for the press enables me to give the following description of the living coloration:

Male. Dull, rather bluish, green, brighter and more yellow on the face and sternum. Eyes purple-pink dorsally, pale green ventrally, with a dark ' equatorial ' band separating the two colours. Ocelli very pale yellow, no red spot above each. Antennae with two basal segments mottled brown, flagellum pale green at base rapidly darkening to black.

Pronotum dark, dull green on dorsum, paler green on lateral lobes; a very fine, pale median line. Lateral carinae yellow, flanked mesad with a fine dusky crimson line which expands on the posterior lobe into a dark crimson or blackish, suffused, transverse band, interrupted in the middle. Unlike *P. phillipsi*, there is no black line along the ventral side of lateral carinae.

All the coxae and trochanters are yellow-green. All the tarsi pale greenish-castaneus. The fore femora, proximally, suffused castaneus, distally green. As in all the other species described in this paper the ventral sulcus is black in its proximal half or more. The fore tibiae mottled brownish and purple about the auditory organ, the remainder suffused castaneus. The auditory tympana black. The mid and hind femora and tibiae green, the hind femora being somewhat suffused on their external face with opaque white.

Left tegminal organ slightly paler and yellower green than the rest of the tegmen, black at its proximal border and distally dark crimson, which colour continues as a fine line along the sutural margin of the tegmen. The wings are colourless hyaline with dull crimson veins in the vannal area, green veinules at the apex.

Abdomen dark crimson dorsally, glaucous green on the sides, and greenish white below. The occiput, dorsum and sides of pronotum, mes- and met-epimera, sides of tergites and all femora are sprinkled with blackish or dark crimson specks.

The female is coloured similarly to the male except that, in the tegmina, the portion which corresponds to the tympanal area of the male is concolorous except for a small distal ochreous spot. The ovipositor is pale glaucous green, narrowly castaneous along the dorsal margin and the distal part of the ventral margin.

Genitalia (male). The cerci are almost cylindrical, slightly broadened and truncate at the tip and with a small hook on their inner, distal side (Plate VI, figs. 5-7). The supra-anal plate and sub-genital lamina are as figured. The latter is much narrower, especially distally, than in *P. phillipsi*, and quite lacks the conspicuous, median tooth which is present in the latter. These genital characters are quite constant in the series at hand and afford a good means for separating this species from its near relatives *P. phillipsi* and *P. turbida*.

I have not succeeded in discovering any good specific characters in the female genitalia.

Measurements.	♂ mm.	♀ mm.
Length of body	10.0 to 11.0	*ca* 14.0 to 16.0
Length of pronotum	3.0	3.0 to 3.2
Breadth of pronotum (between lateral carinae)	2.0 to 2.2	2.4 to 2.5
Length of tegmen	13.0 to 13.5	15.0 to 17.5
Breadth of tegmen	2.6 to 2.8	3.3 to 3.7
Length of wing	14.0 to 15.5	17.0 to 20.0
Length of hind femur	11.0 to 12.3	13.3 to 14.0
Length of ovipositor	—	4.5 to 4.7

Material examined. Five males and three females from Nuwara Eliya, 17-iv-1914, 31-vii-1924, 28-iv and 14-v, 1927, and 12-v-1938; one male, Pidurutalagala, 28-vii-1924; one male, Elk Plains, 2-iv-1914; three males and two females, Hakgala, 15 and 30-viii-1929 and 8-v-1938; one female, Ambawela, 5-v-1938; five males and eight females, West Haputale Estate, immediately south of the Horton Plains, viii-1937 and iv-1938; one male, Ohiya, 7-iv-1928. A male from West Haputale Estate, *ca* 6,700 feet, 5-viii-1937 is designated as the type and will be deposited in the British Museum, which already possesses a male from Hakgala, 4-iv-1924, and a female from Nuwara Eliya, 25-iv-1923, both of my collecting. All the localities given are situated on the main mountain massif of Ceylon, between 5,000 and 7,000 feet, and within a radius of eight miles.

Bionomics. At West Haputale Estate a number of specimens were collected in jungle on the sides of the bridle-path from Haldummulla to the Horton Plains, above 6,500 feet. With few exceptions, all adults were found sitting on the upper surface of fronds of a dark green, glossy fern. They perched along the midrib with the antennae laid backwards, beneath the body, and the hind-legs extended behind. In this situation and position (a common resting attitude amongst the Scaphurinae), they were very inconspicuous. I found no evidence that they fed upon the fern and believe that they use it merely as a resting-place; there seemed, however, to be a strong preference for that particular species of fern, as the many other kinds of fern and jungle plants available appeared to be almost unpatronized. This applies to the adults only, however, as young individuals were found, often in twos and threes, sitting on the leaves of various shrubs, some of which showed signs of having been eaten. In several instances a male and a female adult were taken on fronds of the same fern.

At Hakgala and Nuwara Eliya, where I have recently collected, the above mentioned fern was not found and specimens of the species were captured on other jungle shrubs.

The species is named in honour of Mr. A. H. Malpas, Director of the Colombo Museum.

Pseudophaneroptera grandis, sp. nov.

(Plate VIII)

This is the largest of the Ceylonese members of the genus so far known, equalling or surpassing in size Brunner's *P. major* from Deli in Sumatra. I have not had the opportunity of examining any specimen of *P. major* but it seems likely that when the male becomes known (it was described from the female only) it may require a new genus.

The Colombo Museum is indebted to Mr. W. W. A. Phillips for the three specimens on which the following description is based.

This species resembles *P. phillipsi* and *P. malpasi* in general structure and coloration but is considerably larger and has very distinctive male genitalia.

The antennae are black, faintly annulated with green in the proximal part of the flagellum and with green marks on the basal two segments. There is a black spot immediately above the central ocellus and the area between the lateral ocelli is dark crimson. A black line ventral to the lateral carinae on pronotum is well marked. The posterior portion of the stridulatory area of the left tegmen, in the male especially, is conspicuously pale green. The dorsum of abdomen is dark crimson fading into the glaucous green sides. The thorax, abdomen and femora are plentifully sprinkled with small, dark crimson specks. The wing-veins, except the apical reticulation, which is green, are dark crimson.

In other respects the coloration is similar to that described for *P. phillipsi* but darker and richer.

Genitalia. These are figured in Plate VIII, figs. 4 to 6; a long verbal description is, therefore, unnecessary. The bulbous portion of the male cercus is strongly concave on the internal face. The male supra-anal plate, which, in the only male available, is strongly bent downwards and forwards between the bases of the cerci, appears to be long, almost parallel-sided, dorsally longitudinally concave, and truncate at its apex.

The female genitalia are figured in Plate VIII, figs. 2 and 6.

Measurements.	♂ mm.	♀ mm.
Length of body	18.0	20.0 to 21.0
Length of pronotum	4.25	4.0 to 4.2
Breadth of pronotum (between lateral carinae)	2.8	2.9 to 3.0
Length of tegmen	19.0	18.0 to 18.5
Breadth of tegmen	*ca* 3.7	4.2 to 4.5
Length of wing	20.0	20.0
Length of hind femur	19.5	18.0 to 19.0
Length of ovipositor	—	6.0

Material examined. One male (type) 26-vii-1933, and two females, 14-vii-1932 and 14-viii-1933, all from Mousakande, Gammaduwa. I understand from Mr. Phillips that these were captured at a lower elevation than *P. phillipsi*. Mousakande Group is a tea estate situated at the north end of the East Matale hills, at an elevation of 2,000 to 4,000 feet. It is partly surrounded by virgin forest and intersected with belts of jungle.

The type and one female will be deposited in the British Museum. Unfortunately the type, which was taken to the British Museum for study in 1935, was somewhat damaged on the voyage, its right tegmen and wing, which are spread, being badly broken through the breaking loose of another specimen in the same box.

Pseudophaneroptera ramicerca, sp. nov.

(Plate VII, figs. 1-3)

In general structure this species is very similar to the preceding ones but it may readily be distinguished from them by the organs of flight which are much reduced; in addition, the shoulder-bay in the pronotum is much shallower and the genitalia, in both sexes, are quite different. From the following species (*P. pinnicerca*) it can only be distinguished by genital characters, which, however, are very distinctive.

This paper had already been accepted for publication when two recent collecting trips, to West Haputale Estate (*ca* 6,000 feet), and Hakgala (*ca* 5,500-5,800 feet), respectively, provided me with material of the previously unknown female and with additional males, and enable me to present a far more satisfactory description of the species than would have been the case if these trips had not taken place.

Genitalia (male). These are shown in Plate VII, figs. 2 and 3, which make a detailed description superfluous but it may be mentioned that each cercus consists of a stout basal portion from which arises a three-pronged, antler-like structure. The innermost of these prongs is near the base and projects somewhat backwards and downwards. The cerci are closely studded on their ventral and lateral surfaces with short, black spinules, and towards their bases with long, colourless setae. The subgenital lamina, in lateral view, is seen in fresh specimens to have the ventral outline of the free portion forming a stronger curve than is shown in fig. 2 which was drawn, as it now appears, from a somewhat contracted specimen

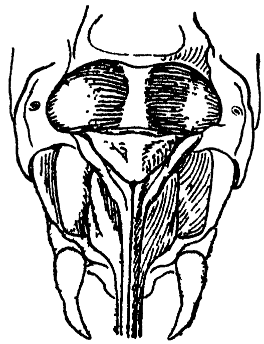


Fig. 1. Female genitalia of *Pseudophaneroptera ramicerca*, sp. nov., ventral aspect, showing the sclerotized plates.

Genitalia (female). In the shape of the ovipositor and related parts the female of this species seems to be almost indistinguishable from *P. phillipsi* and *P. malpasi;* it possesses, however, a very distinctive feature in the presence of two strongly sclerotized, convex, rounded plates, separated by a median strip of membrane. immediately anterior to the subgenital lamina. These plates are shown in the above text-figure, which was drawn from one of the melanistic examples, mentioned below, in which the plates were deeply pigmented; in normally-coloured specimens they are not deeper in colour than the surrounding parts but are quite easily recognizable. No similar structures have been detected in any other species. The female is considerably larger than the male, but, although specimens have not been taken *in coitu*, the circumstances of their capture leave me in no doubt at all that I am correct in associating these males and females in one species.

Coloration. This account of the coloration was drawn up from freshly-killed individuals. Preserved specimens inevitably change, tending to become more or less brown all over.

Dull yellow-green, yellower ventrally, darker dorsally. Antennae black, shading to brown proximally, the basal segment ventrally mottled greenish and brown, dorsally and internally brownish-pink with dorsal and external stripes of black. Eyes greenish chrome-yellow ventrally, brownish-pink dorsally, with equatorial band and dorsal 'cap' of dark brown. Ocelli colourless, the median with two small, dull red spots above it, the lateral each with a dull red spot on its dorsal margin. Mouthparts and ventral portions of bases of legs greenish-yellow. Pronotum, especially the dorsum, speckled with dull, dark crimson; the lateral carinae are chrome-yellow and have no dark line below them on the outer side. Tegmina somewhat glaucous green, paling to greyish towards the apex and costa. Stridulatory area of left tegmen ochreous, suffused black at base; file vein and anal margin dull red, the latter colour extending along the sutural border and with a black submarginal line. Fore femora yellow-green in ground colour, strongly suffused, especially pre-axially, with dull red; the ventral sulcus and a dorsal line black. Fore tibiae brownish-green with the auditory region suffused with dull red and black on the dorsal aspect; tympanal membranes black. Mid and hind legs yellow-green, speckled with red and with red suffusion at bases of tibiae. All tarsi brownish-green. Meso- and metathoraces and abdomen dull yellow-green, speckled with dull crimson. Genitalia self-coloured green. The female coloration agrees with that of the male, described above, but the basal area of the tegmina is not ochreous but self-green, with black and dull red at the base. The ovipositor is dull green, narrowly brown on dorsal margin and, towards the apex, on ventral margin as well.

One male and two female specimens were collected at West Haputale 13 to 18-iv-1938 which differ from the above description in being melanistic. The degree of melanism however, varies, the male and one female being very black while the other female is intermediate between them and the normally-coloured specimens described above. Apart from the dark coloration these specimens show no difference in genital or other structure from the Hakgala specimens.

Measurements.	♂ mm.	♀ mm.
Length of body	12.0 —13.0	18.0 —19.5
Length of pronotum	2.95— 3.0	3.1 — 3.7
Breadth of pronotum (between lateral carinae)	2.0 — 2.2	2.5 — 2.7
Length of tegmen	8.5 — 9.0	12.0
Breadth of tegmen	2.5	3.5
Length of wing	9.0 —10.0	12.0 —13.0
Length of hind femur	11.0 —11.5	12.0 —14.0
Length of ovipositor	—	4.6 — 5.25

Material examined. One male from Kandapola *ca.* 6,000 feet, 20-ix-1926; two males and two females from Hakgala, *ca.* 5,500 feet 28-viii-1929, 2-ix-1929, and 6-v-1938; one male (type) from Sita Eliya, *ca.* 5,800 feet 14-v-1938; one male and two females from West Haputale Estate (immediately below the Horton Plains to the south, elevation *ca.* 6,000 feet) 14 to 16-iv-1938. The type and a female paratype will be deposited in the British Museum (Natural History).

Bionomics. The West Haputale melanistic specimens were taken in low, secondary, scrub jungle, sitting on the upper side of leaves of various shrubs. The male was in the last larval instar when captured and was brought alive to Colombo and reared to maturity, becoming adult on 28-iv-1938. It was supplied with a variety of weeds and seemed to prefer the flowers. It was killed and specimenized on 25-v-1938. At Hakgala and Sita Eliya specimens were taken, mostly at night, on various shrubs in jungle.

Pseudophaneroptera pinnicerca, sp. nov.

(Plate VII, figs. 4 & 5)

This species is very close to the preceding one (*P. ramicerca*, sp. nov.) and would be indistinguishable from it but for the very distinctive form of the male cerci, which as shown in the figures (Plate VII, figs. 4 & 5) are shaped like the hind flipper of a turtle. Each bears at its base, on the internal side, a projection which terminates in a curved spine. The cerci, on the ventral surfaces, are closely studded with minute black spinules and their bases are longly setose. The subgenital lamina is shaped much like that of *P. ramicerca* (see Plate VII, figs. 2 & 3) but appears to curve more gradually from its base.

The female, of which only one, rather badly preserved, specimen is available, resembles that of *P. ramicerca* but shows no trace of the sclerotized plates, anterior to the subgenital lamina, that are so well-marked in that species.

Coloration. All the specimens are badly discoloured but, so far as can be discerned, the coloration does not differ greatly from that of *P. ramicerca*. There appears to be no dark line on the ventral border of the pronotal lateral carinae.

Measurements.	♂ mm.	♀ mm.
Length of body	10.0 —11.0	15.0
Length of pronotum	2.75— 2.9	3.35
Breadth of pronotum (between lateral carinae)	12.0 — 2.1	2.5
Length of tegmen	8.0 — 8.3	13.0
Breadth of tegmen	2.3	3.5
Length of wing	9.5 —10.5	15.0
Length of hind femur	10.5 —10.7	12.3
Length of ovipositor	—	4.8

Material examined. Three males and one female, all from Ohiya, *ca.* 6,000 feet, iv-1929. The type will be deposited in the British Museum (Natural History). The specimens were taken in low scrub jungle.

UNDESCRIBED AND DOUBTFUL SPECIES OF PSEUDOPHANEROPTERA

In addition to the species of this genus described above, the Colombo Museum possesses a male of another species collected at Morningside Estate, Rakwana (*ca.* 4,000 feet) 8-v-1829. It has very characteristic cerci but, being teneral as well as unique, it is desirable to defer its description until further material comes to hand. There are also a very teneral male and female, from Haputale, vi-1926, which, in view of the recent discovery of *P. turbida* at West Haputale, only about twelve miles from Haputale, and of very similar topography, climate and elevation, probably represent that species; and a female collected at North Punduloya Estate, 26-31-x-1936 which appears to differ from females of *P. phillipsi* only in lacking the black ventral border of the lateral carina of pronotum and in being much less profusely speckled with dark crimson spots. Its determination must await the collection of a male from the same locality.

Acknowledgements. The writer wishes to express his grateful thanks to Mr. W. W. A. Phillips of Mousakande Estate, Gammaduwa, for having provided him with most of the material of *Pseudophaneroptera* *phillipsi* and all of that of *P. grandis;* to Mr. & Mrs. A. C. Tutein-Nolthenius of West Haputale Estate, Ohiya, whose kind hospitality on several occasions enabled him to collect a specimen of *Pseudophaneroptera turbida*, much material of *P. malpasi*, and three specimens of *P. ramicerca;* and to Mr. A. H. Malpas, Director of the Colombo Museum for facilitating and encouraging the researches which have resulted in this paper.

EXPLANATION OF PLATES

PLATE VI.

Fig. 1.	*Pseudophaneroptera phillipsi*, sp. nov.	♂, left cercus
Fig. 2.	,, ,,	♂, genitalia, lateral
Fig. 3.	,, ,,	♂, genitalia, postero-dorsal
Fig. 4.	,, ,,	♀, genitalia, ventral
Fig. 5.	*Pseudophaneroptera malpasi*, sp. nov.	♂, left cercus
Fig. 6.	,, ,,	♂, genitalia, lateral
Fig. 7.	,, ,,	♂, genitalia, postero-dorsal
Fig. 8.	*Pseudophaneroptera turbida* Br. W.	♂, left cercus
Fig. 9.	,, ,,	♂, supra-anal plate
Fig. 10.	,, ,,	♂, subgenital lamina

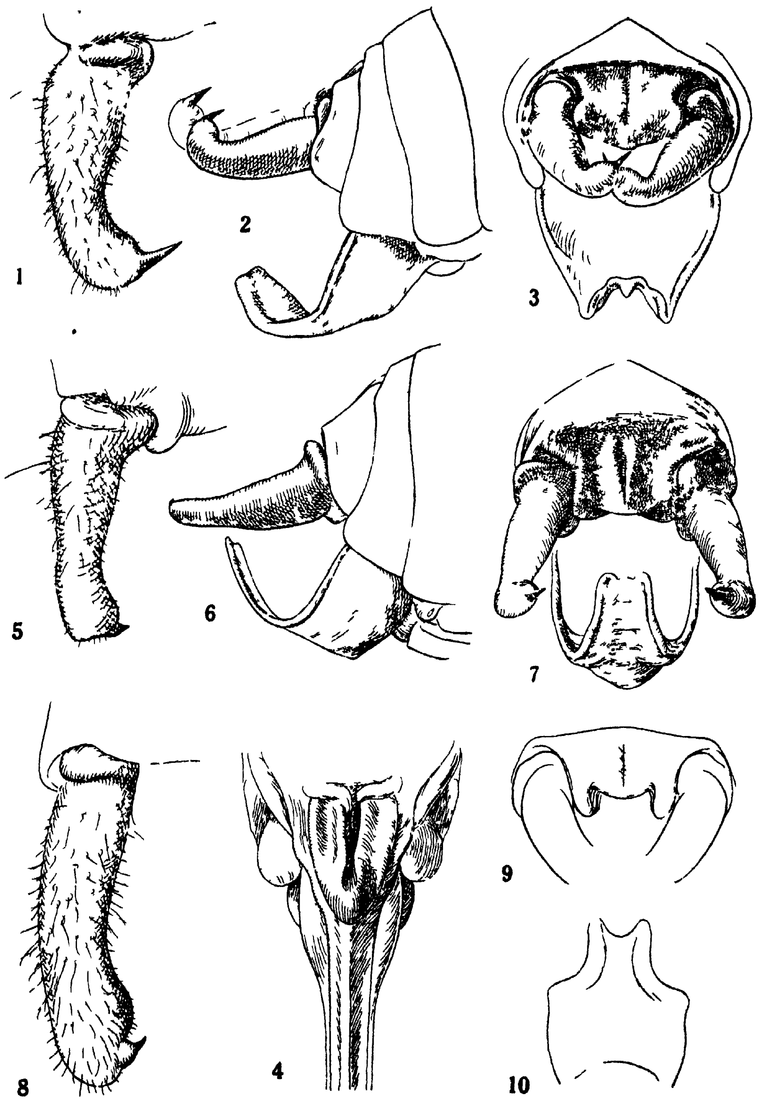
(N. B.—In figures 2, 3, 6, 7 and 9 the setae on cerci, &c., are omitted for the sake of clearness)

PLATE VII.

Fig. 1.	*Pseudophaneroptera ramicerca*, sp. nov.	♂, dorsal
Fig. 2.	,, ,,	♂, genitalia, lateral
Fig. 3.	,, ,,	♂, genitalia, postero-dorsal
Fig. 4.	*Pseudophaneroptera pinnicerca*, sp. nov.	♂, lateral. (The abdomen in the specimen figured is considerably retracted. In life it would extend beyond the tegmina)
Fig. 5.	,, ,,	♂, genitalia, dorsal

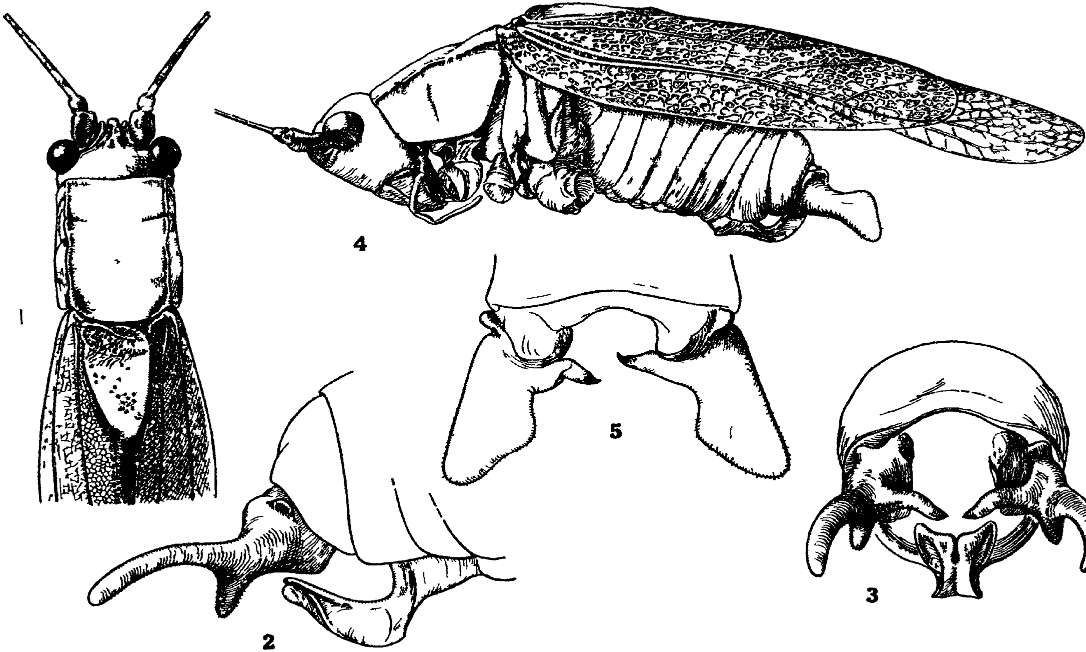
PLATE VIII.

Fig. 1.	*Pseudophaneroptera grandis*, sp. nov.	♂, dorsal
Fig. 2.	,, ,,	♀, lateral
Fig. 3.	,, ,,	♂, fore-tibial organ
Fig. 4.	,, ,,	♂, genitalia, lateral
Fig. 5.	,, ,,	♂, genitalia, postero-dorsal
Fig. 6.	,, ,,	♀, subgenital lamina



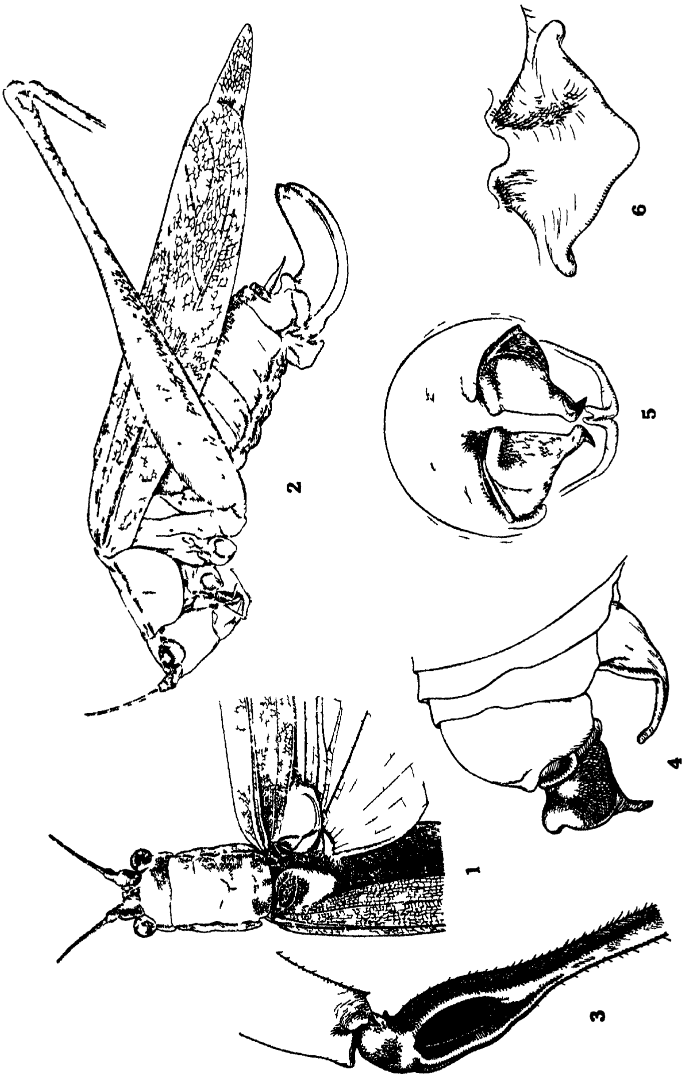
G M Henry del

Figs 1 4 *Pseudophaneroptera phillipsi* sp nov
Figs 5 7 *Pseudophaneroptera malpasi* sp nov
Figs 8 10 *Pseudophaneroptera turbida* Br W.



G M Henr del

Figs 1 3 *Pseıdophaneroptera ıam cerca* sp nov
Figs 4 and 5 *Pseudophaneroptera pınnı cr a* sp nov



Figs 1-6 *Pseudophaneroptera grandis* sp nov

G M Henry del

CEYLON J. SCI. (B) VOL. XXI, PT. 2. (*February 10, 1939*)

Nests and Eggs of Ceylon Birds

BY

W. W. A. PHILLIPS, F.L.S., F.Z.S., M.B.O.U.

(With Seven Plates)

INTRODUCTION

There are already in existence several excellent works on the birds of Ceylon, in which are included a few paragraphs on the nesting habits of each species. There is, at present, however, no publication dealing exclusively and at length with the nests and eggs of those species that are known to breed with us. The nearest approach to such is Stuart-Baker's monumental work on the *Nidification of the Birds of the Indian Empire*, a publication, running into four large volumes, that contains descriptions of the nests and eggs of the birds of the whole of the Indian area including Ceylon.

Stuart-Baker's book records the general nesting habits of the majority of our Ceylon birds. It is, however, an expensive work and is not readily available to many of our local ornithologists. Moreover, the accounts given in it, of the habits of our Ceylon species are, in most cases, taken from the notes of other observers and are not derived from personal observations. Further, very few photographs of the nests and eggs of Ceylon or Indian birds have been published and few coloured plates, depicting the eggs of our birds, have yet appeared.

The object of the present series of papers is, therefore, to give, as fully as space and knowledge will permit, a comprehensive account of the breeding habits of all our resident species and to illustrate, with photographs, many of them with their nests or eggs. It is hoped, in addition, that several coloured plates, depicting the eggs of a number of species, will also appear, eventually.

In the attainment of this object, I have received invaluable help and co-operation from Mr. E. C. Stuart-Baker, in connection with the

6——J. N. 76094 (7/38)

descriptions of the eggs of each species and their measurements. As the eggs of many species are subject to wide individual variations, it is only with the aid of large series of eggs, that a proper conception of the range of variation, to which each species is liable, can be gained and a trustworthy description of them given. Mr. Stuart-Baker is the recognized authority on the eggs of birds of the Indian region and his extensive collections, which have now been lodged in the Natural History Section of the British Museum, have placed him in an unique position in this respect. Mr. Stuart-Baker has, most kindly, undertaken to add to these papers the descriptions of the eggs of each species and also their measurements.

I have also been most fortunate in that I have received many interesting notes from Mrs. Cicely Lushington, Mr. T. E. Tunnard and Mr. C. E. Norris on the birds of the hill zone and from Mr. C. Felsinger on those of the wet and the dry zones of the lowlands. These notes have proved to be of great assistance in supplementing my own numerous notes and augmenting my knowledge of the nesting of certain species; I am most grateful to those who have furnished them.

Owing to the fact that, in the three definite zones into which the island is divided by differences of climate, the seasons and habits of many species vary greatly, the study of the nesting seasons and habits of birds in Ceylon is of more than ordinary interest. Of those numerous species with an island-wide distribution, comparatively few breed at the same time of the year throughout all parts of the island. In the hills and the low-country wet zone, the majority of the tree-nesting species commence to lay during March and April, but in the dry zone, where climatic conditions are so different, many species breed during the rains of December or even earlier, should the north-east monsoon be a light one.

On the other hand, in the dry zone, the ground-nesting birds, that are liable to have their nests flooded out by heavy rains, do not nest until the monsoon rains are over. They wait until the end of May or early June before depositing their eggs and continue to breed throughout the driest period of the year, while the country is parched and the tanks are at their lowest. The same species that nest during June, July, and August, in the dry zone, however, if they nest at all in the wet zone, lay their eggs in that area during March and April, in order to finish their breeding before the advent of the south-west monsoon rains in May and June. Again, many of the Herons, Egrets, and Cormorants, will nest whenever the conditions of the water, in the tanks that they favour, are suitable to their requirements. The same species may, therefore, be found nesting at different tanks at different times of the year.

In the hills, many of our resident species choose the months of March, April, and May for their chief nesting season, but, should the weather be favourable during the latter part of August, September, and October, many will breed again during these months. Numerous species in the hills, therefore, have two distinct nesting seasons, the main season during the spring months and a supplementary one during the autumn. One or two species, however, appear to continue to nest, intermittently, throughout the greater part of the year.

In this series of papers, the nesting-seasons in each zone are given, under each species, as far as inquiries have been able to ascertain them. But there are still many gaps in our knowledge of the breeding of several species in Ceylon, both as to the times of their nesting and, in a few cases, as to the entire nesting habits. We are, for example, still in complete ignorance as to the nesting of the Ashy-headed Babbler (*Turdoides cinereifrons*) and Legge's Flower-pecker (*Acmonorhynchus vincens*), the eggs of neither of which species have yet been found.

Interest in bird-photography, in Ceylon, is still confined to a few enthusiasts but it is a hobby that will become increasingly popular as time goes on. Here in Ceylon, we have a vast field for this fascinating persuit and now that certain areas are being reserved as Bird Sanctuaries, it should be more easy to indulge it with good results.

The majority of the photographs that illustrate these papers were taken with a ¼ plate Reflex Camera, using either a 4.5 in. Velos Anastigmatic lens or a 6.8 in. Ross Telecentric lens. They were taken with the help of a " hide "—well camouflaged—placed at a convenient distance from the nest or the eggs. The lot of a bird photographer, in Ceylon or any other tropical country, is not always a very easy or cool one, but the wealth of bird life that is to be found, in certain areas—notably around dry zone, irrigation tanks and secluded beaches—makes it a particularly interesting and enthralling one.

While I have been engaged upon these papers, I have taken full advantage of reference to the chief works of Ceylon Birds—viz., Legge's *Birds of Ceylon* (1880); Wait's *Handbook of the Birds of Ceylon* (1931) and Stuart-Baker's *Fauna of British India; Birds* (1924) and *The Nidification of the Birds of the Indian Empire* (1932). It gives me great pleasure to acknowledge my indebtedness to the authors of these works.

Order PASSERES

Family Corvidae—*Crows*

No. 1. **Corvus levaillanti culminatus** Sykes

The Southern Black Crow

Corone macrorhyncus (Black Crow) Legge. 1880. p. 347.
Corvus coronoides culminatus (Black Crow) Wait. 1931. No. 1 p. 12.
Corvus levaillanti culminatus (Southern Jungle-Crow) 1932. Stuart-Baker No. 6 p. 9 Vol. 1.

Since 1880, when Legge published his *Birds of Ceylon*, the Black Crow has considerably extended its breeding range. It is now common in most parts of the Island, although there are still one or two isolated valleys, in the higher hills, in which it has not yet established itself as a resident. From many parts of the sea-coast it has, on the other hand, been ousted by the House-Crow (*Corvus splendens protegatus*), coupled possibly with the too-pressing attentions of the Koel (*Eudynamis scolopaceus scolopaceus*). It is found also in South India, south of a line drawn from the Madras Presidency, say from about Masulipatam, through the Deccan, to Bombay.

Legge (p. 348) states that this Crow nests principally during May, June, and July, " most nests being built during May ", but, in my experience, serious nest-building, in a normal year, does not generally commence until towards the end of May or beginning of June. Wait has also recorded the late breeding of the species and gives (p. 12) the breeding season as from June to August. It would seem possible therefore, that this crow has, since Legge's day, changed slightly the time of its nesting, in addition to extending its range.

In the Kalutara district (W. P.) of the low-country wet zone, of the many nests that I have examined, the majority were built in July and August, the earliest date being July 23rd and the latest September 3rd. In the hills, I have found one or two in May and a number towards the end of June but, here again, most were found during July and August. Tunnard, in his notes, gives June to August as the breeding season in the Dickoya and Pussellawa districts (C. P.).

In the dry zone, I have found both fresh eggs and fledged young during July and I have been credibly informed that, in Jaffna, many birds have been seen incubating their eggs during the fourth week in July.

In many instances, it is not difficult to assign a plausible reason for a species choosing to nest late in the year but, in the case of the present species, I am at a loss to suggest a satisfactory explanation. Food would appear to be, if anything, scarcer during July and August than at other times and climatic conditions are then, generally speaking, unfavourable for tree-nesting. During the months of June, July and August, the south-west monsoon winds are at their strongest and I have known of crow's nests, built in exposed trees, being blown out by the force of the wind. One would have expected that the breeding season, for this crow, would have been during the early months of the year, when climatic conditions are so much more favourable and the majority of the tree-nesting species have their nests and young.

The nest is generally placed in a high fork amongst the slender branches at the top of a tall tree—a Jak-tree (*Artocarpus integrifolia*) Rubber tree (*Hevea Brasiliensis*) or a Sapu (*Michelia champaca*) being a very favourable selection. Sometimes, however, when a more suitable tree is not available, a tall coconut-palm may be chosen, the nest being placed at the base of one of the fronds, in the angle where it meets the main stem. Usually, little trouble is taken to conceal the nest; the tree chosen is often adjacent to human habitations, beside a main-road or in a conspicuous position on the edge of a paddy-field. Often in towns, as in Kandy, the nests are placed in the shady trees overhanging roadways.

The nest is a large structure of twigs, 12 to 15 inches across and 12 inches or more in height, built into a fork. In the centre of the twigs is a cup, measuring about 6 inches across and 2½ to 3½ inches in depth, lined with coarse rootlets, wiry fern-stems and coconut fibre or, quite often, with a thick layer of coconut fibre only. Occasionally the bird will select wiry fern-stems only, or hair and fibrous rootlets, being guided in its choice, presumably, by the ease with which suitable materials are procurable.

The eggs are generally four in number but five are not uncommon. I have found five, occasionally, both in the hills and in the low-country, but never more.

The Koel prefers the nest of this species in which to deposit its eggs and, in some districts of the low-country, more often than not, Koel's eggs will be found together with the crows'. The Koel evidently, at times, removes one or more of the crow's eggs after depositing its own, for I have never found less than four crow's eggs in a nest when no Koel's eggs have been present; but, when Koel's eggs have also been present, I have sometimes found only two crow's. On one occasion, I found two crow's and six Koel's eggs, all incubated, and on another occasion three crow's and one Koel's. On the other hand, I have frequently found a full clutch of crow's eggs together with several Koel's.

In the hills, the crows are not troubled by the Koels and there they are able to hatch, in peace, their full complement.

In shape, the Southern Black Crow's eggs are long ovals, rather pointed at the smaller ends, but occasionally they are somewhat stumpy. The ground colour is pale olive or blue-green, varying considerably in depth and occasionally tinged with grey or more distinctly green rather than blue in tint. The markings consist of blotches, spots and speckles of umber-brown or darkish-brown, generally fairly numerous over the whole surface but sometimes more at the larger end than elsewhere.

Sixty-eight eggs, in Stuart-Baker's collection, average 38.0 × 28.1 mm.; maxima *47.0* × 29.8 mm. and 42.0 × *30.2 mm.*; minima *36.3* × 29.0 and 42.4 × *26.3 mm.*

No. 2. **Corvus splendens protegatus** Madarasz

The Ceylon House-Crow

Corone splendens (Common Grey Crow) Legge. 1880. p. 349.
Corvus splendens protegatus (Ceylon House-Crow) Wait. 1931. No. 2. p. 13.
Corvus splendens protegatus (Ceylon House-Crow) Stuart Baker. 1932. No. 14. p. 20. Vol. 1.

Like the Black Crow, the Common House-Crow has also extended its range, very considerably, since Legge's time. In addition to ousting the Black-Crow from many of its former coastal haunts, it has now colonized the whole of the south coast. In Legge's day, this species was not resident to the south of Kalutara, on the west coast, or to the south of Arugam Bay, on the east. It has now, however, extended its breeding range throughout the coastal belt of the entire Island, except in one or two arid tracts that are unsuited to its requirements. Generally speaking, its range is confined to a narrow belt, a few miles in width, along the sea-coast. In the Colombo District, however, it has spread inland along some of the main roads. It may now be seen, upwards of twenty-five miles from Colombo, along the Kandy road.

There would appear to be no good reason why this Crow should not establish itself in the interior of the Island and, should the species continue to increase at its present rapid rate, it will, in all probability, be not many years before it becomes resident in many of the inland towns and larger villages.

Within its range, it is exceedingly numerous in all towns and villages but it is not so common in the intervening country where the Black Crow is dominant. It is confined to Ceylon but closely allied races are found, commonly, throughout India.

This species nests rather earlier than the Black Crow and is more gregarious but, in other respects, the breeding habits of the two species appear to be very similar. The nesting season extends from April to August. but the majority of birds, in the wet zone, lay their eggs during April and May, while in the Trincomalee District (E. P.) of the dry zone, nesting is not commenced until early in June.

The nest is placed in a fork amongst the upper, small branches of a medium sized tree. Often several nests are built in the same tree and sometimes there may be many nests, forming 'rookeries', in a favourable group of trees. Shade trees, planted along roadsides and in bazaars, in coastal towns and villages, are very favourite resorts. Some House-Crows, however, prefer coconut palms, building their nests in the crowns, in the angles formed by the fronds meeting the stem. Often there may be several nests to one palm, when the breeding season is at its height.

Little trouble is taken to conceal the nests; they are often built in most exposed situations and are sometimes destroyed by the violence of the sea winds.

In India, a closely allied race nests occasionally on buildings, but the Ceylon House-Crow appears to be more conservative and rarely chooses any other site than a tree.

The nest is very similar to, but smaller than, that of the Black Crow. It is built of small sticks and twigs and is lined with rootlets, fibre, coir, wool or other such-like soft material.

The full clutch of eggs is generally four; sometimes there may be only three and five is exceptional. The Koel lays its eggs in the nests of this crow also, but does not, I think, victimize this species to the same extent as it does the Black Crow. Probably this is due to the earlier nesting of the present species, the Koel prefering to lay its eggs during July and August.

In shape, the eggs are, typically, slightly pointed ovals; the ground colour and markings closely resemble the eggs of the Black Crow from which, indeed, they differ merely in size. If examined as a series, the eggs of the House-Crow are, perhaps, a little darker, the markings more numerous and so covering more of the pale ground-colour.

One hundred eggs, in Stuart Baker's collection, average 34.8 × 25.6 mm.; maxima *41.0* × 26.3 and 37.2 × *27.1* mm.; minima *31.0* × 24.9 mm. and 34.2 × *24.2* mm.

No. 3. **Cissa ornata** Wagler

The Ceylon Magpie

Cissa ornata (Ceylonese Jay) Legge. 1880. p. 355.
Cissa ornata (Ceylon Magpie) Wait. 1931. No. 3. p. 14.
Cissa ornata (Ceylon Magpie) Stuart Baker. No. 25. p. 32. Vol. 1.

This beautiful bird is confined to the ever-green forests of the higher hill-slopes and plateaux of the Central and Uva Provinces, except in the south-west where it descends into the damp forests at the foot of the Adam's Peak range; from thence it spreads into the jungles of the Rakwana and Morawak korale districts. It is still moderately common around Kitulgala (Sab.), at the upper end of the Kelani Valley, and in the Adam's Peak wilderness, as well as in some of the remote forests around the Horton Plain's (C. P.).

The nest has been found on one or two occasions only. Legge (p. 354) records the finding of a nest in the Kandapola jungles, during January, while Stuart-Baker has two clutches of eggs obtained for him in the Kandy District, during February and March, respectively, and two other clutches taken on the 3rd and 4th March, from the ' foot-hills near Colombo '—probably from the Kegalle or Ruanwella district. From this evidence, it would appear that the usual breeding season is during the first quarter of the year, from January until the end of March.

The nest recorded by Legge was situated in a fork of the top branch of a tall sapling, about 45 feet in height. It was a tolerably bulky structure, made of small sticks, in the centre of which was a deep cup, 5 inches across by 2½ in depth, made entirely of fine roots. The nests taken by J. E. Jenkins, for Stuart-Baker, were all found in dense forests and are described (p. 32) as " Stick nests with linings of roots and measuring 6 inches in diameter and 2 inches deep, internally, and 2 inches bigger each way externally; cup-shaped and strongly built. They were all placed in small trees between 15 and 20 feet from the ground and all were in small branches and very difficult to get at and bring down in spite of being so near the ground ".

It is evident, from the foregoing, that the nest is somewhat like that of the House-Crow, but it is generally placed among the small branches at the top of a sapling, in dense ever-green forest.

The number of eggs in a full clutch appears to vary from 3 to 5, four being the most usual number. The eggs are very like those of the Indian Green Magpie, differing only in being slightly more boldly blotched on an average. The ground colour varies from practically white to white faintly tinged with olive-grey or yellowish, stippled, speckled or blotched all over with marks ranging from pale reddish to dark buff-brown. These are scattered profusely over the whole surface and are seldom more numerous at the larger end than elsewhere. The texture of the egg is hard and fine.

Twenty eggs, in Stuart-Baker's collection, average 30.5 × 22.1 mm.; maxima *32.0* × 22.9 mm. and 29.9 × *23.1* mm.; minima *28.0* × *21.0* mm.

Family Paridae—*Tits*

No. 4. **Parus major mahrattarum** Hartert

The Southern Grey Tit (Plate IX)

Parus atriceps (Grey-backed Titmouse) Legge. 1880. p. 557.
Parus major mahrattarum (Southern Grey Tit) Wait. 1931. No. 4. p. 15.
Parus major mahrattarum (Southern Grey Tit) Stuart-Baker. 1932. No. 55. p. 61. Vol. 1.

The Grey Tit is more numerous in the hills of the Central and Uva Provinces, above 2,000 feet altitude, than in the lowlands, but it may be found, locally, in forest and woodland country over the greater part of the Island. It is a familiar bird in most gardens and on estates in the hills and does much good by devouring many insect pests. It is also found throughout the greater part of South India and as far north as the Bombay Presidency and Western Bengal.

In the lowlands, Wait has observed a pair breeding in a Colombo (W. P.) garden during February and in the Puttalam District (N.W.P.) during April. In the hills, however, the species is known to breed at least twice, if not more often, during the year. Nests have been found by a number of observers, during January, February, March, April, May, and June, while Tunnard and Mrs. Cicely Lushington have frequently found eggs also during the months of September, October, and November, in the Dimbulla, Dickoya, and Pussellawa districts of the Central Province.

It is probable that the normal nesting season, throughout the Island, is during the early part of the year but, should the weather in the hills be sunny and favourable again towards the close of the south west monsoon, many birds will then breed a second, or perhaps a third time, during the latter half of the year.

The nest is generally placed in a small, deepish hole in a tree-trunk, branch, wall, hollow post or such-like site or in an artificial nesting box. Occasionally a barbet's or woodpecker's old nesting-hole is used or a crevice under the eaves of a bungalow, while I have received a record of one pair that nested in a child's topee, that was left lying on the top of a cupboard in a little-used lumber room in a tea-estate bungalow. In South India, this bird has been discovered nesting in holes in banks and Mrs. Lushington tells me that she has once seen a nest in a similar situation at Ragalla, in Uda Pussellawa (Uva). In this country, however, the most usual site is in a small deep hole, some six to twenty feet from the ground, in a tree-trunk.

Tunnard describes a nest that was built during September in a hollow bamboo post of a garden-fence. This post had been sawn off through a joint at the top, a small hole being left through which the birds were able to enter the top section. The nest rested on the next lower joint, some 18 inches below. It was composed of various materials, mostly collected from a door-mat and carpets in the nearby bungalow, the lining of the nest being made of hairs from carpets and rugs together with dogs hairs and a few feathers. While the material for the nest was being collected, the two birds would enter the front room of the bungalow. One would keep guard, on the back of a chair, while the other would get busy on the door-mat or rugs often falling back, on its tail, with its efforts to pull out the materials. The one on guard would keep up a low twitter, the whole time, as if to encourage its mate to greater efforts.

The eggs in this nest having been taken, the pair built again, during October, in a hole under the eaves of the bungalow. These eggs also having been taken, they returned to the bamboo post where they successfully reared a brood of four, the fifth egg being infertile.

Nests are usually composed of a mass of green moss, feathers, hair, vegetable down, tow-like inner bark or other soft material, thickly covering the floor of the nest chamber; in the centre of this mass is a cup, neatly lined with vegetable down, fur, hair or feathers, which contains the eggs. Both birds build the nest and both feed the young—though the female is the more assiduous of the two. In all probability both birds take turns to incubate the eggs. They are very confiding and do not easily take alarm.

The eggs usually number either four or five, four being the more usual number, while six are reputed to have been found on one or two occasions. They are oval in shape. The ground colour is white or pinkish-white on which are speckles and small blotches of red, principally at the larger end.

Fifty eggs, in Stuart-Baker's collection, average 17.5 × 12.6 mm.; maxima *19.3 × 14.0* mm.; minima *15.8* × 12.8 and 17.8 × 12.6 mm.

Family Sittadae—*Nuthatches*

No. 5. **Sitta frontalis frontalis** Horsf.

The Velvet-fronted Nuthatch (Plate X)

Dendrophila frontalis (Indian Blue Nuthatch) Legge. 1880. p. 560.
Sitta frontalis frontalis (Velvet-fronted Blue Nuthatch) Wait. 1931. No. 5. p. 17.
Sitta frontalis frontalis (Velvet-fronted Nuthatch) Stuart-Baker. 1932. No. 119. p. 99. Vol. 1.

This beautiful little Nuthatch is found throughout the forests of the Island. It is common in most of the highland jungles, but is inclined to be somewhat local in the lowlands, confining its range chiefly to the larger forest tracts. It is found also throughout Java, Burma, and India to the Himalayas.

The nest is not easy to find unless the birds are kept under close observation. The breeding season seems to be confined to the months of February, March, April, and May, most pairs probably nesting during March and April and, I think, rearing one brood only.

The nest is somewhat like that of the Gray Tit, but smaller. It is generally a small pad of green moss, down and hair, or hair-like fibre, with sometimes a few dead leaves, in a small hole in the trunk or a branch of a tree. In the centre of the pad there is a small cup, lined with vegetable down or hair, to accommodate the eggs.

The hole selected for the nest is generally a natural one, situated between 10 and 30 feet from the ground, in a tree in tall forest or open woodland. Occasionally, however, the abandoned nesting-hole of a barbet or woodpecker is utilized, or a crevice formed by two trunks meeting one another. One nest, found near Gammaduwa (3,300 ft. C. P.), was in the old nesting-hole of a Yellow-Fronted Barbet, some 15 feet from the ground, in the trunk of a decayed albizzia tree, standing in a patch of seed-bearing tea-bushes near the jungle. Another was in a limb of a larger tree in tall forest, while several others have been found in isolated dead albizzia trees, standing in tea fields near the jungle. Stuart-Baker (p. 99) states that, should the entrance hole be too small, it may be enlarged by the birds, or, if too large for safety, they will, very occasionally, reduce its diameter by plastering it up with clay, leaving a neat round hole for entrance I have, however, never, in Ceylon, seen the entrance hole reduced with clay, nor have I met anyone who has In all the nests that I have examined, the hole has been a natural, untouched one.

The nest is generally discovered only through the action of the birds. When entering the nesting hole, they alight some yards above it and run down, head foremost, to the entrance, often twittering as they go.

Stuart-Baker (p. 100 Vol. I) writes " The birds sit very close but the nest is often given away by the restless little male, who will run all about the nest tree uttering his shrill little musical " cheep " all the time. I do not think they feed on the nesting-tree but, whenever the male returns to visit his wife, he always precedes his visit to the nest with a run round the premises first, squeaking all the time ". Both birds feed the young; they are inclined to be rather nervous and shy of human intruders.

The eggs generally number three or four, probably more usually four. They are small, rather broad ovals, glossless white, spotted or blotched with red, in most cases rather more numerously at the larger end than elsewhere. In a few eggs, the spots are confined to this end, while, very rarely, they may form indefinite rings or caps.

Fifty eggs, in Stuart-Baker's collection, average 17.2 × 13.2 mm.; maxima *18.0* × 13.4 and 17.9 × *13.8* mm.; minima *16.0* × *12.3* mm.

Family Timaliidae—*Babblers*

Sub-family TIMALIINAE *True Babblers*

No. 6. **Turdoides striatus striatus** (Swains.)

The Ceylon Babbler (Plate XI)

Malacocercus striatus. Common Babbler. Legge. 1880, p. 494.
Turdoides griseus striatus. Ceylon Babbler. Wait. 1931. No. 6. p. 21.
Turdoides striatus striatus. Ceylon Babbler. Stuart-Baker. 1932. No. 187. p. 155. Vol. I.

From its habit of going about in small parties, this Babbler has gained the nick-name of " The Seven Sisters ". It is a noisy and very familiar bird, in most gardens and compounds, on the outskirts of towns, as well as in open country, over all the lowlands. In the hills, it appears to be increasing in its numbers and its range and it is now moderately common to altitudes of 4,500 feet and occasionally higher. It is a bird of the semi-open country, scrub-jungles, gardens and chenas, but is rarely encountered in heavy forest. It is confined to Ceylon, its place being taken in South India by a closely-allied race.

Nests of this Babbler have been found during every month of the year, but there appear to be two recognized breeding seasons, both in the hills and in the wet zone. In the Kalutara and Colombo Districts (W. P.), nests have commonly been found during March and April, but one or two have been discovered during February, and others in October. In the hills, nests have been found chiefly during March, April, and May, and again during August September and October, but they have occasionally been seen during December and January also. In the low-country dry zone, on the other hand, the common nesting season is probably from November to March, a few birds continuing, with second clutches, even later into the dry weather. In all probability each pair breeds at least twice during the year.

The nest is usually built in an open fork in a bush, shrub, hedge-row, or small tree growing in scrub-jungle, a garden, or an overgrown chena, but I have also seen them built on young palm trees, in the angle between a frond and the stem. Commonly the nest is between four and eight feet from the ground but, on several occasions, it has been discovered quite 30 feet up in a fork on the lateral branch of a tree. Usually it is ill-concealed and can be found without difficulty.

It is a rather untidy but compactly built, cup-shaped structure of wiry rootlets, dead plant-stalks, coarse grasses or similar material, measuring some 6 to 7 inches across and 3½ to 4 inches in height. The inner cup measures about 3 inches across and 2 inches in depth, and is lined sometimes with fine grass but more usually with fine but wiry black fern-stems and rootlets.

Occasionally the lining is quite sparse, or even entirely wanting, but generally it is fairly generous. Both the parent birds co-operate in building the nest and feeding the young, but whether or not both sit on the eggs has not been ascertained. When the young leave the nest, they accompany their parents and others of the same species, in small parties. They are then frequently fed by the other members of the party, as well as by their own parents.

The eggs generally number four in the hills but the full complement varies from three to five. In the lowlands three only are commonly laid, four being rarely found. Wait (page 22) states that—" Clutches of five or six occur, but these are the products of two hens ". On several occasions I have found five eggs in a nest, but I have had no reason to suspect that they had been laid by more than one hen.

The Pied-crested Cuckoo (*Clamator jacobinus taprobanus*) singles out this Babbler to be the foster-parent of its young and, in the low-country, Cuckoo's eggs may frequently be found. Generally there is only a single Cuckoo's egg in each nest but occasionally two have been found, and Wait records (page 212) that three were taken from one nest on one occasion. The Cuckoo's eggs are very similar in size and colour to those of the Babbler, but they are generally broader, with rather more obtuse ends; the shell is harder, and the ' white ' is greenish, instead of colourless as in the Babbler's eggs. In the north of the Island, the Red-winged Crested Cuckoo (*Clamator coromandus*) is reported also to lay its eggs in the nests of this species, but I know of no authentic instance of the eggs of this Cuckoo being found in Ceylon.

In shape the Babbler's eggs are short, broad ovals, with obtuse smaller ends; in colour they are plain, deep, glossy greenish-blue, quickly fading to glossy blue after they have been blown and kept for a few weeks.

Fifty eggs, in Stuart-Baker's collection, average 23.8 × 18.4 mm.; maxima *26.2* × 17.6 and 26.0 × *19.5* mm.; minima *21.8* × 17.8 and 25.8 × 17.2 mm.

No. 7. **Turdoides rufescens** (Blyth)

The Ceylon Rufous Babbler

Malacocercus rufescens. Rufous Babbler. Legge. 1880. p. 497.
Turdoides rufescens. Ceylon Rufous Babbler. Wait. 1931. No. 7. p. 22.
Turdoides rufescens. Ceylonese Rufous Babbler. Stuart-Baker. 1932. No. 189. Vol. 1. p. 157.

Although this Babbler behaves in very much the same manner as the last species, in that it goes about in sociable parties of half a dozen or more, it keeps much more to cover and is essentially a scrub and forest-loving bird. The species is peculiar to Ceylon and is found only in the forest areas of the low-country wet zone and in the neighbouring southern portions of the highlands to altitudes of about 7,000 feet and over.

Except close to the sea, it is fairly plentiful, locally, throughout the wetter districts of the Southern and Western Provinces, the whole of the Sabaragamuwa Province and in the forest areas, with a high rainfall, of the southern and western districts of the highlands of the Central Province. It rarely strays into the Uva Province or far to the northwards of the Kelani Ganga valley, where the country becomes too dry for its liking.

Unlike the last species, this Babbler is such an adept at concealing its nest that little is known of its nidification. Although I lived for several years in a district where it was far from uncommon, I was unable to discover a nest which undoubtedly belonged to the present species.

Legge (p. 498) states the nesting season, in the Western Province, is during March, April, and May and, as the majority of species in the low-country wet zone breed during these months, this statement is most probably correct. The nest is said to be very similar to that of the Ceylon Babbler (*T. striatus striatus*). It is built of small twigs, rootlets, grass and such-like materials and is lined with rootlets. It is placed in a low fork in a bushy tree, or probably more usually amongst creepers surrounding and overgrowing the trunk of a tree, in heavy forest. It is concealed with the greatest care—so much so that only a few authentic nests have been discovered.

Two eggs appear to be the normal complement, though Legge states that either two or three are laid. The eggs are very similar to those of the Common Babbler (*T. striatus striatus*); in shape they are pointed ovals, deep greenish-blue in colour and measure about 24.2 × 18 mm.

No. 8. **Turdoides cinereifrons** (Blyth)

The Ashy-headed Babbler

Garrulax cinereifrons. Ashy-headed Babbler. Legge. 1880. p. 499.
Turdoides cinereifrons. Ashy-headed Babbler. Wait. 1931. No. 8. p. 23.

The Ashy-headed Babbler still remains one of Ceylon's mystery birds. Little more is known of it, to-day, than was known in Legge's time and of its nidification we are still in complete ignorance.

The bird is peculiar to Ceylon, and is confined in its range to the dense, humid forests of the Western, Southern and Sabaragamuwa Provinces, and to the south-western portion of the Central Province, to altitudes of about 3,500 feet. It is probably more plentiful in the jungles of the Adam's Peak range and the adjacent forest areas, than elsewhere. It is essentially a forest-loving species and is found only in the gloomy hearts of the dampest forest tracts.

Nothing definite is known of the nesting of this bird. Legge (page 500) states that—" The breeding season of this bird is from April till July. Full-fledged nestlings may be found abroad with the parents in August; and from this I base my supposition, for I have never found the nest myself. Intelligent native woodmen, in the western forests, who are well acquainted with the bird, have informed me that it nests in April, building a large cup-shaped nest in the fork of a bush-branch, and laying three to four dark blue eggs. Whether this account is correct or not, future investigation must determine ".

Until the nest and eggs have been found and authenticated, the genus to which this bird is correctly referable, must remain a matter of some doubt. Should the eggs be uniform dark blue, as reported, the bird is probably correctly referable to the present genus, but should the eggs prove to be white, or spotted, the bird is probably a *Garrulax*.

No. 9. **Pomatorhinus horsfieldi melanurus** Blyth

The Ceylon Scimitar-Babbler (Plate XII)

Pomatorhinus melanurus. Ceylonese Scimitar-Babbler. Legge. 1880. p. 501.
Pomatorhinus horsfieldi melanurus. Ceylon Scimitar-Babbler. Wait. 1935. No. 9. p. 23.
Pomatorhinus horsfieldi melanurus. Ceylon Brown-flanked Scimitar-Babbler. Stuart-Baker. 1932. No. 209. Vol. 1. p. 174.

The Scimitar-Babbler is well known, by its loud, far-sounding, melodious call, to most dwellers in the country. This call, which has been likened by Legge to the words " Wok, wok, ek, ek, wok " is heard very frequently, especially in the early mornings and evenings, issuing from the depths of the jungle. The bird is inclined to be somewhat shy and keeps much to cover, being more often heard than seen. It is, however, plentiful throughout suitable forest country all over the highlands and, locally, in the damper forests of the lowlands. It becomes scarcer, however, in the arid jungles towards the north and is rarely seen in the Northern Province. The race is peculiar to Ceylon but several closely-allied forms are common on the Indian mainland.

Like so many other species, resident in the highlands, this bird has two definite breeding seasons. A few commence to nest in February and March but the majority wait until April and carry on throughout the month, possibly with second broods, into May. Then occurs a break while the south west monsoon rages, nesting being resumed, on a smaller scale, during October and lasting through November into December.

In all probability, each pair nests twice during the year. Those that nested early in February and March probably breed again in April or May, while the late nesting birds possibly wait until October and November to rear their second broods. In my experience, nests are very much more numerous during April than during any other month.

In the dry zone, Wait (page 24) records the taking of a nest in March in the Puttalam District. Probably the nesting season extends from about November or December to March and April, the majority of species resident in this zone electing to nest during this period.

In the selection of sites for its nests, the Scimitar-Babbler is catholic in its tastes. Most nests, that have been examined, have been in tall forest, almost on the ground, either in the base of Cardamom plants, or other low vegetation, or among dead leaves and refuse at the foot of a bank. Several, however, have been in crevices and hollows in the trunks of trees some two or three feet from the ground, one or two have been in tea-bushes and small shrubs growing near the jungle, and one was under a rock in the forest. Tunnard records a nest, discovered in the Ambagamuwa district on December 22nd, that was built in the fork of a jungle tree about six feet from the ground—a most unusual site and another, found near Norwood on February 5th, was low down in a garden hedge. Evidently this Babbler is very adaptable and makes use of any site that suits its individuality.

The nest is an untidy, rather deep, generally semi-domed cup, built of decaying leaves or dead grass, mixed with plant stems, rootlets or strips of the soft, tow-like inner bark of certain trees. In heavy jungle, where bamboos abound, dead bamboo leaves are generally chosen and built in with strips of inner bark, while in more open country, dead grasses are chiefly used. The material is put together loosely and untidily and there may, or may not, be an attempt at a dome to cover the upper part of the nest. In some nests that have been examined the dome has been well made, in others it has been almost lacking.

The lining is generally of semi-decayed leaves, strips of soft inner bark, rootlets or grass and often is quite scanty. A nest found at Mousakande, Gammaduwa, in November, was built of dead leaves and creeper-stems and thickly lined with strips of soft inner bark. It measured 3 inches × 3 inches across the inner cup, was 1¼ inches in depth and the width of the entrance gap was 2½ inches between the edge of the inner cup and the dome. This nest was built into a collection of twigs and dead leaves at the foot of a low bank in heavy jungle.

The bird generally sits closely on the nest, leaving it only if almost trodden upon. Cases have been known of her allowing herself to be caught by hand.

Both Legge and Wait state that three to five eggs are laid, but I have never seen more than three. Over two-thirds of the nests that I have examined—and I have seen upwards of thirty—contained three eggs each, fresh or incubated, and the remainder have had but two, some of which have been incubated. It is probable, therefore, that generally the full clutch is three, but at times only two are laid. The eggs are rather thin shelled, fine and smooth in texture, though with little or no gloss, and pure white.

Thirty-two eggs in Stuart-Baker's collection average 25.1 × 18.6 mm. ; maxima 27.1 × 20.0 mm. ; minima 22.9 × 17.8 mm.

7——J. N. 76094 (7/38)

No. 10. **Dumetia albogularis albogularis** (Blyth)

The Small White-throated Babbler

Dumetia albogularis. White-throated Wren-Babbler. Legge. 1880. p. 505.
Dumetia albogularis albogularis. Small White-throated Babbler. Wait. 1931. No. 10. p. 24.
Dumetia albogularis albogularis. Small White-throated Babbler. Stuart-Baker. 1932. No. 230. p. 192. Vol. I.

The little White-throated Babbler is a common bird, in suitable open country, throughout the greater part of the Island. It is plentiful in the hills, to altitutes of nearly 6,000 feet, and is well distributed throughout the lowlands, with the possible exception of the Northern Province, where it is reported to be scarce. It frequents long grass, low bushes and undergrowth in open country, such as around tea estates, grass and paddy-fields, waste-lands, low scrub-jungles and patanas. It generally goes about in small parties, busily engaged in hunting the undergrowth for insects and seeds. A similar bird is found in South-west India, to as far north as, but not including, Rajputana.

In the hills, the chief nesting seasons of this little Babbler are during March, April and May, and again during August and September. But I have seen nests of this species in every month throughout the year, with the exception of November and December. In the Kalutara and Colombo Districts of the low-country wet zone, however, the chief season is during January and February, while nests have been seen also in September. In the dry zone, in the Southern Province as well as in the more northern provinces, on the other hand, the season starts with the November rains and may continue until well into June, though the majority of nests are met with during December, January and February. In all probability, each pair breeds at least twice during the year, raising a second brood as soon as the first has learnt to look after itself.

The nest is generally placed, often within a foot of the ground, among the stems of a large tussock of coarse grass in a patch of scrub, or else amongst the leaves and twigs of a low bush. Often it is beside a foot-path or in a boundary fence, but sometimes it may be a few yards within the shade of the forest. On tea estates, the upper foliage of a dense tea bush is commonly chosen. Tunnard has twice found nests among the withered leaves of fallen branches, while I once saw one amongst some bushy growth, quite six feet from the ground, in a Grevillia tree. Occasionally, also, it is built amongst fern growth or low bushes on roadside banks. Usually the nest is well concealed, but its position is often given away by the bird suddenly fluttering out.

The nest is a compact, ball-shaped structure with the entrance at one side. The inside egg cavity measures about 2 inches across and 2¼ inches in depth; it is warm and dry whatever the weather may be like. In the great majority of cases, the nest is built of lengths of ribbon-grass but, near the jungle, dead bamboo leaves are often made use of, or occasionally the dead leaves of nearby trees. The material is generally rather loosely put together, although, while it is in position, the nest is quite compact. The lining is of fine grass, decayed leaf-matter or bits of soft inner-bark and is often rather scanty.

The full clutch is generally three eggs; very rarely four are laid and occasionally only two. Out of thirty-seven nests examined, thirty contained three eggs each, one four eggs and six had two only; of the latter, the eggs were incubated in three of the nests.

The eggs are broad, blunt ovals, very little compressed towards the smaller end. In colour, they are glossy china white, spotted and blotched with reddish-brown, or occasionally with umber-brown.

It is possible that the Ceylon Banded Bay Cuckoo (*Penthoceryx sonneratii waiti*) may lay its eggs in nests of this Babbler. It has been found so doing in India. The egg is described as a broad, blunt oval, slightly pointed at one end and measuring about 19.3 × 15.8 mm. In colour it is usually brownish-pink, speckled and freckled with reddish-brown, but colour variations are many some are very like the various types of eggs of the genus *Alcippe*, the most common fosterer in Assam.

No. 11. **Chrysomma sinensis nasalis** (Legge)

The Ceylon Yellow-eyed Babbler (Plate XIII)

Pyctorhis nasalis. Black-billed Babbler. Legge. 1880. p. 512.
Pyctorhis sinensis nasalis. Ceylon Yellow eyed Babbler. Wait. 1931. No. 11. p. 25.
Chrysomma sinensis nasalis. Ceylon Yellow eyed Babbler. Stuart-Baker. 1932. No. 236. p. 199. Vol. I.

The Yellow-eyed Babbler is nowhere common, except on some of the patanas and grasslands of the Uva Province, but is locally distributed, in small numbers, throughout the greater part of the Island. It is partial to patanas, low grassy-jungles, swamps and fernlands, and keeps much to cover. It is peculiar to Ceylon, but allied forms are found on the Indian mainland.

I have seen nests of this bird in the highlands only. The usual breeding season is during May. Legge records several nests seen, during this month, on the Fort Macdonald patanas, Uva, and others have been found near Galaha (3,000 feet C.P.) and Gammaduwa (2,000/3,500 feet C.P.) during the same month. I have also, however, seen a single nest at Gammaduwa (C.P.) in July and two others in December. In the Western Province, in the low-country wet zone, Legge (p. 513) states that the breeding season commences in February. There does not appear to be any record of the nest having been found in the dry zone.

Usually the nest is placed, some three or four feet from the ground, in a large clump of thick-stemmed ' manna ' grass, in an upright fork of a shrub, or amongst the stems of a woody plant, growing amongst the grass of a patana. On several occasions, however, I have seen nests among small upright twigs, six to eight feet from the ground, in Grevillia trees (*Grevillia robusta*) growing in tea-fields bordering grasslands. Generally little care is taken to hide the nest from view but, even so, it is not very frequently discovered.

It is a neat, compact, deep cup of dead ribbon-grass or coarse grasses, laced by the sides to the stems of the manna grass, plant or twigs, in which it is built. The outside and rim are generally neatly finished off and are frequently bound and decorated with cobwebs, as well as sometimes with a few bits of lichen or down. The lining is of fine grass stems, vegetable fibre or rootlets, carefully felted in. The whole nest measures about 3½ inches across by 3 inches in height; with an inside measurement of the cup of about 2¼ inches in diameter and 2 inches in depth. The accompanying photograph is of a nest built amongst the stems of a clump of manna grass, on a patana in the Gammaduwa district (3,000 feet C.P.).

The eggs generally number three, but four have been found occasionally. They are rather broad ovals in shape; in texture, fine, clear and hard, with the surface highly glossed.

They doubtless go through the same variety of coloration as do the eggs of the typical form but, so far, eggs taken come under the following descriptions:—

(1) China-white ground profusely marked with small blotches of chocolate-brown scattered equally over the whole surface, or, rarely, more numerous at the larger end.

(2) Dull salmon ground, marked in the same way with brick-red.

(3) Pink to dull salmon ground blotched and clouded with deep purple-red and greyish-lavender.

Twenty eggs in Stuart Baker's collection average 17.0 × 13.8 mm.; maxima *18.1* × 14.1 mm. and 17.4 × *14.2* mm.; minima *16.2* × 13.9 and 16.8 × *13.3* mm.

No. 12. **Pellorneum fuscocapillum** (Blyth)

The Brown-capped Babbler (Plate XIV)

Pellorneum fuscicapillum. Whistling Quaker thrush. Legge. 1880. p 509.

Pellorneum fuscicapillum. Brown-capped Babbler. Wait. 1931. No 12. p. 26.

Pellorneum fuscocapillum fuscocapillum. Brown-capped Babbler. Stuart Baker. 1932. No. 249. p. 211. Vol. I.

Owing to its habit of skulking unseen in thick undergrowth, this little Babbler was, at one time, considered to be one of our rarer birds. It is, however, in point of fact, quite common and widely distributed. It occurs both in the hills, to about 5,500 feet, and throughout many districts in the lowland but it is found only in tall forests and woodlands and avoids open country.

Although the bird itself is rarely seen, its voice is frequently heard, especially while it is breeding. A monotonous whistling 'to meet you', 'to meet you', kept up for hours at a time, at once betrays its presence.

The species is peculiar to Ceylon and has, of recent years, been split up into two races—that from the dry zone, which is said to be much paler in colour than the typical form, being distinguished under the name *P. f. babaulti*. Wait (p. 26), however, considers that more specimens should be examined before any sub-specific distinction is recognized. Whether or not two races are distinguishable, there does not appear to be any appreciable variation in the nesting habits

The nest has been found frequently of recent years and I, myself, have examined a dozen or more containing either eggs or young. The majority have been found during April but, in the hills, this Babbler has two definite nesting seasons the one during March and April and, the second intermittently from September to December. In the low-country dry zone, I have seen a nest during March, but I suspect that breeding commences as soon as the heavy rains of the north-east monsoon have abated, the nesting season probably extending from about the middle of February to the end of April or later. Before February, a nest on the ground would be liable to be flooded out and in April the country usually becomes very dry again.

Generally, the nest is built on the ground; sometimes it may be in the open among a litter of fallen leaves on the forest floor, but more generally it is at the foot of a large tree. Both Wait and myself have found nests, in the dry zone jungles, camouflaged among dead leaves in the open forest, but the majority of the nests found in the hills have been placed at the foot of a large tree or cardamom clump. Tunnard, however, found a nest under a tea bush and another placed in a decayed hollow in a tree, about a foot from the ground, and I once found one fitted into a crevice, about three feet from the ground level, in a nearly vertical bank in tall forest. The site is almost always in heavy forest but it may be near the outskirts or in a strip of virgin jungle left between cultivated areas.

The nest is a fully domed structure, of dead leaves loosely put together, with the entrance at one side. It measures about four inches across × 3 inches in height, the entrance being large and often taking up almost the whole of one side. The dome is always of dry and often semi-decayed leaves of the same kind as those lying close by and is so well camouflaged that the nest is efficiently hidden. It appears merely as a small rounded dome amongst a litter of leaves.

The interior is lined with a few thin, semi-decayed leaves and fine leaf or fern-stalks, neatly pressed round the inside. The bird sits very close and the majority of nests are discovered through her flying out, suddenly, at one's feet. Generally it is the hen that is seen on the nest but the cock-bird may also take his turn at incubation.

The eggs generally number two only, but I have seen one nest that contained three eggs. They are broad ovals in shape, with blunt narrow ends. The ground colour is white or almost so, being only exceptionally tinged with buff or greyish-green, profusely speckled or with small blotches of brown, red-brown, purplish-brown or blackish-brown. In most eggs the markings are slightly more numerous at the larger end, occasionally decidedly so, while in a few they form rings or caps. In a few eggs, the secondary markings of lavender-grey or grey are sufficiently numerous to dominate the general tint of the egg.

The texture is coarse, not close and the shells are glossless and fragile for their size.

Ten eggs in Stuart-Baker's collection, average 22.2 × 16.2 mm; maxima *22.9* × 16.0 and 22.2 × *17.1* mm.; minima 21.7 × 15.3 mm.

No. 13. **Rhopocichla atriceps nigrifrons** (Blyth)

The Ceylon Black-fronted Babbler (Plate XV)

Alcippe nigrifrons. Ceylon Wren-Babbler. Legge. 1880. p. 507.
Rhopocichla atriceps nigrifrons. Black-fronted Babbler. Wait. 1931. No. 13. p. 27.
Rhopocichla atriceps nigrifrons. Ceylon Black-fronted Babbler. Stuart-Baker. 1932. No. 296. Vol. I. p. 254.

Although perhaps not quite such a familiar bird as the White-throated Babbler (*Dumetia a. albogularis*), this Babbler is common throughout the forest tracts of both the low-country and the highlands. It generally frequents bamboo-brakes, thickets and undergrowth beneath the shade of heavy forest, moving about in small parties, busily engaged in a search for insects. It is rarely seen in the open or in scrub and grasslands. The race to which it belongs is peculiar to Ceylon but is closely allied to other forms found in India.

In the hills, the nests and eggs of this bird have been found in every month throughout the year, with the exception of December and January, but the chief nesting seasons are during April and May, and again in October and November. In all probability, each pair nests at least twice during the year. In the low-country wet zone, nests have been found in the Kalutara District during March, April, and May, while in the dry zone, January to June appears to be the usual season, although Legge states (p. 508) that, in the north of the Island, the season lasts from November until March—that is to say, throughout the north-east monsoon period.

The most usual position for the nest is in a low, slender fork, some three to five feet from the ground, in open undergrowth beneath tall forest. Any suitable site in a bramble, a bamboo clump, or amongst the stems of brushwood may be chosen but, in the highland jungles, a fork in a nillu plant (*Strobilanthes* sp.) is the most favoured position. The nest is generally freely exposed to view and, from a distance, looks like a chance collection of dead leaves.

Sometimes, however, it may be better concealed in a low bush on a bank above or beside a pathway through the forest, the passing of human beings apparently affording the birds some protection against their natural enemies. On one occasion, a nest containing eggs was discovered in a tea bush growing within a few yards of the jungle ; this nest was well hidden amongst the foliage and resembled more the nest of a White-throated Babbler, than one built by this species.

The nest is a moderately large, fully-domed, untidy oval structure of layers of dead leaves laid horizontally one on another, or occasionally of bits of ribbon-grass and leaves, mixed with a few stems of dead creepers and plants. Generally, if they are available, the dead leaves of bamboos are used. The material is very roughly and loosely put together, so much so that, if the nest is taken in the hand, it very quickly disintegrates. It measures about 6 inches across, by 5 inches in depth and 3½ inches in height, whilst the egg chamber, inside, measures about 2¼ inches across by 2 inches in depth. The entrance is wide, taking up almost the whole of one side, and is usually almost on a level with the floor of the egg chamber; it has an unfinished appearance, odd leaves hanging down from the dome and partially obstructing it. The egg-chamber is often sparsely lined with a few bits of dead grass, plants or stems and stalks or mid-ribs of dead leaves, but in many nests a lining is dispensed with entirely.

The birds build these nests with great rapidity, picking up the dead leaves from close by and laying them in position one after the other. I have watched four or five birds all working on the same nest and think that many of the nests one sees in the jungle are purely roosting-shelters. On the other hand it is well known, that, after a nest has been used for rearing a family, it may be resorted to for long afterwards as a family roost, by both the old birds and their fully-grown young. Many old nests of this species, in the highland jungles, are taken possession of by Long-tailed Tree-mice (*Vandeleuria nilagirica nolthenii*). Although so loosely put together, the interior of the nest is warm and dry in the most inclement weather.

The eggs invariably number two only; they are smooth, rather blunt ovals; paper white in ground colour, speckled or spotted with brownish-red, the spots very slightly more numerous at the larger end. Occasionally there are also a few specks of bluish-grey, in addition to the brownish-red spotting.

Stuart-Baker (p. 255) records two unusual clutches, one pair with pale chestnut spots instead of the dark brown or reddish-brown and another pair very small and densely marked like the eggs of the White-throated Babbler.

Thirty eggs in his collection average 19.6 × 13.7 mm. ; maxima *21.3* × 13.9 and 19.1 × 15.2 mm.; minima *17.8* × 13.5 and 18.3 × *13.3* mm.

EXPLANATION OF PLATES

PLATE IX
Southern Grey Tit entering nesting hole

PLATE X
Nesting hole of a Velvet-fronted Nuthatch

PLATE XI
Ceylon Babbler feeding young

PLATE XII
Ceylon Scimitar Babbler at entrance to nest

PLATE XIII
Ceylon Yellow-eyed Babbler on nest

PLATE XIV
Brown-capped Babbler at entrance to nest

PLATE XV
Ceylon Black-fronted Babbler about to feed young

8——J. N. 76094 (7/38)

SOUTHERN [illegible] NESTING HOLE

NESTING HOLE OF A VELVET-FRONTED NUTHATCH

CEYLON BABBLER FEEDING YOUNG

CEYLON YELLOW-EYED BABBLER ON NEST IN MANA GRASS CLUMP

BROWN-EYED BABBLER AT ENTRANCE TO NEST

CEYLON BLACK-FRONTED BABBLER ABOUT TO FEED YOUNG

A Revised Check-list of the Mammals of Ceylon

BY

W. C. OSMAN HILL, M.D., F.Z.S.

It is now ten years since Phillips (1929) published his last check-list of the mammals of Ceylon. That list included the Sirenians, but not the Whales. Since then his well known *Manual of the Mammals of Ceylon* (1935) has appeared, bringing matters more up-to-date, but this work omitted marine forms altogether. Since the appearance of this volume, however, there have been a number of changes, largely due to the researches of Pocock on various groups, more particularly the Carnivora, but also to Phillips's contributions (on Mole-rats) and my own (on Primates and Sciuridae). There have been no startling additions to the fauna, but there are many important nomenclatural changes and taxonomic modifications, and it is with the idea of keeping abreast with these, coupled with the desire to make the list more comprehensive, by inclusion of the marine forms, that the present revised list has been attempted.

In dealing with the Cetaceans, I have taken into account the important collection of that group which is housed in the Trivandrum Museum, Travancore. This first rate collection owes its presence largely to the labourers of the former curator, H. S. Ferguson, who specialized in the group. The collection has also received attention since from R. S. Narayan Pillai (1926). I further owe a great debt to the generosity of Mr. W. W. A. Phillips, who, on hearing that I was preparing this list, gave me free access to his own valuable documents relating to Indian Cetaceans; and, although I had already prepared a tentative list, I found it necessary to make considerable modifications after consulting the above mentioned documents. Included among them are some very valuable notes in the form of letters from the late Sir S. F. Harmer, whose opinions on this group carry considerable weight. Phillips's files also include lists of all the Cetacean specimens in the various museums of India and Malaya, prepared after much labour and correspondence. One thing that strikes one after

. N. 76094 (7/38)

perusing these lists, however, is the fact that the Trivandrum collection, already referred to, is by far the most important of them all, and it is quite manifest that no student of the Cetacea of the Indian Ocean can afford to overlook this collection.

Like Phillips, in his previous check-lists, I have made no attempt at complete synonymies for any animal in the subjoined list. As far as practicable, I have listed the original reference and that given in Phillips's *Manual*, but in most cases some other important references have of necessity, been quoted. Unfortunately many errors have crept into Phillips's synonymies, particularly in the references to literature. All these have been rectified by reference, wherever possible, to the original,—a procedure involving much labour, but obviously essential. For the names given by Kelaart (1852) and Blanford (1888-1891) in their well known works, I refer the reader to Phillips's *Manual*, unless the original works are available to him.

Vernacular names have been omitted entirely, as these are already sufficiently recorded elsewhere.

Order PRIMATES

The classification of this order adopted here is that suggested by the present author in 1936 (a) in dealing with the Lorisoids.

Series A. HAPLORHINI

Suborder I. ANTHROPOIDEA

Family 1. Hominidae—*Mankind*

1. **Homo antiquus ceylonensis** Pycraft, 1925—The Veddah

1925 *Homo ceylonensis* Pycr., *Man*, XXV, p. 163.

Distribution. Type locality uncertain (type specimen is a skull in the Oxford University Museum). At present restricted to the eastern part of Ceylon between the central mountain massif and the east coast, with the exception of the actual coastal strip. Range extends from near Polonnaruwa in the north to the hills known as Westminster Abbey in the south.

Remarks. It is a very controversial question as to how the various members of the human family should be treated and named zoologically. Pycraft (1925) made some sort of attempt to name and diagnose several of the more differentiated " races ", giving most of them full specific status. Amongst these he labelled the aboriginals of Ceylon, commonly known as Veddahs, *Homo ceylonensis*. Most writers on Man, however, are still in the habit of treating all existing types of Man as varieties of a single species, *Homo sapiens*[1]). Though admitting that this latter plan is rather unsatisfactory, and indeed scarcely scientific in the present state of knowledge and with current views regarding the significance of the term " species ", I cannot agree that so many species are warranted as suggested by Pycraft. Some compromise is therefore necessary, and accordingly, I put forward the suggestion that, considering our present concepts on the anatomical relationships of the autochthonous inhabitants of Ceylon, they should be given a zoological status as a subspecies of the Australoid species (*Homo antiquus* Pycr.).

As regards the dominant populations of humanity in Ceylon, it need scarcely be remarked that, zoologically speaking, these are all to be regarded as " introduced ", despite the fact that they have become well established and have almost completely absorbed the autochthones. Like the bulk of the population of India, they belong to the so-called " Brown race " of anthropologists. This is, by common consent, regarded as an offshoot of the " Mediterranean race ". Whether the latter should be given specific or subspecific status in a zoological sense is uncertain, but provisionally I consider it helpful to treat it as a full species (*Homo mediterraneus* Sergi, 1908). In this circumstance the " Brown race " will become a subspecies of *H. mediterraneus*, and will require a name, a diagnosis and a type specimen to be chosen.

Suborder II. PITHECOIDEA

Family 1. Colobidae

This group includes all the Leaf-monkeys and their African allies the Thumbless Monkeys. Formerly considered merely as a subfamily of the Cercopithecidae, they are now treated as of family rank on account of the magnitude of their anatomical differences from the Cercopithecidae. The classification of the family has been dealt with by Hill (1936, b).

Subfamily (a) PRESBYTINAE

This subfamily includes all the Asiatic members of the family Colobidae. Originally all were grouped in a single genus variously named *Semnopithecus*, *Pithecus*, *Presbytis* or *Pygathrix*. Certain peculiar members were gradually removed to form genera of their own, and finally it has become necessary to split up the main mass of the original genus into four further genera. Two of these are represented in Ceylon.

---

[1] Even so pretentious a work as the *Fossilium Catalogus* pars 74, *Hominidarum Catalogus* (1936, 's-Gravenhage, W. Junk) adopts this plan.

2. **Semnopithecus priam thersites** (Blyth, 1847)—Ceylonese Grey Langur

1844 *Semnopithecus pallipes* Blyth, *Ann. Mag. Nat. Hist.*, p. 312.
1844 *S. priam* Blyth, *J. As. Soc. Bengal*, XIII, p. 470 (*nomen nudum*)
1847 *Presbytis thersites* Blyth, *J. Asiatic Soc. Bengal*, XVI, p. 1271
1928 *Pithecus entellus pallipes* Pocock, *J. Bombay N. H. Soc.*, XXXII, p. 495
1935 *idem.*, Phillips, *Manual*, p. 25
1937 *Semnopithecus priam thersites* Hill, *Ceylon J. Sc.* (B) XX, p. 213
1937 *idem.*, Hill, *P.Z.S.* (B) p. 210

Distribution. Type locality, Newera Kalawa, near Trincomalie, E. P. Common throughout the dry zone from Jaffna in the north, and including the eastern low-country and the south-east of the island as far west as Ranna. Also ascends the eastern slopes of the central mountain mass, to altitudes of 1,500 feet. Travancore.

Remarks. Originally treated as the same animal as the Madras Langur, which is the common crested animal of the Coromandel district of South India. As understood at present it is regarded as subspecifically distinct from the Madras animal, but is represented on the Indian mainland by the specimens procured from Travancore. (See Hill, *P.Z.S.*, 1937.)

3. **Kasi vetulus vetulus** (Erxleben, 1777)—Southern Purple-faced Leaf-monkey

1777 *Cercopithecus vetulus* Erxl., *Syst. Reg. Anim.* III, p. 25
1928 *Pithecus senex vetulus* Pocock, *J. Bombay N. H. Soc.*, XXXII, p. 501
1935 *Pithecus vetulus vetulus* Phillips, *Manual*, p. 14
1936 *Kasi vetulus vetulus* Hill, *Ceylon J. Sc.* (B), XX, p. 127

Distribution. The species *Kasi vetulus*, as I now understand it, is peculiar to Ceylon. This, the typical subspecies, is confined to the low-country wet zone south of the Kalu-ganga, extending east towards Ranna on the south coast. The Galle district is assumed to be the type locality.

4. **Kasi vetulus nestor** (Bennett, 1833)—Western Purple-faced Leaf-monkey

1833 *Semnopithecus nestor* Bennett, *P.Z.S.*, p. 67
1935 *Pithecus vetulus nestor* Phillips, *Manual*, p. 18
1936 *Kasi vetulus nestor* Hill, *Ceylon J. Sc.* (B), XX, p. 127

Distribution. Type locality unknown, but probably somewhere in Raygam Korale, W. P. Somewhat sporadically distributed throughout the western coastal tract from the Kalu-ganga northwards as far as a line extending from the coast, just north of Colombo, inland towards the northern extremity of the central mountain mass.

5. **Kasi vetulus monticola** (Kelaart, 1850)—Highland Purple-faced Leaf-monkey or Bear Monkey

1850 *Presbytis cephaloptera* var. *monticola* Kelaart, *J. R. Asiatic Soc. (Ceylon br.)* II, p. 321

1935 *Pithecus vetulus monticola* Phillips, *Manual*, p. 21

1936 *Kasi vetulus monticola* Hill, *Ceylon J. Sc.* (B), XX, p. 128

Distribution. Type locality Newera Elyia, C. P. Restricted to the forested parts of the central mountain cluster above 3,000 ft. Decidedly uncommon in most parts of its range.

6. **Kasi vetulus philbricki** (Phillips, 1926)—Northern Purple-faced Leaf-monkey

1926 *Pithecus philbricki* Phillips, *Ceylon J. Sc.* (B), XIV, p. 57

1935 *P. vetulus philbricki* Phillips, *Manual*, p. 23

1936 *Kasi vetulus philbricki* Hill, *Ceylon J. Sc.* (B), XX, p. 129

Distribution. Type locality, Kanthalai, E. P. Northern low-country, south of a line drawn across the island from Marichchukaddi on the west coast to near Kokkilai on the east; its range extends into the eastern low-country, and the neighbouring hills southwards, for an undefined distance.

Family 2. Cercopithecidae

This family includes all the remaining monkeys of the Old World, which thus incorporates the Baboons, Mangabeys, Macaques, and Guenons. Only the Macaques are represented in Asia.

Genus **Macaca** Lacépède, 1801

The Macaques form a rather heterogeneous assemblage and have several times been subjected to division into subgeneric groups. Pocock (1921) even desires to split them into three distinct genera. In all such schemes the Ceylonese Macaques, with their nearest South Indian relatives, constitute together a well marked subgenus (or genus) which has received the name *Zati* Reichenbach, 1892.

7. **Macaca (Zati) sinica sinica** (Linnaeus, 1771)—Toque Macaque

1771 *Simia sinica* Linnaeus, *Mantissa Plant., Reg. Anim. Append.*, p. 521

1935 *Macaca s. sinica* Phillips, *Manual*, p. 5

Distribution. The species *M. sinica* is peculiar to Ceylon. Pocock (1932a) divided it into three geographical races two of which were described from the dry zone (including the typical form) whilst the third inhabited the lowland wet zone. Phillips considers, and I agree with him after examination of the type specimens in the British Museum, that only one race should be allowed in the dry zone. This will, therefore, be named *M. s. sinica*. It is common throughout the dry zone, both in the north, east, and south-east.

8. **Macaca (Zati) sinica aurifrons** Pocock, 1932—Dusky Toque Macaque

1932 *Macaca sinica aurifrons* Pocock, *J. Bombay N. H. Soc.*, XXXV, p. 286
1935 *idem.*, Phillips, *Manual*, p. 8

Distribution. Sporadically distributed throughout the south-western and western lowlands. Type locality, Raygam Korale, W. P.

9. **Macaca (Zati) sinica** *subsp. ?*—Highland Toque Macaque

Distribution. Highland forests above about 2,500 feet altitude.

Remarks. Although sufficient material is not yet to hand for detailed description of the Toques of the hill forests, those that I have seen alive have convinced me that they will have to be treated as racially distinct from the two preceding.

The new race will be described when sufficient material is available.

Series B, STREPSIRHINI

Suborder III. LORISOIDEA

Family Lorisidae

10. **Loris tardigradus tardigradus** (Linnaeus, 1758)—Lowland Slender Loris

1758 *Lemur tardigradus* Linnaeus, *Syst. Nat.*, I, p. 29
1929 *Loris tardigrdus* Phillips, *Check List*, p. 123
1935 *L. t. tardigradus* Phillips, *Manual*, p. 31

Distribution. Type locality unknown. The lowland race of the Slender Loris occurs throughout the western and south-western low-country of Ceylon; in the foothills it intergrades with the next subspecies.

11. **Loris tardigradus grandis** Hill et Phillips, 1932—Highland Slender Loris

1932 *Loris tardigradus grandis*, Hill et Phillips, *Ceylon J. Sc.* (B), XVII, p. 110
1935 *idem.*, Phillips, *Manual*, p. 34

Distribution. Type locality, Gammaduwa, C. P., altitude 3,000 to 4,500 feet. Originally known only from the type locality and immediate neighbourhood. Has recently been recorded from the Ohiya district. Probably to be found in any suitably wooded parts of the hills between the altitudes quoted above.

12. **Loris tardigradus nordicus** Hill, 1933—Northern Slender Loris

1933 *Loris tardigradus nordicus* Hill, *Ceylon J. Sc.* (B), XVIII, p. 117

1935 *idem.*, Phillips, *Manual*, p. 36

Distribution. Type locality, Kekirawa, N.C P. Found throughout the dry zone, including the Jaffna Peninsula.

Order CHEIROPTERA

Suborder I. MEGACHEIROPTERA

Family 1. Pteropodidae—*Fruit Bats*

13. **Rousettus seminudus** (Kelaart, 1850)—Ceylonese Rousette

1850 *Pteropus seminudus* Kelaart, *J. R. Asiatic Soc.* (*Ceylon br.*) II, p. 329

1918 *Rousettus seminudus* Wroughton, *J. Bombay N. H. Soc.*, XXV, p. 565

1935 *idem.*, Phillips, *Manual*, p. 68

Distribution. Type locality, Mount Lavinia, W. P. Species peculiar to Ceylon, where it occurs sporadically in low-country and hills up to about 3,000 feet Not yet recorded north of Kalpitiya in the Puttalam district.

14. **Pteropus giganteus giganteus** (Brunnich, 1782)—Indian Flying Fox

1782 *Vespertilio gigantea* Brunnich, *Dyrenes Historiae*, I, p 45

1935 *Pteropus g. giganteus* Phillips, *Manual*, p. 71

Distribution. Type locality, " Bengal ". Common locally all over Ceylon below 2,000 feet altitude. Also occurs in many parts of peninsular India.

15 **Cynopterus sphinx sphinx** (Vahl, 1797)—Indian Short-nosed Fruit Bat

1797 *Vespertilio sphinx* Vahl, *Skr. Nat Selsk*, IV, Heft i, p. 123

1935 *Cynopterus s. sphinx*, Phillips, *Manual*, p 77

Distribution. Type locality, Tranquebar, Madras. Common all over the Indian peninsula and the lowlands of Ceylon. In Ceylon it intergrades with the next race at about 3,000 feet altitude.

16. **Cynopterus sphinx ceylonensis** Gray, 1870—Ceylonese Short-nosed Fruit Bat

1870 *Cynopterus marginatus* var. *ceylonensis* Gray, *Cat. Monkeys Lemurs and Fruit-eating Bats Brit. Mus.*, p. 122

1934 *Cynopterus sphinx ceylonensis* Phillips, *Ceylon J. Sc.* (B), XVIII, p. 241

1935 *idem.*, Phillips, *Manual*, p. 79

Distribution. Type locality, Ceylon; subspecies peculiar to Ceylon, where it is restricted to altitudes above about 3,000 feet.

Suborder II. MICROCHEIROPTERA

Family 1. Rhinolophidae—*Horseshoe Bats*

17. **Rhinolophus rouxi rouxi** Temminck, 1835—Rufous Horseshoe Bat

1835 *Rhinolophus rouxi* Temminck, *Mon. Mamm.* II, p. 30
1935 *idem.*, Phillips, *Manual*, p. 84

Distribution. Type locality, Pondicherry and Calcutta. Common in most parts of India, and in Ceylon below 4,000 feet, but occurs occasionally in the hills up to 6,000 feet.

18. **Rhinolophus beddomei sobrinus** Andersen, 1918—Great Ceylonese Horseshoe Bat

1918 *Rhinolophus beddomei sobrinus* Andersen, *Ann. Mag. Nat. Hist.* (9) II, p. 378
1935 *idem.*, Phillips, *Manual*, p. 87

Distribution. Type locality; Kala-oya N. C. P. Subspecies peculiar to Ceylon, where it has only been recovered from low-country and medium altitudes. Uncommon.

19. **Hipposderos lankadiva** Kelaart, 1850—Large Indian Leaf-nosed Bat

1850 *Hipposideros lankadiva* Kelaart, *J. R. Asiatic Soc.* (*Ceylon*) II, p. 329
1935 *idem.*, Phillips, *Manual*, p. 90

Distribution. Type locality, Kandy. Occurs throughout Ceylon except above 3,500 feet and also in Central and South India.

20. **Hipposideros speoris speoris** (Schneider, 1813)—Sykes' Leaf-nosed Bat

1813 *Vespertilio speoris* Schneider, *Schreber's Saugeth.* suppl., S. 159 b
1935 *Hipposideros speoris* Phillips, *Manual*, p. 92

Distribution. Type locality. Timor and Amboina. Widely distributed in southern Asia. Occurs throughout Ceylon below 5,000 feet altitude.

21. **Hipposideros brachyotus** (Dobson, 1874)—Deccan Leaf-nosed Bat

1874 *Phyllorhina brachyota*, Dobson, *J. Asiatic Soc. Bengal*, XLIII, p. 237
1935 *Hipposideros brachyotus* Phillips, *Manual*, p. 94

Distribution. Type locality, Central India. Not common in India or Ceylon, but has been recorded from Bengal, South India, and from all three climatic zones in Ceylon.

22. **Hipposideros atratus** Kelaart, 1850—Ceylonese Bicoloured Leaf-nosed Bat

1850 *Hipposideros atratus* Kelaart, *J. R. Asiatic Soc.*, (*Ceylon*) II. p. 322
1935 *idem.*, Phillips, *Manual*, p. 97

Distribution. Type locality, Colombo. Occurs over most of the low-country, but not in the hills of Ceylon. Has also been discovered in South India. This bat is almost certainly a subspecies of the Indian Bicoloured Bat (*Hipposideros fulvus*).

Family 2. Megadermatidae—*False Vampires*

23. **Megaderma spasma ceylonense** Andersen, 1918—Ceylonese False Vampire

1918 *Megaderma spasma ceylonense* Andersen, *Ann. Mag. Nat. Hist.* (9), II, p. 384
1935 *idem.*, Phillips, *Manual*, p. 101

Distribution. Type locality Trincomalie. Originally regarded as the same animal as that found in India, the race inhabiting Ceylon was separated subspecifically by Andersen in 1918. Recorded from all parts of the low-country and from altitudes as high as 3,000 feet.

24. **Lyraderma lyra lyra** (Geoffroy), 1810)—Indian False Vampire

1910 *Megaderma lyra* Geoffroy,*Ann. Mus. Paris*, XV, p. 190
1918 *Lyraderma lyra lyra* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 581
1935 *idem.*, Phillips, *Manual*, p. 104

Distribution. Type locality, " East coast of Madras ". Occurs throughout India and Ceylon from Kashmir to Galle, with the exception of the Western Ghâts, where it is replaced by another subspecies. In Ceylon it does not occur in the hills above 3,500 feet.

Family 3. Vespertilionidae—*Typical Bats*

Subfamily (a) VESPERTILIONINAE

25. **Pipistrellus mordax** (Peters, 1866)—Grizzled Pipistrel

1918 *Pipistrellus mordax* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 588
1866 *Vesperugo mordax* Peters, *Monatsber, Akad. Berlin*, S. 402
1935 *idem.*, Phillips, *Manual*, p. 109

Distribution. Type locality Java. Has been recorded from the Eastern Himalayas and neighbouring parts of North India at high altitudes. Only once recorded from Ceylon, viz., from the Ohiya district, 6,000 feet.

26. **Pipistrellus ceylonicus ceylonicus** (Kelaart, 1852)—Kelaart's Pipistrel

1852 *Scotophilus ceylonicus* Kelaart, *Prod. Faun. Zeylan.*, p. 22
1918 *Pipistrellus c. ceylonicus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 589
1935 *idem.*, Phillips, *Manual*, p. 110

Distribution. Type locality, "Ceylon". Subspecies peculiar to Ceylon. Common in the highlands, and occasionally seen in the lowland wet zone.

27. **Pipistrellus coromandra** (Gray, 1838)—Coromandel Pipistrel

1838 *Scotophilus coromandra* Gray, *Charlesworth's Mag.* II, p. 498
1918 *Pipistrellus coromandra* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 589
1935 *idem.*, Phillips, *Manual*, p. 113

Distribution. Type locality, Coromandel coast, India. Common in many parts of India from the Himalayas southwards. In Ceylon it is restricted to the dry zone, and ascends the eastern flank of the hills to an altitude of 3,000 feet.

28. **Pipistrellus mimus mimus** (Wroughton, 1918)—Southern Dwarf Pipistrel

1852 *Scotophilus coromandelicus* Kelaart, *Prod. Faun. Zeylan.*, p. 21 (partim)
1899 *Pipistrellus mimus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XII, p. 722
1918 *P. m. mimus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 589
1935 *idem.*, Phillips, *Manual*, p. 115

Distribution. Type locality Inheskatri, Surat Dangs. Occurs in most parts of India. In Ceylon it replaces *P. coromandra* in the wet zone. It probably meets that species in the extreme south in the neighbourhood of Ranna.

29. **Hesperoptenus tickelli** (Blyth, 1851)—Tickell's Bat

1851 *Nycticejus tickelli* Blyth, *J. Asiatic Soc. Bengal*, XX, p. 157
1918 *Hesperoptenus tickelli* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 593
1935 *idem.*, Phillips, *Manual*, p. 118

Distribution. Type locality, Chaibassa, Central India. Common in most parts of the Indian Peninsula, and in the lowlands of Ceylon. in both wet and dry zones; ascending the hills up to 3,000 feet.

30. **Scotophilus kuhli** Leach, 1822— Common Yellow Bat or Kuhl's Bat

1822 *Scotophilus kuhli* Leach, *Trans. Linn. Soc.*, XIII, p. 72
1935 *idem.*, Phillips, *Manual*, p. 121

Distribution. Type locality, unknown. Common throughout India, Burma, Siam, Malaya, and the lowlands of Ceylon.

31. **Scotophilus wroughtoni** Thomas, 1897—Wroughton's Bat

1897 *Scotophilus wroughtoni* Thomas, *J. Bomb. Nat. Hist. Soc.*, XI, p. 274
1935 *idem.*, Phillips, *Manual*, p. 123

Distribution. Type locality, Kim Surat, India. Occurs all over Peninsular India as well as Bengal. In Ceylon it is confined to the dry zone.

32. **Leuconöe hasselti** (Temminck, 1840)—van Hasselt's Bat

1840 *Vespertilio hasselti* Temminck, *Monogr. Mamm.*, II, p. 225
1918 *Leuconöe hasselti* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 598
1935 *idem.*, Phillips, *Manual*, p. 125

Distribution. Type locality, Java. Essentially a Malayan species, it does not occur in India. It appears in Ceylon to be confined to the dry zone, where it is decidedly rare.

Subfamily (b) MURININAE

33. **Murina eileenae** Phillips, 1932—Ceylonese Tube-nosed Bat

1932 *Murina eileenae* Phillips, *Ceylon J. Sc.* (B), XVI, p. 329
1935 *idem.*, Phillips, *Manual*, p. 127

Distribution. Type locality, Mousakande, Gammaduwa (C.P.). Species peculiar to Ceylon, and so far only recorded from the type locality. Probably occurs elsewhere in the hills.

Subfamily (c) KERIVOULINAE

34. **Kerivoula picta** (Pallas, 1767)—Painted Bat

1767 *Vespertilio pictus* Pallas *Spicel. zool.*, *fasc.* III, p. 7
1918 *Kerivoula picta* Wroughton, *J. Bomb. Nat. Hist. Soc.* XXVI, p. 21
1935 *idem.*, Phillips, *Manual*, p. 131

Distribution. Type locality, Peninsula of India. Occurs sparingly throughout the lowlands and lower hills of Ceylon, and in similar country in South India.

35. **Kerivoula malpasi** Phillips, 1932—Malpas's Bat

1932 *Kerivoula malpasi* Phillips, *Ceylon J. Sc.* (B) XVI, p. 331
1935 *idem.*, Phillips, *Manual*, p. 133

Distribution. Type locality, Kumbalgamuwa in the Mulhalkelle district. Known only from the type specimen. Very probably this is an insular race of *Kerivoula hardwickei.*

Subfamily (d) MINIOPTERINAE

36. **Miniopterus fuliginosus** (Hodgson, 1835)—Long-winged Bat

1835 *Vespertilio fuliginosa* Hodgson, *J. Asiatic Soc. Bengal*, IV, p. 700
1935 *Miniopterus fuliginosus* Phillips, *Manual*, p. 135

Distribution. Type locality, Nepâl. Occurs in North India, Burma, and the Western Ghâts. In Ceylon it appears to be confined to the dry zone and the drier parts of the lower hills, up to about 4,000 feet.

Family 4. Emballonuridae

Subfamily (a) EMBALLONURINAE

37. **Taphozous longimanus** Hardwicke, 1823—Long-armed Sheath-tailed Bat

1823 *Taphozous longimanus* Hardw., *Trans. Linn. Soc.*, XIV, p. 525
1935 *idem.*, Phillips, *Manual*, p. 140

Distribution. Type locality, Calcutta. Occurs in many parts of India, and Ceylon, where it appears to be confined to the lowlands in both wet and dry zones.

38. **Taphozous melanopogon** Temminck, 1841—Black-bearded Sheath-tailed Bat

1841 *Taphozous melanopogon* Temminck, *Monogr. Mamm.*, II, p. 287
1935 *idem.*, Phillips, *Manual*, p. 143

Distribution. Type locality, Java. Widely distributed throughout India, Burma, and Malaya. Rare in Ceylon, where it has only been recovered from the lowlands.

39. **Saccolaimus saccolaimus** (Temminck, 1835)—Pouch-bearing Sheath-tailed Bat

1835 *Taphozous saccolaimus* Temminck, *Monogr. Mamm.*, II, p. 285
1918 *Saccolaimus saccolaimus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 95
1935 *idem.*, Phillips, *Manual*, p. 145

Distribution. Type locality, Java. Occurs widely in India, Burma, Malaya Peninsula, and Islands. Common in Ceylon throughout the low-country and up to 3,000 feet in the hills.

Family 5. Molossidae

40. **Tadarida tragata** (Dobson, 1874)—Dobson's Wrinkled-lipped Bat

1874 *Nyctinomus tragatus*, Dobson, *J. Asiatic Soc. Bengal*, XLIII, p. 143
1916 *Tadarida tragata*, Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 97
1935 *idem.*, Phillips, *Manual*, p. 150

Distribution. Type locality, Calcutta. Widely distributed in North and Central India and as far south as Mysore. In Ceylon it has so far only been recorded from Gammaduwa in the East Matale Hills.

41. **Chaerephon plicatus insularis** Phillips, 1932—Ceylonese Wrinkled-lipped Bat

1932 *Chaerephon plicatus insularis* Phillips, *Ceylon J. Sc.* (*B*), XVI, p. 334

1935 *idem.*, Phillips, *Manual*, p. 151

Distribution. Type locality, Kumbalgamuwa (3,000 feet). Only known from the type locality in Ceylon.

Order LIPOTYPHLA

Family 1. Soricidae—*Shrews*

42. **Feroculus feroculus** (Kelaart, 1850)—Kelaart's Long-clawed Shrew

1850 *Sorex feroculus* Kelaart, *J. R. Asiatic Soc.* (*Ceylon*), II, p. 325

1852 *Feroculus macropus* Kelaart, *Prod. Faun. Zeylan.*, p. 32

1918 *F. feroculus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 37

1935 *idem.*, Phillips, *Manual*, p. 40

Distribution. Type locality, Newera Eliya. Species peculiar to Ceylon, where it is confined to the highest plateaux, and is even there uncommon.

43. **Suncus caeruleus caeruleus** (Kerr, 1792)—Common Indian Musk-Shrew

1792 *Sorex caeruleus* Kerr, *Animal Kingdom*, p. 207

1929 *Suncus caeruleus caeruleus* Lindsay, *J. Bomb. Nat. Hist. Soc.*, XXXIII, p. 329

1935 *idem.*, Phillips, *Manual*, p. 44

Distribution. Type locality, "Java and other islands of the East Indies" North and Central India. In Ceylon it is confined to the dry zone.

44. **Suncus caeruleus giganteus** (Geoffroy, 1837)—Grey Indian Musk-Shrew

1837 *Sorex giganteus*, Is. Geoffroy, *Voy. Bélanger*, p. 117

1929 *Suncus caeruleus giganteus* Lindsay, *J. Bomb. Nat. Hist. Soc.*, XXXIII, p. 329-330

1935 *idem.*, Phillips, *Manual*, p. 46

Distribution. Type locality, Darbhanga district, Bihar, N. India. Its basic range appears to be north-eastern India, but it also occurs in Bombay and other large seaports, whither it has probably been transported by human agency. The same factor accounts for its presence in Colombo, Galle, and other Ceylonese ports, whence it has secondarily been carried to Kandy and other main towns, where it always appears to live in proximity to human dwellings.

45. **Suncus caeruleus kandianus** (Kelaart, 1852)—Kandyan Musk-Shrew

1852 *Sorex kandianus* Kelaart, *Prod. Faun. Zeylan.*, p. 30

1929 *Suncus caeruleus kandianus* Lindsay, *J. Bomb. Nat. Hist. Soc.*, XXXIII, p. 331

1935 *idem.*, Phillips, *Manual*, p. 49

Distribution. Type locality, Kandy. Subspecies peculiar to Ceylon, where it occurs at medium altitudes, especially in the drier parts of the central hills.

46. **Suncus caeruleus montanus** (Kelaart, 1850)—Ceylonese Highland Musk-Shrew

1850 *Sorex montanus* Kelaart, *J. R. Asiatic Soc. (Ceylon)*, II, p. 324

1929 *Suncus montanus* Lindsay, *J. Bomb. Nat. Hist. Soc.*, XXXIII, p. 334

1929 *S. m. montanus* and *S. m. ferrugineus* Phillips, *Check-list*, p. 131

1935 *S. c. montanus* Phillips, *Manual*, p. 51

Distribution. Type locality, Newera Eliya. Subspecies peculiar to Ceylon, where it is restricted to the higher plateaux, except in the south-west, where it descends to the lower rain-forested hills of the Southern and Sabaragamuwa Provinces. A closely related geographical race occurs in the Nilgiri Hills of South India.

47. **Suncus zeylanicus** Phillips, 1928—Ceylonese Jungle Shrew

1928 *Suncus zeylanicus* Phillips, *Ceylon J. Sc. (B)*, XIV, p. 311

1935 *idem.*, *Manual*, p. 54

Distribution. Type locality, Kitulgala. At present known only from the type locality and from Gammaduwa in the East Matale Hills.

48. **Suncus fellowes-gordoni** Phillips, 1932—Ceylonese Pigmy Shrew

1932 *S. fellowes-gordoni* Phillips, *Ceylon J. Sc.*, (*B*), XVII, p. 123

1935 *idem.*, *Manual*, p. 56

Distribution. Type locality, West Haputale, Ohiya (6,000 feet). Species peculiar to Ceylon, where it is restricted to the higher hills of the central highlands. Its nearest relative is a Pigmy Shrew from Nepâl and the eastern Himalayas. In all probability this is a subspecies of one of the Indian Shrews.

49. **Crocidura horsfieldi** (Tomes, 1856)—Horsfield's Shrew

1856 *Sorex horsfieldi* Tomes, *Ann. Mag. Nat. Hist.*, (2) XVII, p. 23
1888 *Crocidura horsfieldi* Blanford, *Fauna Brit. Ind. Mamm.*, p. 242
1935 *idem.*, Phillips, *Manual*, p. 58

Distribution. Type locality, Peradeniya. Species peculiar to Ceylon, where it is confined to the central highlands at altitudes between 1,500 and 6,000 feet.

50. **Crocidura miya** Phillips, 1928—Long-tailed Shrew

1928 *C. miya* Phillips, *Ceylon J. Sc.* (*B*), XV, p. 113
1935 *idem.*, *Manual*, p. 61

Distribution. Type locality, Moolgama, near Galaha (3,000 feet). Peculiar to Ceylon where it is rare and confined to the central highlands.

51. **Solisorex pearsoni** Thomas, 1924—Pearson's Shrew

1924 *Solisorex pearsoni* Thomas, *Ceylon J. Sc.* (*B*), XIII, p. 95
1935 *idem.*, Phillips, *Manual*, p. 63

Distribution. Type locality, Hakgala (5,400 feet). A rare species, peculiar to Ceylon, where it is confined to the central highlands above 3,000 feet.

Order CARNIVORA

Suborder I. FISSEPEDIA

Section A. AELUROIDEA

Family 1. Felidae—*Cats*

Subfamily (a) PANTHERINAE

52. **Panthera pardus fusca** (Meyer, 1794)—Indian Leopard or Panther

1794 *Felis fusca* Meyer, *Zool. Annalen*, I, S. 394
1929 *F. pardus* Phillips, *Check-list*, p. 133
1930 *Panthera pardus fusca* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIV, p. 307
1935 *idem.*, Phillips, *Manual*, p. 162

Distribution. Type locality, Bengal. The range of this subspecies of the Leopard is from the Himalayas in the north to Galle in the south. Westwards it extends to the Konkan, but its eastward range is undetermined. It has, of course, been exterminated in the more cultivated western coastal districts of Ceylon.

Remarks. The East African Yellow Leopard, which ranges through Kenya, Tanganyika, and Zanzibar, is declared by Pocock (1932) to be indistinguishable from the Indian animal, and, as he does not consider a subspecies separable on geographical grounds alone, this animal bears the same name as the Indian race. Considering that all the other African Leopards are easily separable, this seems strange, but must be accepted tentatively.

Subfamily (b) FELINAE

53. **Felis affinis affinis** Gray, 1830—Jungle Cat

1830 *Felis affinis* Gray, *Hardwicke's III Indian Zool.*, I, p. 141

1852 *Felis chaus*, *apud* Kelaart *et* Blanford

1888 *F. affinis* Phillips, *Manual*, p. 160

Distribution. Type locality, Gangutri, Kumaon, North India. This is the common " wild cat " of India from the Himalayas to Ceylon; it extends westwards into Iran, and eastwards into Burma. In Ceylon it is uncommon and confined to the northern part of the dry zone.

54. **Felis catus** Linnaeus, 1758—Domestic Cat

1758 *Felis catus* Linn., *Syst. Nat.*, I, p. 42

1907 *idem.*, Pocock, *P. Z. S.*, p. 149 (also *F. torquatus*, *loc. cit*)
Felis domestica auct,

Distribution and remarks. Domestic Cats occur throughout the island where there are human habitations. There is no evidence of the domestication of any local species of the genus *Felis*, though it is possible that crossings have occurred with *Prionailurus rubiginosus*. Most specimens, however, appear to be malnourished descendants of imported European Cats, or possibly of Indian ancestry. Cats are not kept by the Veddahs. The commonest types are particoloured and striped tabby varieties, the blotched tabby being scarcer. Siamese Cats are popular with the cultured classes and have crossed with the more usual varieties. Feral cats, of *F. catus* descent, are found wild in the scrub jungle round Hambantota.

55. **Prionailurus rubiginosus** (Is. Geoffr., 1834)—Rusty-spotted Cat

1834 *Felis rubiginosus* Is. Geoffroy, *Bélanger, Voy. Ind. Or. Zool.*, pl. 140

1917 *Prionailurus rubiginosus* Pocock, *P. Z. S.*, p. 339

1935 *Felis rubiginosus* Phillips, *Manual*, p. 156

Distribution. Type locality Pondicherry. Confined to Ceylon and South India. In Ceylon, it occurs in all the climatic zones, even in the hills, but it is nowhere common. In India it is only known from the drier Coromandel side of the peninsula.

56. **Zibethailurus viverrinus** (Bennett, 1833)—Fishing Cat

1833 *Felis viverrina* Bennett, *P. Z. S.*, p. 68

1917 *Zibethailurus viverrinus* Pocock, *Ann. Mag. Nat. Hist.* (8), XX, p. 341

1935 *Felis viverrina* Phillips, *Manual*, p. 156

Distribution. Type locality, " Madras Presidency ". Occurs in many, but not all parts of the Indian Peninsula, and ranges as far north as Sind and Nepâl. In Ceylon, it ranges all over the island, with the exception of the extreme north. Anuradhapura is believed to be its northern limit. Nowhere common.

Family 2. Viverridae—*Civets*

Subfamily (a) VIVERRINAE

57. **Viverricula indica mayori** Pocock, 1933—Ceylonese Civet Cat

1852 *Viverricula malaccensis* Kelaart, 1852, *Prod. Faun. Zeylan.*, p. 37

1929 *idem.*, Phillips, *Check-list*, p. 134

1933 *V. indica mayori* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXVI, p. 632

1935 *idem.*, Phillips, *Manual*, p. 168

Distribution. Type locality, Maha-oya, E. P. Subspecies peculiar to Ceylon, where it is common all over the island.

Subfamily (b) PARADOXURINAE

58. **Paradoxurus zeylonensis** (Schreber, 1778)—Golden Palm-civet

1778 *Viverra zeylonensis* Schreber, *Saugethiere*, III, S. 451

1822 *P. aureus* F. Cuvier, *Mém. Mus. Hist. Nat.*, IX, p. 48

1933 *P. zeylonensis* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXVI, p. 859

1935 *idem.*, Phillips, *Manual*, p. 174

Distribution. Type locality " Ceylon ". Species peculiar to Ceylon, where it is moderately common, but locally distributed, more in the wetter areas than the dry. *P. jerdoni* of the Malabar Coast is very closely related.

59. **Paradoxurus hermaphroditus hermaphroditus** (Schreber, 1778)—Common Indian Palm-civet

1778 *Viverra hermaphrodita* Schreber, *Saugethiere*, III, S. 426

1864 *Paradocurus hermaphroditus* Gray, *P. Z. S.*, p. 532

1885 *P. niger* Blanford, *P. Z. S.*, p. 92

1933 *P. h. hermaphroditus* Pocock, *J. Bomb. Nat. Hist. Soc.* XXXVI, p. 867

1935 *idem.*, Phillips, *Manual*, p. 171

Distribution. The locality, unknown, but said to be ' Barbary '. Occurs throughout South India from the Narbada river to Cape Comorin and throughout Ceylon. Very common.

10——J. N. 76094 (7/38)

Subfamily (c) HERPESTINAE

60. **Herpestes edwardsii lanka** (Wroughton, 1915)—Ceylonese Grey Mongoose

1852 *Herpestes griseus* Kelaart, *Prod. Faun. Zeylan.*, p. 41

1915 *Mungos lanka* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 53

1935 *Herpestes lanka*, Phillips, *Manual*, p. 177

1937 *H. edwardsii lanka* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 224

Distribution. Type locality, Cheddikulam. Subspecies peculiar to Ceylon, where it is confined to the dry zone.

Remarks. Regarded by Phillips as a full species, but now shown to be but an insular race of the South Indian *H. edwardsii* (see Pocock, *loc. cit*).

61. **Herpestes smithii zeylanius** Thomas, 1921—Ceylonese Ruddy Mongoose

1852 *Herpestes rubiginosus* Kelaart, *Prod. Faun. Zeylan.*, p. 43

1888 *H. smithii* Blanford, *Faun. Brit. India. Mamm.*, p. 126

1921 *H. smithii zeylanius* Thomas, *J. Bomb. Nat. Hist. Soc.*, XXVIII, p. 24

1935 *H. s. zeylanicus* (*in errore*) Phillips, *Manual*, p. 188

1937 *H. s. zeylanius* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 228

Distribution. Type locality, Mankeni, E. P. Subspecies peculiar to Ceylon, where it occurs commonly in the low-country, both in the wet and dry zones. It ascends the hills to altitudes of 3,500 to 4,000 feet.

62. **Herpestes fuscus flavidens** Kelaart, 1850—Highland Brown Mongoose

1850 *Herpestes flavidens* Kelaart, *J. R. Asiatic Soc.* (*Ceyl.*), II, p. 323

1924 *H. flavidens flavidens* Thomas, *Ann. Mag. Nat. Hist.* (9), XIII, p. 239

1935 *idem.*, Phillips, *Manual*, p. 181

1937 *H. fuscus flavidens*, Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 231

Distribution. Type locality, Kandy, C. P. Subspecies peculiar to Ceylon. Common throughout the central highlands.

63. **Herpestes fuscus rubidior** Pocock, 1937—Lowland Brown Mongoose

1935 *H. flavidens maccarthiae* Phillips, *Manual*, p. 184

1937 *H. fuscus rubidior* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 233

Distribution. Type locality, Anasigalla, Matugama, W.P. Subspecies peculiar to Ceylon. Confined to the western low-country.

64. **Herpestes fuscus maccarthiae** (Gray, 1851)—Mrs. Maccarthy's Brown Mongoose

1851 *Cynictis maccarthiae* Gray, *P. Z. S.*, p. 181

1864 *Onychogale maccarthiae* Gray, *P. Z. S.*, p. 570

1924 *Herpestes flavidens maccarthiae* Thomas, *Ann. Mag. Nat. Hist.* (9), XIII, p. 239 (*partim*)

1937 *H. fuscus maccarthiae* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 234 (Not *H. flavidens maccarthiae* of Phillips, *Manual*, p. 184)

Distribution. Type locality, Jaffna (N. P.). Probably occurs very sparingly throughout the dry zone of Ceylon.

65. **Herpestes fuscus siccatus** Thomas, 1924—Thomas's Brown Mongoose

1924 *Herpestes flavidens siccatus* Thomas, *Ann. Mag. Nat. Hist.* (9), XIII, p. 240

1935 *idem.*, Phillips, *Manual*, p. 187

1937 *H. fuscus siccatus* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXIX, p. 234

Distribution. Type locality, Aripo, near Mannar, Ceylon. Known only from the type specimen. The specimen is most likely only an individual variant of *H. f. maccarthiae*, as it is unlikely that two races of the Brown Mongoose occur in the dry zone, at any rate so close to one another.

66. **Herpestes vitticollis** Bennett, 1835—Striped-necked Mongoose

1835 *H. vitticollis* Bennett, *P. Z. S.*, p. 67

1935 *idem* , Phillips, *Manual*, p. 190

Distribution. Type locality, Travancore. Peculiar to Ceylon and the Malabar coastal belt of South India. In Ceylon it occurs in all the faunal zones, but very sporadically, being commoner in the hills than the lowlands. In India it is commoner in the Nilgiris than in the lowlands.

Section B. CYNOIDEA

Family 1. Canidae—*Dogs*

67. **Canis familaris** Linnaeus, 1758—Domestic Dog

Remarks. Pariah Dogs are common associates of Man throughout the island. Even the Veddah has them and uses them in hunting, more especially for the Indian Monitor (*Varanus monitor*), upon which he partly subsists. Crosses readily with the succeeding species.

68. **Canis lanka** Wroughton, 1916—Ceylonese Jackal

1852 *Canis aureus* Kelaart, *Prod. Faun. Zeylan.*, p. 35

1916 *C. lanka* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 652

1935 *idem.*, Phillips, *Manual*, p. 194

Distribution. Type locality, Mankeni, E.P. Species peculiar to Ceylon. It is found practically all over the island, but is more common in lowlands than in the mountains.

Remarks. Closely related to the Indian Jackal (*Canis aureus*) of which it is most probably merely a subspecies.

Section C. ARCTOIDEA

Family 1. Ursidae—*Bears*

69. **Melursus ursinus** (Shaw, 1801)—Sloth Bear

1791 *Bradypus ursinus* Shaw, *Nat. Miscellany*, p. 19, pl. 58-59
1852 *Prochilus labiatus* Kelaart, *Prod. Faun. Zeylan.*, p. 34
1935 *Melursus ursinus* Phillips, *Manual*, p. 203
1932 *Melursus ursinus inornatus* Pocock, *J. Bomb. Nat. Hist. Soc.*, XXXVI, p. 105

Distribution. Type locality, ' interior part of Bengal '. Occurs over the entire Indian Peninsula from the foothills of the Himalayas to Cape Comorin, and eastwards for an unknown distance into Burma. In Ceylon, it is confined to the low-country dry zone.

Remarks. Pocock (1932 c), following Pucheran, separates the Ceylonese examples of Sloth Bear under the name *inornatus*, on insufficient grounds, in my opinion.

Family 2. Mustelidae—*Weasel Tribe*

Subfamily (a) LUTRINAE

70. **Lutra lutra ceylonica** Pohle, 1920—Ceylonese Otter

1852 *Lutra nair* Kelaart, *Prod. Faun. Zeylan.*, p. 35
1888 *L. vulgaris* Blanford, *Faun. Brit. Ind., Mamm.*, p. 182
1920 *L. lutra ceylonica* Pohle, *Archiv. f. Naturgesch.*, Abth. A. Heft 9, S. 72
1935 *idem.*, Phillips, *Manual*, p. 199

Distribution. Type locality, ' Ceylon '. Subspecies peculiar to Ceylon. Commoner in the wet zone than the dry, commonest in the hills.

Order RODENTIA

Suborder I. SCIUROMORPHA—*Squirrels*

Family Sciuridae

Subfamily (a) SCIURINAE

71. **Ratufa macroura macroura** (Pennant, 1769)—Pennant's Long-tailed Giant Squirrel

1769 *Sciurus macrourus* Pennant, *Ind. Zool.*, I, plate i.
1888 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 374, *partim*
1935 *Ratufa macroura macroura* Phillips, *Manual*, p. 217

Distribution. Type locality, 'Ceylon'. The species *Ratufa macroura* is confined to Ceylon and South India. This, the typical subspecies, is the highland representative, and is confined to the mountains of the Central and Uva Provinces of Ceylon.

72. **Ratufa macroura melanochra** Thomas et Wroughton, 1915—Black and Yellow Giant Squirrel

1915 *R. macroura melanochra* Thos. et Wr., *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 35
1935 *idem.*, Phillips, *Manual*, p. 220

Distribution. Type locality, Kottawa, S. P. This is the lowland wet zone representative of the Long-tailed Giant Squirrel. Confined to the wet south-western lowlands between the central mountain mass and the coast. Inland it ranges as far north as Kegalle. Eastwards it ranges to Ranna and the Walawe Ganga valley inland from there.

73. **Ratufa macroura dandolena** Thomas et Wroughton, 1915—Grizzled Giant Squirrel

1915 *R. m. dandolena* Thos. et Wr., *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 35
1935 *R. m. dandolena* et *R. m. sinhala* Phillips, *Manual*, pp. 221 and 223

Distribution. Type locality, Wellawaya, Uva Province. This is the dry zone counterpart of the preceding.

Remarks. Phillips (*Manual*) restricts the name *dandolena* to the foothills representatives, which are intermediate between the highland form and the typical dry zone animal, to which he gives the name *sinhala*. In my opinion the intergrading type is not worthy of a separate subspecific title, and I therefore list both forms as *dandolena*. This subspecies has also been recorded from the Madura district in South India (Wroughton, 1920).

74. **Funambulus palmarum brodiei** (Blyth, 1849)—Northern Ceylonese Palm Squirrel

1849 *Sciurus brodiei* Blyth, *J. Asiatic Soc. Bengal*, XVIII, p. 602
1935 *Funambulus palmarum brodiei* Phillips, *Manual*, p. 227

Distribution. Type locality, 'Northern Provinces, Ceylon'. This is the first of four races of the Palm Squirrel that are peculiar to Ceylon. It is restricted to the driest part of the island, the extreme north-east, namely, the coastal tract on the north-east from Puttalam to Jaffna, including the Jaffna peninsula.

75. **Funambulus palmarum kelaarti** (Layard, 1849)—Ceylonese Lowland Palm Squirrel

1849 *Sciurus kelaarti* Layard, *J. Asiatic Soc.* (*Ceylon*), XI, p. 195
1935 *Funambulus palmarum kelaarti*, Phillips, *Manual*, p. 228

Distribution. Type locality, 'Southern Provinces, Ceylon'. This is the common dry zone form of Palm Squirrel, and inhabits the remainder of the dry zone not occupied by *brodiei*.

76. **Funambulus palmarum favonicus** Thomas et Wroughton, 1915—Submontane Palm Squirrel

1852 *Sciurus tristriatus* Kelaart, *Prod. Faun. Zeylan.*, p. 51
1915 *Funambulus palmarum favonicus* Thos. et Wr., *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 39
1935 *idem.*, Phillips, *Manual*, p. 229

Distribution. Type locality, Udugama, south Ceylon. This is the race inhabiting the wet lowland coastal tract on the south-west of the island. It meets the territory of the preceding at about Ranna on the south coast, and towards Puttalam on the north-west. Inland it ascends the hills for a few hundred feet only and then intergrades with the next race.

77. **Funambulus palmarum olympius** Thomas et Wroughton, 1915—Highland Ceylonese Palm Squirrel

1892 *Sciurus tristriatus* Kelaart, *Prod. Faun. Zeylan.*, p. 51 (*partim*)
1915 *Funambulus palmarum olympius* Thos. et Wr., *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 41
1935 *idem.*, Phillips, *Manual*, p. 233

Distribution. Type locality, Urugalla, C. P. Confined to the central hill ranges above 1,000 feet altitude. Upper limit of altitudinal range appears to have been raised considerably in recent years (Phillips, 1935).

78. **Funambulus layardi layardi** (Blyth, 1849)—Layard's Striped Jungle Squirrel

1849 *Sciurus layardi* Blyth, *J. Asiatic Soc. Bengal*, XXIII, p. 602
1924 *Funambulus l. layardi* Thomas, *Ann. Mag. Nat. Hist.* (9), XIII, p. 241
1935 *Tamiodes l. layardi* Phillips, *Manual*, p. 236

Distribution. Type locality, Ambegamuwa hills. The species *F. layardi* is peculiar to Ceylon, where it has a peculiar distribution. This, the typical form, has a similar range to that of the north-eastern race of the Purple-faced Monkey (*Kasi vetulus philbricki*) being found in the central hills (between 1,000 and 4,000 feet altitudes) and also in the foothills leading northwards from the central mountain mass, and the neighbouring parts of the lowland dry zone of the North-Central Province.

Remarks. This species and the next were placed by Phillips in Pocock's genus *Tamiodes* as their genitalia differed considerably from those of *F. palmarum*. I have recently (1936) examined the penis and its bone in all the Ceylonese Squirrels and came to the conclusion that, for the present, it is better to leave all the Palm Squirrels and Jungle Squirrels in the genus *Funambulus*.

79. **Funambulus layardi signatus** Thomas, 1924—Flame-striped Jungle Squirrel

1924 *F. l. signatus* Thomas, *Ann. Mag. Nat. Hist.* (9), XIII, p. 241

1935 *Tamiodes l. signatus* Phillips, *Manual*, p. 238

Distribution. Type locality, Ratnapura. Rain forests of the south-western foothills and the forests of the south-western lowlands. Definitely rare.

Remarks. For nomenclature see under preceding.

80. **Funambulus sublineatus obscurus** (Pelzeln et Kohl, 1886)—Ceylonese Dusky-striped Jungle Squirrel

1886 *Sciurus obscurus* Pelzeln et Kohl, *Verhandl. Zool. Bot. Gesellsch. Wien*, XXXV, S. 525

1891 *Sciurus sublineatus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 385 (*partim*) (based on Waterhouse, *P. Z. S.*, 1838, p. 19)

1911 *F. trilineatus* Ryley, *J. Bomb. Nat. Hist. Soc.*, XXII, p. 662 (based on Waterhouse, Blyth, *J. As. Soc. Bengal*, XX, p. 165, 1851)

1915 *F. kathleenae* Thos. et Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 38

1918 *F. sublineatus obscurus* Robinson et Kloss, *Rec. Ind. Mus.*, XXV, p. 247

1929 *idem.*, Phillips, *Check-list*, p. 142 (ref. wrongly recorded)

1935 *Tamiodes sublineatus obscurus* Phillips, *Manual*, p. 239

Distribution. Type locality, ' Uplands of Ceylon '. An insular race of the Nilgiri species, *F. sublineatus*, to which it is closely allied. In Ceylon, it is confined to the hill jungles above 2,000 feet, except in the wet south-western area where it descends to the low-country around Galle. It does not extend northwards, in the low-country wet zone, as far as Kalutara.

Family 2. Petauristidae—*Flying Squirrels*

81. **Petaurista philippensis lanka** Wroughton, 1911—Ceylonese Grey Flying Squirrel

1852 *Pteromys oral* Kelaart, *Prod. Faun. Zeylan.*, p. 55

1911 *Petaurista lanka* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XX, p. 1017

1915 *P. philippensis lanka* Rob. et Kloss, *J.*

1935 *idem.*, Phillips, *Manual*, p. 211

Distribution. Type locality, 'Ceylon'. Subspecies peculiar to Ceylon, where it is only found in the central parts of the island, principally at medium altitudes, 1,500 to 3,000 feet; though ascending to 7,000 in places, and descending as low as 500 feet in the eastern and southern parts of its range. Not found in frankly lowland territory or at any place near the coast.

82. **Petinomys layardi** (Kelaart, 1850)—Layard's Flying Squirrel

1850 *Sciuropterus layardi* Kelaart, *J. R. Asiatic Soc.* (*Ceylon*), II, p. 328

1891 *Sciuropterus fuscocapillus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 368 (*partim*)

1919 *Pteromys* (*Petinomys*) *layardi* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 359

1929 *Petinomys fuscocapillus* Flower, *List Vertebrates, Zool. Gard., London*, p. 163 (*partim*)

1935 *Pteromys layardi* Phillips, *Manual*, p. 215

Distribution. Type locality, Dimbula, Central Ceylon. Species peculiar to the island, where it is restricted to the central hills of medium altitude, similar to the last species, but descending into the western lowlands, at any rate as far as Horana, W. P. It is, however, much rarer than the other Flying Squirrel, and in fact, is one of the most uncommon mammals on the list.

Remarks. This species is very closely related to the Small Travancore Flying Squirrel (*Petinomys fuscocapillus* Jerdon) and may, in time, have to be treated merely as a local race thereof.

Suborder II. MYOMORPHA

Family 1. Muridae—*Rats and Mice*

Subfamily (a) GERBILLINAE

83. **Tatera ceylonica** Wroughton, 1917—Ceylonese Gerbil

1917 *Tatera ceylonica* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXV, p. 45

1935 *idem.*, Phillips, *Manual*, p. 243

Distribution. Type locality, 'Ceylon'. Species peculiar to the island, where it is almost universally distributed, except at altitudes above 3,000 feet.

Remarks. This form will probably turn out to be only a subspecies of *T. indica*.

Subfamily (b) MURINAE

84. **Bandicota malabarica** (Shaw, 1801)—Malabar Bandicoot Rat

1801 *Mus malabaricus* Shaw, *Gen. Zool.*, II, pt. 1, p. 54

1804 *Mus giganteus* Hardwicke, *Trans. Linn. Soc.*, VII, p. 306

1891 *Nesocia bandicota* Blanford, *Faun. Brit. Ind. Mamm.*, p. 425

1908 *Bandicota malabarica* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XVIII, p. 749

1935 *idem.*, Phillips, *Manual*, p. 249

Distribution. Type locality, Malabar coast, South India. Ranges through south-western and south-central India and Ceylon. In the last named it probably occurs thoughout the island, though up to date the only place in the dry zone from which it has been recorded is Batticaloa.

85. **Gunomys kok gracilis** (Nehring, 1902)—Common Ceylonese Mole-rat

1937 *Mus kok*, Gray, *Charlesworth's Mag. N. H.*, I, p. 585

1891 *Nesocia bengalensis* Blanford, *Faun. Brit. Ind. Mamm.*, p. 423

1902 *Nesokia gracilis* Nehring, *Sitzungsber. Ges. Naturforsch. Freunde*, Berlin, S. 116

1908 *Gunomys gracilis* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XVIII, p. 748

1935 *idem.*, Phillips, *Manual*, p. 253

1936 *G. kok gracilis* Phillips, *Ceylon J. Sc.*, (*B*), XX, p. 94

Distribution. Type locality, ' Ceylon '. Subspecies peculiar to Ceylon, where it occurs commonly throughout the wet zone, both in lowlands and the hills.

86. **Gunomys kok insularis** Phillips, 1936—Jaffna Mole-rat

1936 *Gunomys kok insularis* Phillips, *Ceylon J. Sc.* (*B*), XX, p. 95

Distribution. Type locality, Thinney, near Jaffna. Subspecies peculiar to Ceylon, where it is only known, at present, from the Jaffna Peninsula.

87. **Rattus rattus kandiyanus** (Kelaart, 1850)—Kandyan House Rat

1850 *Mus kandiyanus* Kelaart, *J. Asiatic Soc.* (*Ceylon*), II, p. 326

1919 *Rattus rattus kandianus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 794

1935 *R. r. kandiyanus* Phillips, *Manual*, p. 259

Distribution. Type locality, Newera Eliya, C. P. This is the common House Rat of Ceylon. It appears to be indigenous to the lowlands but has ascended the hills along human communications.

88. **Rattus rattus kelaarti** (Wroughton, 1915)—Kelaart's House Rat

1915 *Epimys kelaarti* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 48

1935 *Rattus rattus kelaarti* Phillips, *Manual*, p. 264

Distribution. Type locality, Pattipola. This is the House Rat of the higher altitudes in Ceylon, but, on account of the migrations of the preceding subspecies, the two may sometimes be found in the same locality, and intermediate types are known to exist from hybridization.

89. **Rattus rattus alexandrinus** (E. Geoffroy, 1812)—Mediterranean House Rat

1812 *Mus alexandrinus* E. Geoffroy, *Descr. de l'Egypte, Hist. Nat.*, II, p. 733 (Not listed in Phillips', *Manual.*)

Distribution. Type locality, Alexandria, Egypt. This race of the House Rat is not indigenous to Ceylon, but commonly occurs in the dock areas of seaports like Colombo, whither it has been brought from Europe in shipping. It breeds readily with indigenous races, producing various intermediate types.

90. **Rattus rattus rattus** (Linnaeus, 1758)—Black Rat

1758 *Mus rattus* Linn., *Syst. Nat.*, I, p. 61

1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 406

Distribution. The typical form of *Rattus rattus* as now understood is restricted to Europe in its natural state, but the animal has been transported by man to all parts of the world. It has been reported from dock areas in seaports in India and Ceylon.

91. **Rattus rattus rufescens** (Gray, 1837)—Tree Rat, Common Indian House Rat

1837 *Mus rufescens* Gray, *Charlesworth's Mag. Nat. Hist.*, I, p. 585

1919 *Rattus rattus rufescens* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 794

1935 *idem.*, Phillips, *Manual*, p. 258

Distribution. Type locality, Dharwar, India. Common in South India, but apparently not indigenous to Ceylon. The same remarks therefore apply as to the two preceding forms of *R. rattus*, but *R. r. rufescens* is also found in the country surrounding small coastal villages.

92. **Rattus norvegicus** (Erxleben, 1777)—Brown Rat; Norway Rat

1777 *Mus norvegicus* Erxleben, *Syst. Reg. Anim.*, I, p. 381

1779 *M. decumanus* Pallas, *Glires*, p. 91

1916 *Rattus norvegicus* Hollister, *Proc. Biol. Soc., Washington*, XXIII, p. 126

Distribution. Said to have originated in the Orient, and to have been transferred to Europe by human agency, and thence nearly all over the world. Wroughton (1919) said that there was not a single authentic instance of its occurence in India outside seaport towns, although listed by Blanford. The same applies to Ceylon.

93. **Rattus montanus** (Phillips, 1932)—Nillu Rat

1932 *R. montanus* Phillips, *Ceylon J. Sc.* (*B*), XVI, p. 323

1932 *idem.*, *Manual*, p. 266

Distribution. Type locality, West Haputale, Ohiya. Species peculiar to Ceylon. Essentially a jungle rat confined to the highest forests of the central montane region.

94. **Rattus blanfordi** (Thomas, 1881)—White-tailed Rat

1881 *Mus blanfordi* Thomas, *Ann. Mag. Nat. Hist.* (5), XII, p. 24

1919 *Rattus blanfordi* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVI, p. 791

1935 *idem.*, Phillips, *Manual*, p. 268

Distribution. Type locality, Kadapa, Madras. Occurs in many places in South and Central India. In Ceylon it has been recorded from the Uva hills, the dry submontane zone on the eastern flank of these hills, and the lowlands of the Eastern Province.

95. **Rattus ohiensis** (Phillips, 1929)—Ceylonese Bi-coloured Rat

1929 *R. ohiensis* Phillips, *Ceylon J. Sc.* (B), XV, p. 167

1935 *idem.*, *Manual*, p. 270

Distribution. Type locality, West Haputale, Ohiya. Species peculiar to Ceylon, where it has been recovered only from the type locality and from Gammaduwa, the former at 6,000 feet and the latter at 3,500 feet. Probably occurs in suitable jungle at these altitudes elsewhere in the Central and Uva Provinces.

96. **Millardia meltada meltada** (Gray, 1837)—Soft-furred Field Rat or Mettad

1837 *Golunda meltada* Gray, *Charlesworth's Mag. Nat. Hist.*, I, p. 586

1911 *Millardia meltada* Thomas, *J. Bomb. Nat. Hist. Soc.*, XX, p. 998

1935 *M. m. meltada*, Phillips, *Manual*, p. 272

Distribution. Type locality, Dharwar. Occurs all over Peninsular India and in the dry zone of Ceylon.

97. **Legadilla fernandoni** Phillips, 1932—Ceylonese Spiny Mouse

1932 *Legadilla fernandoni* Phillips, *Ceylon J. Sc.* (B), XVI p. 325

1935 *idem.*, *Manual*, p. 274

Distribution. Type locality, Kumbalgamuwa, 3,000 feet. Species peculiar to Ceylon. Has been recovered from the dry zone and from the eastern flank of the foothills up to 3,000 feet.

98. **Mus musculus urbanus** Hodgson, 1845—Indian House Mouse

1845 *Mus urbanus* Hodgson, *Ann. Mag. Nat. Hist.*, XV, p. 269

1891 *Mus musculus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 413

1935 *Mus urbanus* Phillips, *Manual*, p. 276

Distribution. Type locality, Nepâl. Occurs throughout India and Ceylon.

Remarks. I do not consider that this mouse should be given more than subspecific rank as it is but the Indian variant of the European *Mus musculus* Linn.

99. **Leggada booduga fulvidiventris** (Blyth, 1852)—Ceylonese Field Mouse, Fawn-coloured Field-Mouse

1852 *Mus fulvidiventris* Blyth, *J. Asiatic Soc. Bengal*, XXI, p. 351

1891 *Mus buduga* Blanford, *Faun. Brit. Ind., Mamm.*, p. 416

1928 *Leggada booduga* Phillips, *Ceylon J. Sc.* (B), XIV, p. 272

1935 *L. booduga fulvidiventris* Phillips, *Manual*, p. 279

Distribution. Type locality, Trincomalie. Subspecies peculiar to Ceylon. Distributed over the whole island up to 6,000 feet.

100. **Coelomys mayori** Thomas, 1915—Highland Spiny Rat

1915 *Coelomys mayori* Thomas, *J. Bomb. Nat. Hist. Soc.*, XXIII, p. 416

1935 *idem.*, Phillips, *Manual*, p. 281

Distribution. Type locality, Pattipola, 6,200 feet. Peculiar to Ceylon. Confined to the jungles of the highest altitudes in the Central and Uva Provinces.

Remarks. The genus *Coelomys* was instituted by Thomas (1915) for the reception of this species, as it presented annectant characters with several other genera of Indian Muridae, yet not fitting into any of them.

101. **Coelomys bicolor** Thomas, 1915—Bicoloured Spiny Rat

1915 *Coelomys bicolor* Thomas, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 49

1935 *idem.*, Phillips, *Manual*, p. 283

Distribution. Type locality, Kottawa, S. P. Peculiar to Ceylon. It occurs in the wettest part of the south-western low-country area, including the Udugama Hills, which lie in that area. The same form has also been recovered from the East Matale Hills. It is not known to overlap the range of the preceding species, so that it may eventually have to be treated as a subspecies thereof.

102. **Vandeleuria rubida** Thomas, 1914—Long-tailed Tree-mouse

1914 *Vandeleuria rubida* Thomas, *J. Bomb. Nat. Hist. Soc.*, XXIII, p. 202
1935 *idem.*, Phillips, *Manual*, p. 285

Distribution. Type locality, Begeswar, Kumaon, North India. Appears to be an inhabitant of the lower Himalayas and of Ceylon, where it has been discovered in several localities in all the climatic and fauna zones below 4,000 feet. An interesting example of discontinuous distribution.

103. **Vandeleuria nilagirica nolthenii** Phillips, 1929—Ceylonese Tree-mouse

1929 *Vandeleuria nilagirica nolthenii* Phillips, *Ceylon J. Sc.* (B), XV, p. 165
1935 *idem.*, *Manual*, p. 287

Distribution. Type locality, West Haputale, Ohiya, 6,000 feet. Known only from the type locality and from the East Matale Hills. It is regarded as a geographical race of the Malabar species.

104. **Golunda ellioti nuwara** (Kelaart, 1850)—Newera Eliya Bush-rat

1850 *Mus nuwara* Kelaart, *J. R. Asiatic Soc.* (*Ceylon*), II, p. 327
1928 *Golunda ellioti nuwara*, Phillips, *Manual*, p. 290

Distribution. Type locality, Newera Eliya. Subspecies peculiar to Ceylon where it is confined to the central hills above an altitude of about 4,000 feet.

105. **Golunda ellioti coffaea** (Kelaart, 1850)—Coffee rat

1850 *Mus coffaeus* Kelaart, *J. R. Asiatic Soc.*, (*Ceylon*) II, p. 327
1928 *Golunda ellioti coffaea* Phillips, *Ceylon J. Sc.* (B), XIV, p. 348
1935 *idem.*, *Manual*, p. 291

Distribution. Type locality, unknown. Subspecies peculiar to Ceylon. Ranges through the south-western low-country and the neighbouring hills at medium altitudes, grading into the preceding at altitudes higher than 3,500 feet. One or two Bush-rats have been recovered from places in the dry zone, but whether these are subspecifically separable from the two forms mentioned is at present uncertain.

Suborder III. HYSTRICOMORPHA

Family 1. Hystricidae—*Porcupines*

106. **Acanthion leucurus leucurus** (Sykes, 1831)—Indian Porcupine

1831 *Hystrix leucurus* Sykes, *P. Z. S.*, p. 103

1920 *Acanthion l.leucurus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 65

1935 *idem.*, Phillips, *Manual*, p. 295

Distribution. Type locality, " Dukhun ". Ranges over the greater part of the Indian Peninsula from the foothills of the Himalayas southwards, but excluding Cutch and Sind, where it is replaced by another subspecies (*A. l. cuneiceps*). It is universally distributed in Ceylon, but commoner in the lowlands than the hills.

Order DUPLICIDENTATA vel LAGOMORPHA

Family I. Leporidae—*Hares*

107. **Lepus nigricollis singhala** Wroughton, 1915—Ceylonese Black-naped Hare

1915 *Lepus nigricollis singhala* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 42

1928 *Lepus singhala* Phillips, *Ceylon J. Sc.* (B) XIV, p. 290

1935 *L. nigricollis singhala* Phillips, *Manual*, p. 301

Distribution. Type locality, Kumbukkan, Uva Province, Ceylon. Subspecies peculiar to Ceylon. Ranges throughout the island in suitable localities.

Order ARTIODACTYLA

Suborder I. PECORA

Family 1. Bovidae—*Hollow-horned Ruminants*

Subfamily (a) BOVINAE

108. **Bos indicus** Linnaeus, 1758—Domestic Humped Ox or Zebu

1758 *Bos indicus* Linnaeus, *Syst. Nat. I*, p. 72
(Not listed in Phillip's *Manual*)

Distribution. Occurs throughout the island in association with Man.

Remarks. The majority of local domestic cattle are malnourished, stunted representatives of this species, but in large towns like Colombo there has been considerable mixture with imported European Cattle

(*Bos taurus*). The local type of *Bos indicus* is different in many respects from the various well differentiated Indian forms. Specimens of the latter, more particularly of the Mysore, Hissar and Scind varieties are also to be met with in Ceylon, and have crossed with the local variety.

109. **Bubalus bubalis bubalis** (Linnaeus, 1758)—Indian Water Buffalo

1758 *Bos bubalis* Linn., *Syst. Nat.*, I, p. 72
1852 *Bubalus buffelus* Kelaart, *Prod. Faun. Zeylan.*, p. 87
1935 *Bubalus bubalis bubalis*, Phillips *Manual*, p. 319

Distribution. Type locality, Rome, Italy (domesticated). The Water Buffalo occurs wild in many parts of India, including Assam, as well as Ceylon, where it is confined to the dry zone. Domesticated animals are to be found all over India and Ceylon, and have been introduced to many other parts of Asia, Africa, and Europe. Feral examples are known from Borneo and Australia.

Subfamily (b) CAPRINAE

110. **Capra hircus** Linnaeus, 1758—Domestic Goat

1758 *Capra hircus* Linn., *Syst. Nat.*, I, p. 68
(Not listed in Phillip's *Manual*)

Distribution. Originally an inhabitant of Western Asia, the Goat has been introduced by Man into almost all parts of the world. Most of the local Goats are imported from South India, where, in the drier districts, they are bred in enormous numbers.

111. **Ovis aries,** ? var. Linnaeus, 1758—Domestic Sheep.

1758 *Ovis aries* Linn., *Syst. Nat.*, I, p. 70

Distribution. Origin unknown, but has been introduced into all suitable parts of the world by Man.

Remarks. Scarcely worth listing here, but the Sheep does breed in the extreme north of Ceylon, and in the neighbouring islands. Most of the Sheep kept there are of Indian origin, but occasional samples from Somaliland and Aden are to be met with, including the fat-tailed variety (*O. a. steatopyga*).

Family 2. Cervidae—*Deer*

Subfamily (a) MUNTIACINAE

112. **Muntiacus malabaricus** Wroughton, 1915—South Indian Muntjac or Barking Deer

1915 *Muntiacus malabaricus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXIV, p. 45
1935 *idem.*, Phillips, *Manual*, p. 325

Distribution. Type locality, Nagarhol, Coorg. Confined to the wet Malabar tract of South India and to Ceylon, where it occurs practically all over the island.

Subfamily (b) CERVINAE

113. **Axis axis ceylonensis** Fitzinger, 1874—Ceylonese Spotted Deer

1874 *Axis maculata ceylonensis* Fitzinger, *Sitzungsber. K. Akad. Wiss. Wien*, LXX, S. 269
1905 *Cervus (Rusa) axis zeylanicus* Lydekker, *Field*, IV, p. 947
1915 *Cervus axis ceylonensis* Lydekker, *Cat. Ung. Mamm. Brit. Mus.*, IV, p. 53
1920 *Axis axis ceylonensis* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 304
1935 *idem.*, Phillips, *Manual*, p. 329

Distribution. Type locality, ' Ceylon '. Subspecies peculiar to the island. Occurs in the low-country in both wet and dry zones, but is much commoner in the latter. It does not ascend the foothills to more than 1,500 feet altitude.

114. **Hyelephus porcinus porcinus** (Zimmermann, 1777)—Hog Deer

1777 *Cervus porcinus* Zimmermann, *Spec. Zool. Geogr.*, p. 532
1852 *Axis oryzus* Kelaart, *Prod. Faun. Zeylan.*, p. 83
1920 *Hyelaphus porcinus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 304
1935 *H. p. porcinus* Phillips, *Manual*, p. 333

Distribution. Type locality, Indo-Gangetic Plain. India, Burma, and Ceylon. In Ceylon it is restricted to a small area in the low-country wet zone running parallel with the coast from near Kalutura in the north to Kottawa, near Galle, in the south. Tradition has it that this animal was introduced into the island from India, but there is no historic record of the introduction, which is supposed to have been in Portuguese or Dutch times. Its unusual type of distribution is suggestive of this, but it is now sufficiently well established to rank as a Ceylonese mammal.

115. **Rusa unicolor unicolor** (Kerr, 1792)—Sambhur or Sambar

1792 *Cervus axis unicolor* Kerr, *Anim. Kingdom*, p. 300

1852 *Rusa hippelaphus* Kelaart, *Prod. Faun. Zeylan.*, p. 83

1920 *Rusa unicolor unicolor* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 304

1935 *idem.*, Phillips, *Manual*, p. 337

Distribution. Type locality, 'Ceylon '. In Ceylon, the Sambhur is likely to be found over the whole island, including the montane zone. The typical race also inhabits India from Cape Comorin to the foot of the Himalayas, and eastwards into Assam. Other races occur in south-eastern Asia.

Suborder II. TRAGULINA

Family 1. Tragulidae—*Chevrotains*

116. **Moschiola meminna** (Erxleben, 1777)—Indian Chevrotain

1777 *Moschus meminna* Erxleben, *Syst. Reg. Anim.*, p. 322

1891 *Tragulus meminna* A. Milne-Edwards, *Ann. Sci. Nat.* (5) II, p. 160

1916 *T. (Moschiola) meminna* Thomas, *Ann. Mag. Nat. Hist.* (8), XVIII, p. 73

1920 *Moschiola meminna* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 307

1935 *idem.*, Phillips, *Manual*, p. 344

Distribution. Type locality, ' India '. Occurs throughout Peninsular India and Ceylon.

Suborder III. SUINA

Family 1. Suidae—*Pigs*

117. **Sus cristatus cristatus** Wagner, 1839—Indian Wild Pig

1839 *Sus cristatus* Wagner, *Münch. gelehrt. Anzeig.*, IX, S. 535 (misprint for S. 435)

1920 *S. c. cristatus* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 309

1935 *idem.*, Phillips, *Manual*, p. 349

Distribution. Type locality, Malabar coast of India. Occurs wild throughout India, Ceylon, and Burma, but is replaced in Tenasserim by a second subspecies, *S. c. jubatus.*

Remarks. Domesticated Pigs in Ceylon seem to resemble the wild form in colour and general features, but in the more accessible districts there is evidence of admixture with imported European breeds of domestic swine.

11——J. N. 76094 (7/38)

Order PERISSODACTYLA

Family 1. Equidae—*Horses*

118. **Equus caballus caballus** Linnaeus, 1758—Horse

1758 *Equus caballus* Linn., *Syst. Nat.*, I, p. 53

1916 *E. c. caballus* Lydekker, *Cat. Ung. Brit. Mus.*, VI, p.

Distribution. Subspecies unknown in the wild state. Domesticated in all suitable parts of the world. In the greater part of Ceylon the individuals are all imported, as the species fails to breed. In the limestone districts of the extreme north of the island, however, some small ponies are bred, and these constitute a distinct breed, the Mannar Pony. Ponies also occur and breed in a semi-wild condition on the island of Delft, off the north-west of Ceylon.

Order PROBOSCIDEA

Family 1. Elephantidae—*Elephants*

119. **Elephas maximus maximus** Linnaeus 1758—Ceylonese Elephant

1758 *Elephas maximus* Linneaus, *Syst. Nat.*, I, p. 33 (Ceylon)

1832 *E. indicus* Kelaart, *Prod. Faun. Zeylan.*, p. 77

1816 *E. i. zeylanicus* Blainville, *Ostéographie*, Pl. I (Osteology)

1891 *E. maximus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 463

1911 *idem.*, Thomas, *P. Z. S.*, p. 131

1926 *E. m. zeylanicus* Lydekker, Cat. Ung. Brit. Mus., VI, p. 83

1935 *idem.*, Phillips, *Manual*, p. 307

Distribution. Type locality, ' Ceylon '. Subspecies peculiar to the island, where it occurred originally all over the island. There are still a few protected wild herds in the hills, otherwise it is confined to-day, as a wild animal, to the low-country dry zone. In domestication it may be met with almost anywhere in the island.

Remarks. Linnaeus gave the name *maximus* to the Asiatic Elephant, basing his description on an animal from Ceylon (*vide* Thomas, 1911). If the Ceylonese form is to have subspecific rank apart from the animals found on the mainland, it is the latter which should receive the new name. Lydekker (1916) maintained that true Indian Elephants, descended from imported specimens, were to be found wild in the forests of Ceylon, and that it was to one of these to which Linnaeus gave the name *maximus*. This was purely a matter of opinion, and was not backed by any substantial facts. Until such facts are forthcoming, I consider that Linnaeus' name should stand for the Ceylonese animal, in which case Cuvier's title *indicus* (1798) will have to be used for the Indian Elephant.

Order CETACEA

Suborder I. MYSTACOCETI

Family 1. Balaenopteridae—*Whale bone Whales*

Genus **Balaenoptera** Lacépède 1804

This genus includes the Fin-whales or Rorquals, of which many supposed species have been described. Like many other Cetacean genera this one is in a confused state, but recent opinions trend in the direction of the reduction of the number of true species to not more than four or five, many of the others being based on individual, sexual, and especially age variations. Four species have been recorded from Indian waters, and are represented in Indian museums. There is some doubt as to the proper specific names for these four species, but, mainly following Harmer, I use the following names;—*musculus*, for the Blue Whale (*indica*, is a synonym); *physalus* for the Common Rorqual (with *blythii* as synonym); *edeni*, Bryde's Whale, for which *brydei* is a synonym; and *borealis* for Rudolphi's Rorqual, (with *schlegelii* as synonym). There is some doubt about the species named *acutorostrata*, Lacépède, 1804, the Lesser Rorqual. This may be identical with *edeni*, though Harmer thinks them separable. Beddard (1900) allowed four forms only;—*sibbaldii*, *borealis*, *rostrata* and *musculus*.

120. **Balaenoptera musculus** (Linnaeus, 1758)—Blue Whale, Sulphur-bottom Whale or Sibbald's Rorqual

1758 *Balaena musculus* Linnaeus, *Syst. Nat.*, I, p. 106
1847 *Physalus (Rorqualus) sibbaldii* Gray, *P. Z. S.*, p 92
1859 *Balaenoptera indica* Blyth, *J. Asiatic Soc. Bengal*, XXVIII, p. 488
1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 567
1936 *B. musculus* Pearson, *Proc. R. Soc. Tasmania*, p. 168

Distribution. Worldwide. Has been recorded many times from Indian waters, and from Ceylon waters on several occasions The type of *B. indica* Blyth was from the Bay of Bengal, and its bones are now in the Indian Museum, Calcutta. Others are represented in the museums of Karachi, Trivandrum, and Colombo. The Colombo Museum specimen was stranded at Ambalangoda off the south-west of the island. Another was stranded off Trincomalie in 1932.

121. **Balaenoptera physalus** (Linnaeus, 1758)—Common Rorqual

1758 *Balaena physalus* Linnaeus, *Syst. Nat.*, I, p. 75
1804 *Balaenoptera rorqual* Lacépède, *Cétacés*, p. 126
1878 *Balaenoptera blythii* Anderson, *Anat. Zool. Res.*, p. 561
1891 *idem.*, Sclater, *Cat. Mamm. Ind. Mus.*, II, p. 314

12—J. N. 76094 (7/38)

Distribution. Probably worldwide, except in pack ice. Its presence in Indian waters is based upon the specimen which formed the type of *B. blythii* of Anderson, the remains of which are said to be in the Medical College, Calcutta.

122. **Balaenoptera borealis** Lesson, 1828—Sei Whale or Rudolphi's Rorqual

1828 *Balaenoptera borealis* Lesson, *Hist. Nat. Cétacés*, p. 342

1868 *Sibbaldius schlegelii* Gray, *Synopsis of Whales and Dolphins*, p. 3 (Java)

1869 *Balaenoptera schlegelii* van Beneden, *Ostéographie Cétac.*

1916 *B. borealis* Andrews, *Mem. Amer. Mus. Nat. Hist.* N. Y. (n.s.) I, pt. VI, p. 291

Distribution. Essentially a northern species. Its being recorded as an inhabitant of the Indian seas is based upon the supposed identity with the form labelled *schlegelii* by Gray (from Javan waters). It also seems to have been reported from the Seychelles. The appearance of the Sei Whale south of the equator or anywhere in the Indian Ocean is evidently very spasmodic.

123 **Balaenoptera edeni** Anderson, 1878—Lesser Indian Rorqual or Bryde's Whale

1878 *Balaenoptera edeni* Anderson. *Anat. and Zool. Res.*, p 551

1891 *idem.*, Sclater, *Cat. Mamm. Ind. Mus.*, II, p. 314

1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 568

1913 *B. brydei* Olsen, *P. Z. S.*, p. 1074

1929 *idem.*, Harmer, Art. *Cetacea*, *Encycl. Britt.*, 14th ed., V, p. 169

Distribution. Type locality, Sittoung Estuary, Bay of Bengal. Probably occurs throughout the Indian Ocean, from East Africa and the Cape across to Malayan waters.

Remarks. Many authors, from van Beneden onwards, have regarded the smaller Indian Fin-whale as identical with *B. acutorostrata*, but Harmer (1929) has maintained that the form described as *B. brydei* by Olsen, from South African waters is separable from *B. acutorostrata*, and probably therefore synonymous with *B. edeni*. I have accepted this decision, but use the older name in accordance with the priority rule. Another specimen of this whale has been obtained in recent times (1926) from the Gulf of Martaban. The material from this specimen is now in the Indian Museum, Calcutta.

124. **Megaptera nodosa** (Bonnaterre, 1789)—Humpbacked Whale

1789 *Balaena nodosa* Bonnaterre, *Encycl. Méth.*, *Cétologie*, p. 5

1780 *Balaena böops* Fabricius, *Faun. groenland.*, p. 36

1829 *B. longimana* Rudolphi, *Abhandl. Akad. Berlin*, s. 133

1846 *Megaptera longimana* Gray, *Zool. Voy. Erebus and Terror*, p. 17

1936 *Megaptera nodosa* Pearson, *Proc. R. Soc.*, *Tasmania*, p. 172

Distribution. Almost worldwide. Common in the Atlantic, Pacific, and Antarctic Oceans, less common in the Indian Ocean, where it has been recorded from the Persian Gulf and from Javan waters.

Remarks. On the authority of such eminent cetologists as Flower, Beddard, and Harmer, only one species of *Megaptera* is now recognized

Suborder II. ODONTOCETI

Family 1. Delphinidae—*Dolphins*

125 **Neophocaena phocaenoides** (Cuvier, 1829)—Little Indian Porpoise

1829 *Delphinapterus phocaenoides* Cuvier, *Règne Anim.*, éd. 2, I, p. 291

1891 *Phocaena phocaenoides* Blanford, *Faun. Brit. Ind. Mamm.*, p. 574

1924 *Neophocaena phocaenoides* Dammerman, *Treubia*, V., p. 352

Distribution. Shores of Indian Ocean from South Africa to Japan. Not definitely recorded from Ceylon though I learn on good authority of its presence in Trincomalie Harbour. Known also from Travancore, as it is represented in the Trivandrum Museum.

126. **Orcinus orca** (Linnaeus, 1766)—Killer Whale

1766 *Delphinus orca* Linn., *Syst. Nat.*, I, p. 108

1846 *Orca gladiator* Gray, *Zool. Voy. Erebus and Terror*, p. 83

1924 *Orcinus orca* Dammerman, *Treubia*, V., p. 352

Distribution. As only one species of Killer now seems to be recognized, its range would appear to be worldwide. It is, however, commoner in the more northern waters of the world. It was seen off the west coast of Ceylon as early as 1868.

127. **Orcella brevirostris** (Owen, 1866)—Larger Indian Porpoise

1866 *Phocaena (Orca) brevirostris* Owen, *T. Z. S.*, VI, p. 24

1871 *Orcella brevirostris* Anderson, *P. Z. S.*, p. 143

1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 578

Distribution. Bay of Bengal. Has been found as far east as North Borneo. Not definitely known from Ceylon, but likely to occur off the east coast at any rate. A skull from Vizagapatam harbour is in the British Museum (Flower).

128. **Pseudorca crassidens** (Owen, 1846)—False Killer Whale

1846 *Phocaena crassidens* Owen, *Brit. Fossil Mamm.*, p. 516

1862 *Pseudorca crassidens* Reinhardt, *Overs. K. Danske Vid. Selsk. Forh.*

1864 *Orca meridionalis* Flower, *P. Z. S.*, p. 240 (Tasmania)

1931 *Pseudorca crassidens* Pearson, *Ceylon J. Sc.* (B), XVI, p. 200 (*q. v.* for more detailed synonymy)

Distribution. As only one species of *Pseudorca* is now recognized, its distribution is worldwide. Although a rare Whale, it has on several occasions been recorded from waters off Ceylon, and on one occasion a school of 167 individuals was stranded on the island of Velanai near Kayts, N. P. (Pearson, *loc. cit.*)

129. **Globicephalus indicus** Blyth, 1852—Indian Pilot Whale

1852 *Globicephalus indicus* Blyth, *J. Asiatic Soc. Bengal*, XXI, p. 358

1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 577

Distribution. Originally described by Blyth from two type examples stranded in the Ganges delta near Calcutta. The species is allowed by Blanford, but may not prove distinct from the well known Blackfish or Ca'ing Whale of the Atlantic (*Globicephalus melas*). If this proves to be the case the species will have a worldwide distribution. A large school was stranded on the east coast of Java in 1923 (Dammerman).

130. **Grampus griseus** (Cuvier, 1812)—Risso's Grampus

1812 *Delphinus griseus* Cuvier, *Ann. Mus.*, XIX, p. 14

1828 *Grampus griseus* Gray, *Spicil. Zool.*, p. 2

Distribution. Mainly Mediterranean and North Atlantic, but Blanford states that it may occur in the Indian Ocean, and this is also affirmed by Dammerman (1924).

131. **Lagenorhynchus electra** Gray, 1846—Indian Broad-beaked Dolphin

1846 *Lagenorhynchus electra* Gray, *Zool. Voy. Erebus and Terror*, p. 35

1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 580

Distribution. Indian and Pacific Oceans in their tropical latitudes. It has been obtained off the eastern coast of India.

182. **Lagenorhynchus obscurus** (Gray, 1828)—Dusky Dolphin or Beakless Dolphin

1828 *Delphinus obscurus* Gray, *Spicil. Zool.*, p. 2

1889 *Langenorhynchus obscurus* True, *Delphinidae*, p. 104

1900 *idem.*, Beddard, *Book of Whales*, p. 263

Distribution. Indian and Pacific Oceans. Has been obtained from the Ceylon side of Palk Strait.

Genus **Sotalia** Gray, 1866

There is a good deal of confusion among cetologists as to the exact scope of this genus. Some would restrict it to one or two species, leaving a large number of others in the related genus *Steno*, Gray, 1846. *Steno* is the older name, and should it finally be proved that only one genus of these Dolphins is allowable, this will be the name of it. The chief monographers of the group, Flower (1883), Lütken (1889) and True (1889) each had a different arrangement, but both Flower and True, at any rate, gave more species to *Sotalia* than to *Steno*. Blanford (1891) placed all the Indian forms in *Steno*, but Beddard (1900) placed only two forms in this genus, neither of them Indian. The group has recently been reviewed by Miranda-Ribeiro (1936) who restricts *Sotalia* to a single species, *guianensis*, placing all the others in *Steno*, except one new species for which he creates a new genus *Stenopontistes*. In view of all this confusion, it is impossible to give a final scheme here, so that True's scheme, being a commonly accepted one, is now followed.

183. **Sotalia lentiginosa** (Owen, 1866)—Speckled Dolphin

1866 *Delphinus (Steno) lentiginosus* Owen, *T. Z. S.*, VI, p. 20

1883 *Sotalia lentiginosa* Flower, *P. Z. S.*, p. 489

1889 *idem.*, True, *Delphinidae*, p. 15

1891 *Steno lentiginosus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 584

1936 *idem.*, Miranda-Ribeiro, *Bol. Mus. Nac. Rio de Janeiro*, XII, p. 7

Distribution. Bay of Bengal and Arabian Sea. Has been obtained off both east and west coasts of Ceylon.

184. **Sotalia plumbea** (Dussumier, 1829)—Plumbeous Dolphin

1829 *Delphinus plumbeus* Dussumier, *Cuvier's Règne An.* éd. 2, I, p. 288

1883 *Sotalia plumbea* Flower, *P. Z. S.*, p. 489

1889 *idem.*, True, *Delphinidae*, p. 21

1891 *Steno plumbea* Blanford, *Faun. Brit. Ind. Mamm.*, p. 583

Distribution. Indian Ocean. Recorded from Coromandel and Malabar Coasts and also from Ceylon. Said to be common in estuaries in Burma.

135. **Sotalia gadamu** (Owen, 1866)—Gadamu Dolphin

1866 *Delphinus (Steno) gadamu* Owen, *T. Z. S.*, VI, p. 17
1888 *Sotalia gadamu* Flower, *P. Z. S.*, p. 480
1889 *idem.*, True, *Delphinidae*, p. 13
1900 *idem.*, Beddard, *Book of Whales*, p. 269

Distribution. Recorded only from Vizagapatam, whence it was described from a sketch and a skull. Not recognized as separable from the next by Blanford. Believed to be identical with the succeeding species by some authorities.

136. **Sotalia perniger** (Blyth, 1848)—Elliot's Dolphin

1848 *Delphinus perniger* Blyth, *J. Asiatic Soc. Bengal*, XVII, p. 250
1891 *Tursiops perniger* Sclater, *Cat. Mamm. Ind. Mus.*, II, p. 323
1891 *Steno perniger* Blanford, *Faun. Brit. Ind. Mamm.*, p. 583

Distribution. Indian Ocean. Also recorded from Australia.

137. **Steno rostratus** (Desmarest, 1817)—Rough-toothed Dolphin

1817 *Delphinus rostratus* Desmarest, *Nouv. Dict. Hist. Nat.*, IX, p. 160
1823 *D. frontatus* Cuvier, *Ossemens foss.*, éd. 2, V, p. 278 (*partim*)
1859 *Steno rostratus* Blyth, *J. Asiatic Soc. Bengal*, XXVIII, p. 491
1889 *idem.*, True, *Delphinidae*, p. 24
1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 582
1900 *Steno rostratus* Beddard, *Book of Whales*, p. 278
1936 *Steno frontatus et S. rostratus* Miranda-Ribeiro, *Bol. Mus. Nac. Rio de Janeiro*, XII, p. 7

Distribution. Indian and Atlantic Oceans. It occurs in the Bay of Bengal, having been taken off the Nicobars.

Remarks. The only other species which Beddard allows to the genus *Steno* is a South Atlantic form (*S. perspicillatus* Peters).

138. **Tursiops truncatus** (Montagu, 1815)—Bottle-nosed Dolphin

1815 *Delphinus truncatus* Montagu, *Mem. Wern. Soc.*, III, p. 75
1855 *Tursiops tursio* Gervais, *Hist. Nat. Mamm.*, II, p. 323
1866 *Tursio truncatus* Gray, *Cat. Seals Whales, Brit. Mus.*, p. 258
1883 *Tursiops tursio* Flower, *P. Z. S.*, p. 478
1889 *idem.*, True, *Delphinidae*, p. 32
1891 *idem.*, Blanford, *Faun. Brit. Ind. Mamm.*, p. 581
1900 *idem.*, Beddard, *Book of Whales*, p. 275
1936 *T. truncatus* Pearson, *Proc. Royal Soc. Tasmania*, p. 185

Distribution. Universal, with the exception of polar seas. Has often been found in the Bay of Bengal and off Ceylon and the Seychelles. A specimen dissected in the Anatomy Department, Medical College, Colombo (1935), was obtained off Chilaw.

139. **Tursiops catalania** Gray, 1862—Queensland Bottle-nosed Dolphin

1862 *Tursiops catalania* Gray, *P. Z. S.*, p. 143
1883 *idem.*, Flower, *P. Z. S.*, p. 482

Distribution. Originally obtained off N. E. Australia, but almost undoubtedly occurs farther north in the Indian Ocean. Many authors assume it to be indentical with *T. abusalam* Rüppell, 1845, of the Red Sea, though Flower and True regarded them as distinct. Casts labelled with both names are housed in the Trivandrum Museum, based on osteological material obtained off the Malabar coast. The originals are said to be in the British Museum.

140. **Tursiops parvimanus** (Reinhardt, 1889)—Small-handed Bottle-nosed Dolphin

1889 *Delphinus parvimanus* Reinhardt (Lütken 1889)
1889 *Tursiops parvimanus* Lütken, *Kong. Danske Vidensk. Selskaps. Skr.*, ser. 6, Vol. VI, p. 391

Distribution. Described originally from the Adriatic, a specimen labelled as this species is found in the Trivandrum collection.

Remarks. The original specimen was a young individual. A very doubtful species. Believed by Lütken to be inseparable from *T. catalania*.

141. **Tursiops dawsoni** Lydekker, 1908—Dawson's Bottle-nosed Dolphin

1908 *T. dawsoni* Lydekker, *P. Z. S.*, p. 806

Distribution. Type locality, Trivandrum, Travancore. Original description was based on two examples captured at the type locality in 1907, since when no other specimen has been obtained. A skull in the Colombo Museum, however, was provisionally identified as this species by Harmer (*in litt.*).

Remarks. This is but one of a large number of species and supposed species of *Tursiops* represented in the Trivandrum Museum. Remarks on some of the others have already been made. Another, *T. gilli*, Dall, known otherwise only from the Pacific Ocean is also represented, but I do not list this as a possible Indian Ocean Cetacean, as there may be some error of identification. *T. fergusoni* Lydekker, 1903, was by Lydekker himself, 1908, regarded as the young of the Speckled Dolphin, *Sotalia lentiginosa*.

142. Delphinus delphis Linnaeus, 1758—Common Dolphin

1758 *Delphinus delphis* Linnaeus., *Syst. Nat.* ed. 10, I, p. 77, and all subsequent authors.

Distribution. Apparently universal. Has been recorded from the Coromandel Coast, and from Ceylon.

Remarks. The Common Dolphin is a very variable animal, and, as a result, many different " species " have been described. Not more than two others are, however, currently allowed.

143. Delphinus longirostris Dussumier, 1829—Indian Long-nosed Dolphin

1829 *Delphinus longirostris* Dussumier, *Cuvier's Règne Anim.*, éd. 2, I, p. 288

1883 *idem.*, Flower, *P. Z. S.*, p. 508

1889 *idem.*, True, *Delphinidae*, p. 58

1900 *idem.*, Beddard, *Book of Whales*, p. 257

1891 *D. dussumieri* Blanford, *Faun. Brit. Ind. Mamm.*, p. 588

Distribution. Malabar Coast.

144. Delphinus roseiventris Wagner, 1844-46—Pink-bellied Dolphin

1844/6 *Delphinus roseiventris* Wagner, *Schreber's Saügethiere*, VI, Pl. CCCLX, fig. 1.

1900 *idem.*, Beddard, *Book of Whales*, p. 258

1924 *idem.*, Dammerman, *Treubia*, V, p. 352

Distribution. Recorded from the Moluccas and the Torres Straits, and therefore likely to be found anywhere in the Indian Ocean. Suspected to be partly fluviatile in habit.

145. Prodelphinus malayanus (Lesson, 1826)—Malayan Dolphin

1826 *Delphinus malayanus* Lesson, *Voy, Coquille, Zool.*, I, p. 184

1889 *Prodelphinus malayanus* True, *Delphinidae*, p. 67

1891 *Delphinus malayanus* Blanford, *Faun. Brit. Ind. Mamm.*, p. 588

1900 *Prodelphinus malayanus* Beddard, *Book of Whales*, p. 259

1924 *idem.*, Dammerman, *Treubia*, V, p. 352

Distribution. Bay of Bengal and eastwards to the coasts of all the Malayan islands. The typical form has been recorded from the Bengal Sunderbunds, but varieties, listed under various names, have been obtained from many parts of the Indian seas and elsewhere. One named *Delphinus velox* by Dussumier (1829), which was probably the young of *malayanus*, was founded on a specimen taken from a large school between Ceylon and the Equator.

146. **Prodelphinus alope** (Gray, 1850)—Gray's Dolphin

1850 *Delphinus alope* Gray, *Cat. Seals and Whales Brit. Mus.*, p. 252
1866 *Clymene alope* Gray, *P. Z. S.* p. 214
1868 *Clymenia (Eusphrosyne) alope* Gray, *Synopsis Whales and Dolphins*, p. 6
1866 *idem.*, *P. Z. S.*, p. 214
1926 *Prodelphinus alope* Harmer, *in litt.* X.

Distribution. Type locality, Cape Horn. Probably widely distributed in southern latitudes.

Remarks. A skull in the Colombo Museum, originally labelled *Delphinus delphis*, submitted to Harmer, was by him identified as *Prodelphinus alope*, a species which he believed to be distinct.

Family 2. Physeteridae—*Sperm Whales*

147. **Physeter catodon** Linnaeus, 1758—Sperm Whale or Cachalot

1758 *Physeter catodon* Linnaeus, *Syst. Nat.*, ed 10, p. 76
1766 *P. macrocephalus* Linnaeus, *Syst. Nat.*, XII, I, p. 107 and most subsequent authors
1936 *P. catodon* Pearson, *Proc. Royal Soc. Tasmania*, p. 175

Distribution. All tropical and sub-tropical seas, and occasionally straying beyond. Essentially a whale of the open sea, it is, however, occasionally stranded on the shores of the Indian Ocean, having been thus recorded several times from Ceylon.

148. **Kogia breviceps** (Blainville, 1838)—Pygmy Sperm Whale

1838 *Physeter breviceps* Blainville, *Ann. Anat. Phys.*, II, p. 337
1846 *Kogia breviceps* Gray, *Zool. Erebus and Terror*, p. 22
1865 *Euphysetes macleayi* Krafft, *P. Z. S.*, p. 708
1891 *Cogia breviceps* Blanford, *Faun. Brit. Ind. Mamm.*, p. 572
1920 *Kogia breviceps* Pearson, *Spol. Zeylanica* XI, p. 303

Distribution. Range wide, but represented very sparsely. It has been recorded from Vizagapatam on the Coromandel Coast, and from both Australian and South African sides of Indian Ocean. Specimens labelled "*Cogia macleayi*", including the cast of a foetus, are exhibited in the Trivandrum Museum. There is in the Colombo Museum a specimen from Moratuwa on the west coast of the island.

Family 3. Ziphiidae—*Beaked Whales*

149. **Ziphius cavirostris** Cuvier, 1823—Cuvier's Beaked Whale

1823 *Ziphius cavirostris* Cuvier, *Ossemens fossiles*, 2 éd., V, p. 352

1885 *idem.*, Flower, *List Cetacea Brit. Mus.*, p. 10

1926 *idem.*, Dammerman, *Treubia*, VIII, p. 336

Distribution. Recorded from Atlantic, Mediterranean, North Pacific, and southern parts of the Indian Ocean. It has recently been discovered in Malayan waters, hence it is likely to appear around Ceylon, though never yet recovered from there. Like all the Beaked Whales, this animal is very rare.

150. **Mesoplodon densirostris** Blainville, 1817—Blainville's Beaked Whale

1817 *Mesoplodon densirostris* Blainville, *Nouv. Dict. Hist. Nat.*, éd. 2, IX, p. 178

1876 *Ziphius sechellensis* Gray, *P. Z. S.*, p. 457

Distribution. Another rare Ziphioid, based on a skull and skeleton. It has been recorded from South Africa, the Seychelles and Lord Howe's Island, so that it is likely to occur elsewhere on the shores of the Indian Ocean.

Order SIRENIA

Family Dugongidae—*Dugongs*

151. **Dugong**[1] **dugong** (Erxleben, 1777)—Dugong

1777 *Tricheohus dugung* Erxleben, *Syst. Reg. Anim.*, p. 599

1811 *Halicore dugong* Illiger, *Prod.*, p. 140

1822 *H. indicus* Desmarest, *Mamm.*, p. 509

1891 *H. dugong* Blanford, *Faun. Brit. Ind. Mamm.*, p. 594

1929 *H. dugung* Phillips, *Check-list*, p. 152

1931 *Dugong dugung* Simpson, *Bull. Amer. Mus. Nat. Hist.*, LIX, p. 423

Distribution. Coastal waters of Indian Ocean from the Red Sea to North-western Australia. The Red Sea and Australian forms have been described as separate species, on rather flimsy evidence. As far as Ceylon is concerned the animal appears to inhabit shallow coastal waters and lagoons on the north-west coast, from the Gulf of Calpentyn northwards to Jaffna. Beyond there it is represented on the Malabar Coast. It has on rare occasions been procured from the north-eastern part of the island.

---

[1] The generic name *Dugong*, Lacépède 1799 is apparently the correct name for the Dugong according to Simpson, 1931.

Order PHOLIDOTA

Family 1. Manidae—*Pangolins*

152. **Manis crassicaudata** Geoffroy, 1803—Indian Pangolin

1803 *Manis crassicaudata* Geoffroy, *Cat. Mamm.*, p. 213
1891 *M. pentadactyla* Blanford, *Faun. Brit. Ind. Mamm.*, p. 597
1920 *M. crassicaudata* Wroughton, *J. Bomb. Nat. Hist. Soc.*, XXVII, p. 313
1935 *idem.*, Phillips, *Manual*, p. 354

Distribution. Type locality, ' India '. Found locally in most parts of India from the foothills of the Himalayas to Cape Comorin, and ascending the hills to an altitude of 3,500 feet. In Ceylon it is also very local, but occurs throughout the low-country and up to the same altitudes in the hills as in India. It seems to be found more frequently in the dry zone than elsewhere.

In conclusion I have to acknowledge my great indebtedness to Mr. W. W. A. Phillips for reading through the typescript and making some useful suggestions and for his generous assistance in the matter of cataloguing the Indian Cetaceans, as detailed in the introduction, as well as for advice in several other groups. I have also to tender my warmest thanks to Mr. L. de Fonseka, of the Colombo Museum library, for his ready help in the troublesome matter of tracing and checking references.

REFERENCES TO LITERATURE

(Other than those concerned merely in synonymies)

BEDDARD, F. E., 1900—*Book of Whales*, Murray, London
BLANFORD, W. T., 1888-1891—*Fauna of British India, Mammalia*, London
DAMMERMAN, K. W., 1924—*Treubia*, V, pp. 340-352 (Whales)
1926—*Treubia*, VIII, pp. 336-339 (Whales)
FLOWER, W. H., 1883—*P. Z. S.*, pp. 466-515 (Delphinidae)
HILL, W. C. O., 1936a—*Ceylon J. of Sc.* (B), XIX, pp. 287-314 (Primates)
1936b—*op. cit.* XX, pp. 115-133 (Leaf monkeys)
1936c—*op. cit.* XX, pp. 99-113 (Sciuridae)
1937—*P. Z. S.* (B), pp. 205-216 (Primates)
KELAART, E. F., 1852—*Prodromus Faunae Zeylanicae*
LÜTKEN, C. F., 1889—*Kong. Danske Vidensk. Selskap. Skr.*, 6to Raekhe, Naturvidenskabelig og matehmatisk Afd. 5to, Bd. 1 (Whales)
LYDEKKER, R., 1916—*Cat. Ung. Mamm. Brit. Mus.*, VI, p. 83 (Elephant)
MIRANDA-RIBEIRO, A. DE., 1936—*Bol. do Museo Nac.*, Rio de Janeiro, XX, No. 1., pp. 3-46 (*Sotalia*, etc.).

PEARSON, J., 1936—*Papers and Proc. Royal Soc. Tasmania*, pp. 163-192 (Whales)
NARAYAN PILLAY, R. S., 1926—*J. Bombay Nat Hist. Soc.*, XXXI, pp. 815-817 (Whales)
PHILLIPS, W. W. A., 1929—Check List, *Ceylon J. of Sc.* (B), XV, pp. 119-152 (with Map) a
1935—*Manual of the Mammals of Ceylon*, Colombo
1936—*Ceylon J. of Sc.* (B), XX, pp. 93-97 (Mole-rats)
POCOCK, R. I., 1921—*Ann. Mag. Nat. Hist.* (9) VII, pp. 224-229 (Macaques)
1932a—*J. Bombay Nat. Hist. Soc*, XXXV, pp. 276-288 (Macaques)
1932b—*P. Z. S.*, p. 558
1932c—*J. Bombay Nat. Hist. Soc.*, XXXVI, p. 105 (Bears)
1937—*J. Bombay. Nat. Hist. Soc.*, XXXIX, pp. 211-245 (Mongooses)
PYCRAFT, W. P., 1925—*Man*, XXV, p. 163
THOMAS, OLDFIELD., 1911—*P. Z. S.*, p. 131 (Elephant)
1915—*J. Bombay Nat. Hist. Soc.*, XXIII, p. 416 (*Coelomys*)
TRUE, F. W., 1889—*Delphinidae*; *Bull U. S. Nat. Mus.*, No. 36, pp. 1-191
WROUGHTON, R. C., 1919—*J. Bombay Nat. Hist. Soc.*, XXVI, p. 790 (Rats)
J. Bombay Nat. Hist. Soc., XXVII, pp. 249-250 (*Ratufa*)

NOTES

1. Stridulatory mechanism in the female tegmina of Scaphurinae

Lysaght (*New Zealand J. Sci. and Tech.* XII, 1931, p. 296) has described a stridulatory organ on the base of the right tegmen of the female of *Caedicia simplex* (Walk). While examining a fresh female specimen of the beautiful *Psyra ceylonica* Brunner, I was struck by the appearance of the anal lobes of the tegmina, which, in this species, are very similar in general appearance in the two sexes; and microscopical investigation revealed a structure on the right tegmen which, while agreeing in the main with the stridulatory organ of *Caedicia*, appears to be more highly developed. Examination of a number of species of Scaphurinae (Phaneropterinae auctt.) has revealed a similar structure in the following genera: *Molpa*, *Himerta*, *Allodapa*, *Holochlora*, *Isopsera*, *Ducetia*, *Letana*, *Elimaea*, *Pseudophaneroptera* and *Anerota;* very likely it is present in greater or less degree throughout the sub-family, but, so far as Ceylonese species are concerned, it is best developed in *Psyra ceylonica*, and the following description is of the organ as found in this species; *Molpa bilineolata* Walker also has the apparatus well marked.

The right tegmen has a small lobe on the margin of the anal area, and this lobe, which consists largely of thin, transparent, presumably vibratory, membrane, is crossed by several stout veins, probably the vannal veins. Each of these veins bears on its dorsal surface a file of close-set, transverse tubercles each of which terminates distally in a short seta which is directed in a horizontal or obliquely ascending direction. The files of the proximal three or four veins are the best developed, those on the distal veins consisting of series of stout, oblique setae rather than setiferous tubercles. Their direction, too, changes, for whereas on the proximal veins each tooth of the files lies parallel with the long axis of the tegmen, on the distal veins of the area the setae point towards the costal margin—*i.e.*, at right angles to the long axis of the tegmen. I am inclined to think that this change in the character and disposition of the setae corresponds with a difference in function between the " file teeth " of the proximal veins and the stiff setae of the distal ones, for whereas the regular, close-set arrangement of the former, and their proximity to vibratory areas indicate stridulatory function, the latter are believed to act as frictional elements for holding the right tegmen in correct position against the left when the tegmina are closed. This view is strengthened by the fact that in females of many genera of Tettigoniidae such " anchoring setae ", as I shall call them, are found in a position corresponding with the distal setae of *Psyra* even though no trace of files or vibratory tympana may be present; thus they are found in *Hexacentrus* (Hexacentrinae), *Mecopoda* (Mecopodinae), *Euconocephalus* (Conocephalinae), *Labugama* (Agraeciinae). In *Cratioma*, *Phylloselus*, *Brunneriana*, *Sathrophyllia*, and *Morsimus* (all Pterophyllinae) they are quite absent. The patch of " anchoring setae " may be looked for at the distal end of the vena dividens (PCu) in the right tegmen. It occurs in the male of *Psyra*, *Molpa*, and other genera, as well as in the female.

There can be no doubt that the file-teeth are merely modified " anchoring setae ", and as the tegmen-anchoring function was clearly the primary one, there has been an interesting change of function in the conversion of an anchoring mechanism into a sound-producing one.

The scraper for use in conjunction with the files is furnished by a sharp, sclerotized ridge which occupies an appropriate portion of the ventral surface of a vein, either Cu_2 or PCu, in the anal area of the left tegmen. In the closed position of the tegmina it crosses the file-bearing area of the right tegmen obliquely and may be seen, through the transparent substance of the tegmen, to engage with the teeth of the series of files on the dorsal surface of the right tegmen below it. By gently compressing the not-quite-closed tegmina of a preserved specimen a click is produced as the files are scraped by the vein. I have not however been fortunate enough to observe any female Tettigoniid in the act of stridulating; this is probably partly due to their shyness under artificial light. It is interesting to note that, in the male, whose stridulatory arrangements are quite different, the corresponding vein shows no sign of the sclerotized ridge.

The left tegmen lacks the lobe which, in the right, bears the file-bearing veins, and the anal area has only a trace of the tympanal development of its fellow, being occupied with a network of small veinules.

The number of file-bearing veins and of tubercles in the files of different specimens varies considerably. The specimen above mentioned shows the following numbers of tubercles on its proximal file-veins.

1st vein	**5**	**tubercles**	
2nd do.	**18**	do.	
3rd do.	**18**	do.	
4th do.	**13**	do.	**(rather irregular)**
5th do.	**9**	do.	**(becoming more setiform)**
6th do.	**9**	do.	**(more setiform still).**

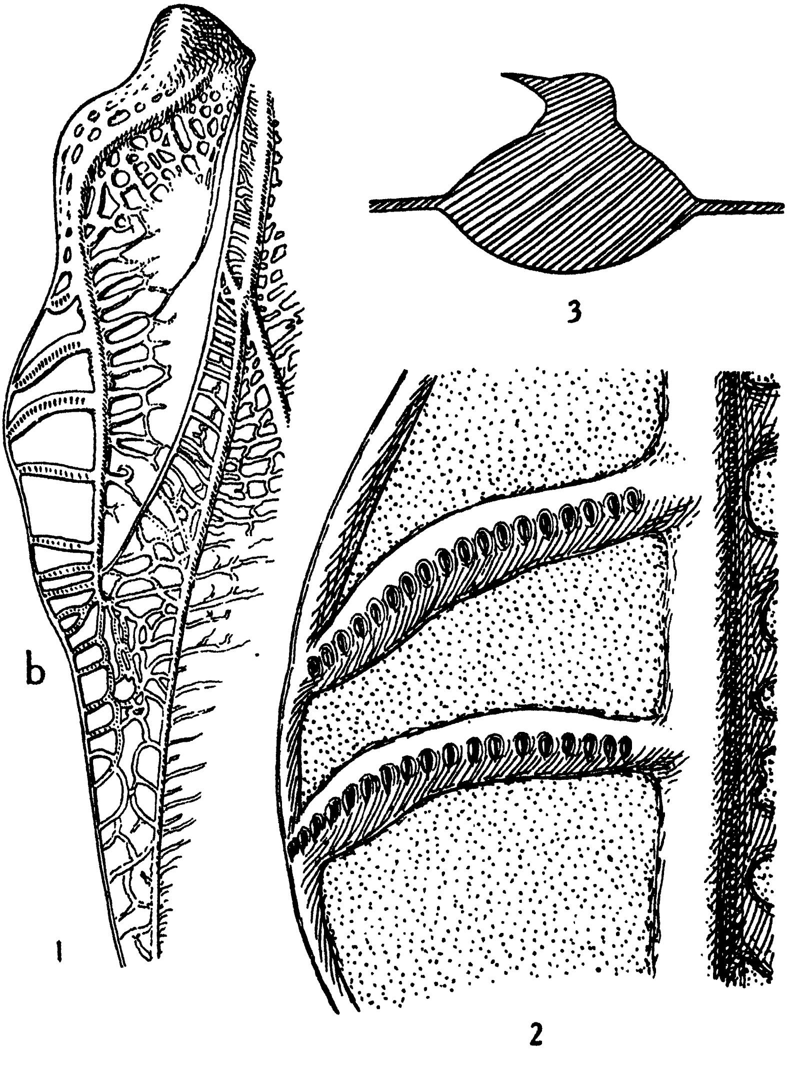


Fig. 1. Stridulatory organ of female *Psyra ceylonica*

1. Base of anal lobe of right tegmen, dorsal, × 14.
   (*a*) stridulatory area
   (*b*) patch of "tegmen-anchoring setae"
2. Files on two of the vannal veins of above, × 66.
3. Diagrammatic transverse section of one file-bearing vein passing through a tooth, × 270.

Comparison of ♂ and ♀ stridulatory organs. As already mentioned, in *Psyra ceylonica* there is much less discrepancy between the appearance of the male and female tegmina than in the majority of the Tettigoniidae, by reason of the stridulatory development in the female, described above, and the fact that the tegminal organ in the male is not extravagantly developed, his vibratory areas being but little more extensive than those of the female. The male tegminal organ, although comparatively small, follows the usual type. The file on the ventral surface of the left tegmen contains 37 ridges in one specimen examined, and a small, vestigial file (non-functional of course) is present on the right tegmen.

The following table gives a detailed comparison of the male and female stridulatory organs:

♂	♀
File (*i.e.*, functional file) single	Files multiple
File probably not composed of modified setae	Files formed from modified setae
File on ventral surface of tegmen	Files on dorsal surface of tegmen
File on left tegmen	Files on right tegmen
Scraper on margin of right tegmen	Scraper on Cu_2 or PCu of left tegmen
Scraper directed dorsalwards	Scraper directed ventralwards
Main tympanum on right tegmen	Main tympanum on right tegmen

From this the interesting fact emerges that the female stridulatory apparatus is not truly homologous with that of the male but is an independent development, its resemblances being convergent rather than genetic. It is evident that the female stridulatory apparatus of *Psyra ceylonica* is considerably more highly developed than that of *Caedicia simplex*, for in the latter (*loc. cit.*) there is said to be " no structure resembling the file " (*i.e.*, of the male), and the tympanal membrane seems to be confined to the spaces between the vannal veins. The metatergum in both sexes of *Psyra* is somewhat swollen, as described in *Caedicia*, but this swelling in life is not hollow but occupied by muscular tissue and it cannot, therefore, act as an amplifier in the former genus as is suggested in the case of *Caedicia* (*loc. cit.*).

I am indebted to Miss A. M. Lysaght for a separate of her paper above-mentioned.

G. M. Henry.

Note.—Since this paper was sent to press I have been fortunate to observe stridulation by a female of *Molpa bilineolata*. The note was a quiet " chukchukchukchukchuk " strongly suggestive of the note of a small gecko and was very different from that of the male—a shrill, but not loud, " chip, chip "—but was produced by similar action of the tegmina. G.M.H.

2. On the Neonatus in *Ratufa* and *Funambulus* (Mammalia; Sciuridae)

Phillips, in his recently published *Manual of the Mammals of Ceylon* (1935), omits all reference to the state of the new-born young and post-natal changes of both the genera of Squirrels mentioned in the title. The birth of individuals of both genera in captivity and their growth, under observation, to maturity, has enabled me to supply the missing information, which is set down in the following notes.

Ratufa

Specimens of the dry zone race of *R. macroura* are easily kept in captivity, and have frequently been known to breed, though it is seldom that the young are reared to maturity. Success is only ensured when the pregnant female is removed from her mate before she is due to give birth. A nest box, completely closed, except for a small egress hole, suited to the mother's size, should be provided. In this the mother will make a nest of straw and leaves and bring forth her baby. The baby,—only one is usually born—will remain in the nest for several months, by which time it has grown half as big as its mother.

I cannot give information relating to the oestrous cycle or the length of the period of gestation, but the following data may assist in leading up to such knowledge later on. An adult female was returned to her mate on 7-vii-37 after having given birth to a baby on 5-ii-37. The male was seen in copula on one occasion, a few days afterwards. The male, who was old and fat, was found dead on 25-vii-37. A second baby was born, but was not seen until 7-xi-37, when it first peeped from the nest, and was apparently half grown. This gives a minimum period of a little over three months for the processes of gestation and lactation (the mother's mammary glands were still secreting when the baby left the nest). From what is known concerning other Rodents, it is probable that the period of gestation is thus about four weeks in *Ratufa*, *i.e.*, one-third of the period mentioned above.

The baby *Ratufa* is born blind, naked, and helpless, but it grows rapidly. A baby female, born on 5-ii-37 was running about a little at the age of one month. The following are the chief changes noted in this individual. At birth the ears are depressed against the side of the head; the body is plump, and the limbs short and incapable of supporting the body. The tail is long and like a rat's, except that it presents no scales like the latter. Hair is present on the body at the age of four days. This first coat is smooth and uniformly brownish. The ventral surface of the body, and also the limbs are still naked. At the age of eleven days evidence of the typical patterning is present in the coat, the blackish saddle over the shoulders being specially noticeable. The eyes were first noticed to be opened on the eighteenth day. Two days later it was attempting to walk and to nibble solid food, and within another week it was running about by itself.

Meanwhile the coat had grown longer and harsher, and the ventral surface and the limbs had become covered with white hair. The tail too had become clothed with a close-fitting coat, the basal half being brownish black and the distal half white. By the end of the second month the baby was similar in general appearance to its parents, resembling its father, who was a more melanistic form, rather than its mother, who was a heavily grizzled example. It differed from the father, however, in the large amount of white on the tail. A second female baby with the same parents had identical characters.

More recently (1-viii-38) a hybrid baby *Ratufa macroura* was obtained. This was the result of a mating between a female *R. m. melanochra* and a male *R. m. dandolena*. It was accidentally killed by its mother whilst still in a hairless condition, *i.e.*, before its fourth day of postnatal life. It was a female and weighed 35 gm. It measured 98 mm. crown-rump length, whilst the tail was 59 mm. long and the hind-foot 20 mm. Skin-pigmentation was much heavier than in pure bred *R. m. dandolena*, as might have been expected. Pigment existed over the cranial portion of the head, the entire dorsal and lateral surfaces and the outer aspects of the limbs and extensor aspect of the tail. This pigment was probably present in the unerupted hairs.

Funambulus

My notes on this genus are based upon a single example, a young male born during the night (14/15-xii-37) from a wild specimen of *F. palmarum favonicus* captured the previous day. Only a single young one was produced though usually two are produced at a birth in *Funambulus*. It was born blind, naked, and helpless, as with *Ratufa*. The skin was smooth and for the most part reddish, but with distinct pigment pattern foreshadowing the future coat pattern, and probably due, therefore, to pigment in the developing hairs still buried in the skin. Thus there is a pale median stripe flanked by darker tracts. Towards the sides there are two less well defined light stripes. The top of the head is light in colour, but the tail is darker. There is faint pigmentation on the outer aspects of the limbs. Whiskers are present on the muzzle. The remains of the umbilical cord were visible for two days.

Hair first made its appearance through the skin at the fifth day. It is smooth and soft, and unlike that of *Ratufa*, remains so. Appearance of the hairy coat accentuates the colour pattern previously visible on the naked skin. The tail has a close fitting coat at first as in *Ratufa*, becoming fluffed up later. Growth is very rapid, the baby being capable of running about in one week. The baby has a very high pitched squeak from the time of birth.

W. C. Osman Hill.

All blocks illustrating this Part by courtesy of the Survey Department, Ceylon.

PRINTED AT THE CEYLON GOVERNMENT PRESS, COLOMBO.

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

A Carbonaceous Jurassic Shale from Ceylon

BY

P. E. P. DERANIYAGALA, M.A. (Cantab.); A.M. (Harvard); F.L.S.; F.Z.S.
Acting Director, Colombo Museum, and Marine Biologist

The Jurassic deposits of Ceylon have hitherto only been recorded from an area less than a mile square near Tabbova in the North-Western Province (Coates 1935, p. 103). The most interesting of these, biologically, is a shale of pipe clay intercalated with the sandstone. This clay contains fossil plants of Jurassic age which Seward and Holttum (1922) identified, and from them dated the deposits as equivalent in age to the Kota of the upper Gondwana of India. An older shale has now been discovered about sixteen miles south of Tabbova, at Āndigama, at a depth of forty to fifty feet below the surface. The greater age of this shale is denoted by its greater compactness and the fact that its plant fossils have metamorphosed into bituminous coal.

The two shales differ as follows —The *Tabbova Shale* is reddish brown, yellow or a dirty white; when dry it adheres readily to the human lip; when heated it does not emit bituminous fumes, and its plant fossils are not metamorphosed into coal. The *Andigama Shale* is dull, dark grey or black, resembling dry asphalt in colour; it does not adhere to the lip; when delaminated under heat, or after immersion in water, it frequently exposes surfaces covered with micaceous particles, while thin sheets of calcite also occur between the laminae; on heating, it emits yellow, tar-smelling fumes; its larger plant fossils are completely metamorphosed into bituminous coal, the others only exist as impressions.

Each shale represents a distinct horizon, the Tabbova deposits are equivalent to the Kota, and the Andigama ones might be regarded as equivalent to the Rajmahal, of the upper Gondwana of India. The presence of bituminous coal in the latter suggests that further investigation might reveal economic possibilities A specimen of Āndigama

2——J. N. 81289–505 (1/39)

shale 55 mm. long, 80 mm. wide, containing a plant stem 30 mm. long, 9 mm. wide metamorphosed into bituminous coal, is deposited in the Colombo Museum.

In conclusion I wish to express my cordial thanks to Mr. A. M. Caldera for his kindness in presenting me with the specimens upon which this article is based, and to Mr. A. F. Seneviratne, owner of Dodanvatta, Andigama, for permitting me to examine the well from which the specimens were obtained.

REFERENCES TO LITERATURE

COATES, J. S. 1935—The Geology of Ceylon, *Ceylon J. Sc.* (B) XIX, pt. 2.

SEWARD, A. C. et HOLTTUM, B. A. 1922—Jurassic Plants from Ceylon, *Quart. J. Geol. Soc.* LXXVIII, No. 311, pp. 271-276

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (*October 24, 1939*)

On the Cestode Family Acoleidae, with a Description of a New Dioecious Species, *Infula burhini* gen. et sp. nov.

BY

D. R. R. BURT, B.Sc., F.L.S., F.R.S.E.
Professor of Zoology, Ceylon University College

(With Six Text Figures)

Dioecious cestodes are extremely rare, and all species so far described belong to the genus *Dioecocestus* Fuhrmann 1900. The discovery in Ceylon of new cestodes which do not belong to this genus, but which are closely akin, apart from their dioecious character, to the genera *Gyrocoelia* Fuhrmann 1899, and *Shipleya* Fuhrmann 1907 of the Acoleinae, has made it necessary to reconsider the present classification of the *Acoleidae*. The resemblance of the female form of the new species to the hermaphrodite forms *Gyrocoelia* and *Shipleya* is so great that the possibility is considered of mistaken interpretation of structures in descriptions of species of these genera. As the female worm of the new species described here, *Infula burhini*, possesses a structure similar in most respects to a cirrus, but interpreted as a vagina, and as accounts of the male genital glands in *Shipleya* are indefinite, and in some species of *Gyrocoelia* are either contradictory, indefinite, or wanting, the possibility of mistaken interpretation in some descriptions becomes still more probable. The reasons in support of this opinion are discussed more fully following the account of the structure of the new worm, when relationships to known forms will be dealt with, and the genera and family redefined in accordance with the evidence available.

Infula burhini gen. et sp. nov.

Hosts: Burhinus oedicnemus indicus (Salva. 1866), the Indian Stone-Curlew, and *Himantopus himantopus himantopus* (Linn. 1758), the Black-winged Stilt.

3——J. N. 81289 (1/39)

Locality: Near Mannar, Northern Province, Ceylon.

♂ *External :* The males measure up to 62 * long, with maximum breadths, towards the posterior end, of 1 44 to 1.78. Strobilation commences almost immediately posterior to the scolex, and proglottides, at first broader than long, become as broad as long when mature. The posterior margins of the proglottis are salient, overlapping the next posterior proglottis and giving the lateral margin a serrate appearance. The genital pore is in the centre of the lateral margin and in posterior proglottides the large extruded cirri are conspicuous. Genital pores alternate almost regularly in successive proglottides, and the degree of alternation is expressed as 95% regularly alternate in the specimen from *Burhinus* and 100% regularly alternate in the two specimens from *Himantopus*.

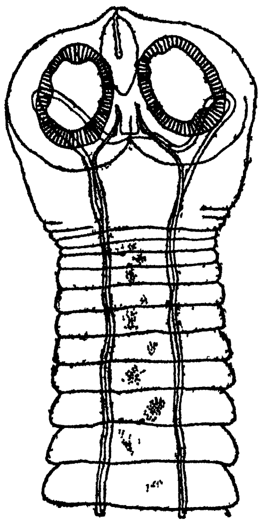


Fig. 1. *Infula burhini* gen. et sp. nov. ♂. Scolex × 80

Scolex: The scolex has a diameter of 0.405 to 0.455 and is much shorter than broad, as the distance from the apex of the scolex to the first definite proglottides is about 0.4. There are four suckers, two directed dorsally and two ventrally, oval in outline with a breadth of 0.112 to 0.156 and a length of 0.188 to 0.205. The mean breadth of the suckers in the three male worms is 0.1393 with a standard deviation of the mean of ± 0.00819, and the mean length 0.1986 ± 0 00185. A

* All measurements, unless otherwise indicated, are in millimetres.

comparatively small rostellum, situate in a rostellar sac, measures 0.075 to 0.082 in diameter and 0.120 to 0.136 in length. The apex of the rostellum is invaginated within the body of it and is unarmed.

Genitalia: The primordia of the genital system appear early and can be identified in the 6th, 10th and 12th proglottides in the three specimens. The testes, 65 to 75 in number, attaining a maximum diameter of 0.095 to 0.1, occupy, when fully mature, the whole of the medulla, except that part occupied by the large cirrus-sac. The cirrus-sac extends from the genital atrium in the centre of the lateral margin in an antero-median direction, and passes between the longitudinal excretory vessels, the base of the sac reaching or extending beyond the mid

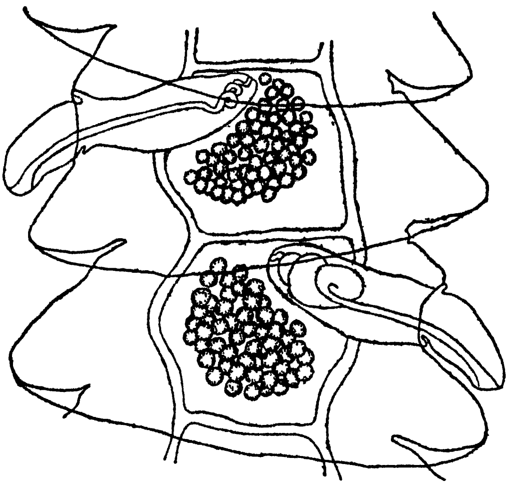


Fig. 2. *Infula burhini* gen. et sp. nov. ♂. Mature proglottides × 60

line close to the anterior border. The cirrus sac is 0.41 to 0.45 in length, the breadth varying according to the extent of extrusion of the cirrus. The diameter of the sac with the cirrus involuted may be 0.207, and in a condition where the cirrus is completely everted by the contraction of the muscles of the wall of the sac it may be only 0.145 The wall of the sac is invested with a layer, 0.0085 thick, of circular muscles, and on account of the deeply staining nature of this region it is a conspicuous object in sections. External to the muscular layer is a single layer of large cells about 0.024 thick. The cirrus is armed with numerous spines which are 0.007 in length at the base of the organ and which decrease in length towards the apex. Extrusion of the cirrus is accompanied, when complete, by the eversion of the genital atrium which appears as a prepuce round the base of the organ. The fully extruded cirrus measures about 0.1 in diameter at the base and its length varies from 0.5 to 0 6 Within the base of the cirrus-sac a few convolutions of the ductus ejaculatorius are expanded to form an internal seminal vesicle which is characterized by possessing a very thin wall. There is no external seminal vesicle.

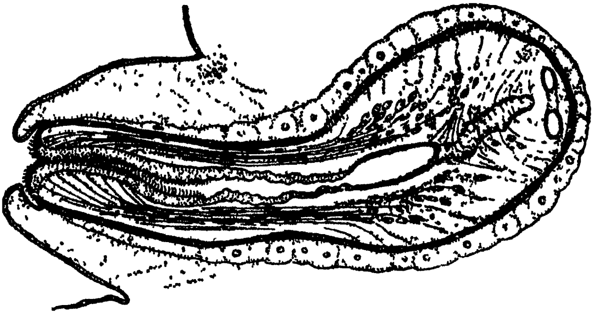


Fig. 8. *Infula burhini* gen. et sp. nov. ♂. Longitudinal section of cirrus × 75

Musculature The arrangement of the longitudinal and transverse bundles is similar to that seen in *Acoleus* and regarded as typical of the Acoleidae. There are two layers of longitudinal bundles, and external, between, and internal to these are the three layers of transverse fibres. In addition dorso-ventral fibres are present. There are from 50 to 60 bundles of fibres in the internal and external layers of longitudinal muscles both dorsally and ventrally. The bundles forming the external layer contain from four to six fibres and are smaller than the bundles of the internal layer which contain eight to twelve fibres.

Excretory system: Dorsal and ventral longitudinal excretory vessels are present on each side. The dorsal vessels have a maximum diameter of 0.01, while posteriorly, in mature proglottides, the ventral vessels attain a diameter of 0 045. There are two transverse excretory vessels in each proglottis, lying posteriorly; one connects the two dorsal longitudinal vessels and the other the two ventrals.

♀ *External:* The lengths of the three female worms vary from 135 to 145, and the maximum breadths vary from 2.8 to 4.9. according to the state of contraction. Proglottides are all broader than long, but in one of the worms, which is more extended than the others, the lengths of mature proglottides are almost as great as the breadths. The genital apertures, situate in the centre of the lateral margins, approach regular alternation but not to the same extent as in the male worms. The alternation is 80% regularly alternate in the specimen from *Burhinus*, and 78% and 83% regularly alternate in the two specimens from *Himantopus*.

Scolex: The scolex resembles that of the male worm but is slightly larger. It has a diameter of 0.43 to 0.52 and is not sharply marked off from the very short neck. The distance from the apex of the scolex to the first definite proglottides is about 0.88. The suckers are oval, their lengths vary from 0.178 to 0.234, and their breadths from 0.11 to 0.158. The mean length of the suckers is 0.2081 with a standard deviation of the mean of $\pm$ 0.00462, and the same statistics for the

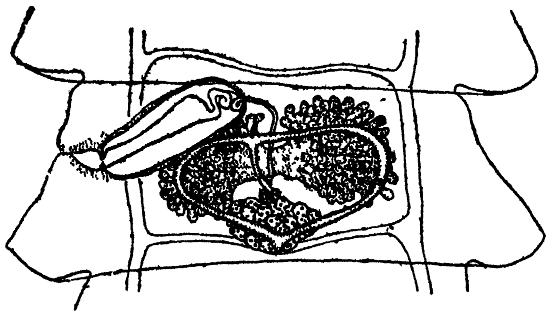


Fig. 4. *Infula burhini* gen. et sp. nov. ♀. Mature proglottis × 60

breadth are 0.1428 and $\pm$ 0.00352. Although the suckers of the females appear slightly larger than those of the males the difference between them is not significant. The mean length of the suckers in all the specimens of both sexes is 0.2033 $\pm$ 0.00255, and the mean breadth 0.141 $\pm$ 0.0023. The rostellum, contracted and lying within a rostellar sac, measures 0.065 to 0.078 in diameter and 0.137 to 0.164 in length. The diameter is more constant than the length, and the mean diameter of the rostella in all specimens of both sexes is 0.0766 $\pm$ 0.00148.

Genitalia: The primordia of the female genitalia do not appear quite so early in the strobila as they do in the case of the male. They are identified in the specimen from *Burhinus* in the 18th proglottis, and in the two specimens from *Himantopus* in the 18th and 22nd proglottis. The ovary is primarily bilobed or winged, each moiety being formed of many long acini. In late mature proglottides, the number and extent of the acini, mask the bilobed nature of the gland which extends fan-wise within the limits of the medulla. In position the ovary is central but, as acini are absent from the region occupied by the vagina, the poral lobe is slightly smaller than the aporal. The vitelline gland lies centrally posterior to the ovary; like the latter gland it is lobed but rather compact. It is transversely elongate, the anterior face of the gland being flat and the posterior face convex. It measures, when fully developed, about 0.325 across and 0.15 in length. A large shell-gland is present between the vitelline gland and the ovary; it lies in the mid line and measures 0.08 to 0.102 across.

Occupying the same relative position as the cirrus-sac in the male, and resembling it in many respects, is the vagina. It lies in a sac 0.37 to 0.4 long by 0 15 to 0 205 in diameter. The sac is surrounded by

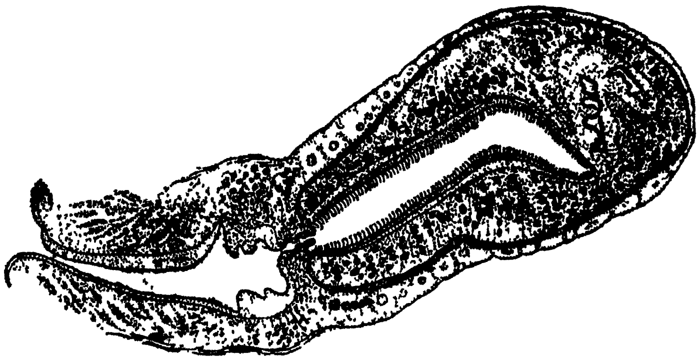


Fig. 5. *Infula burhini* gen. et sp. nov. ♀. Longitudinal section through developing vagina × 60

a layer of circular muscles essentially similar to the layer surrounding the cirrus-sac, and external to this layer there is also a thick layer of larger glandular cells. Within the sac lies the vagina which has a thick cuticular lining armed with spines similar to those of the cirrus. Towards the base of the sac the narrowed vagina shows a few convolutions surrounded by circular muscles. There is no thin-walled expansion in the base of the sac similar to the internal seminal vesicle of the male. From the wall of the vagina to the wall of the vaginal sac there extend retractor muscles similar in arrangement, and in development from myoblasts, to those found in the cirrus-sac. From the sac of the vagina, and continuous with the vagina within the sac, a thin-walled duct leads medially to bend posteriorly dorsal to the ovarian isthmus and expand into a large thin-walled receptaculum seminis, which lies dorsally in the region between the ovary and the vitelline gland. In mature proglottides the genital atrium and vagina are frequently seen in a partially or completely everted condition, precisely like that of the cirri. It is observed, however, that sperms are only found in regions of the strobila where the everted vaginae are seen and never in proglottides anterior to this region, so that one is forced to the conclusion that eversion is brought about by the completion of coitus. Considering the armed nature of the cirrus and vagina, it would seem that the easiest method of withdrawal of the cirrus would be by the eversion of the structure in which it lies, which is apparently what takes place. The only other alternative to the interpretation of this organ as a vagina would be to consider it as a functionless and meaningless cirrus, which alternative is negatived by the identification within it and within the receptaculum seminis of sperms.

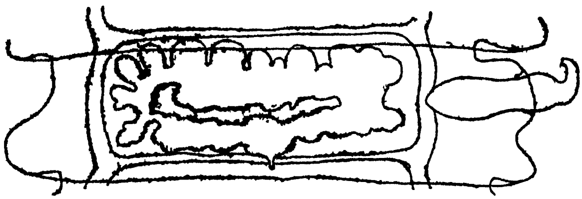


Fig. 6. *Infula burhini* gen. et sp. nov. ♀. Gravid proglottis showing annular uterus and uterine pore × 32

The uterus is dorsal and annular resembling the uterus in *Shipleya inermis* and in species of *Gyrocoelia*. It develops early, its primordia being present when the ovary and vitelline gland are still immature, development proceeding concomitantly with the development of the latter two structures. At first tubular, but later becoming enlarged and sending out numerous out-pocketings, the uterus retains in fully developed forms a central space although the latter becomes restricted to a narrow transverse slit. Posteriorly the uterus opens to the exterior by dorsal and ventral uterine pores which lie in the mid line underneath the projecting posterior margins.

The eggs have an outer membrane 0.068 to 0.075 by 0.024 to 0.041; the middle envelope is thick and deeply staining measuring 0.045 to 0.051 by 0.027 to 0.031. The onchosphere measures 0.027 by 0.03 and is armed with six hooks 0.0135 long.

Excretory and muscular systems: The excretory system is essentially similar to that of the male. The ventral vessel enlarges from 0.01 diameter in young proglottides to 0.017 in early mature, to 0.044 in fully mature and to 0.075 diameter in gravid proglottides. The arrangement of the muscles is similar in the two sexes, the only difference being an apparently greater number of fibres in the bundles of the layers of longitudinal muscles.

A comparison of the measurable characters of the male and female worms from *Burhinus* and *Himantopus* is given in the accompanying table.

TABLE I. *Comparison of the measurable characters of the male and female worms from Burhinus and Himantopus*

	***Infula burhini* gen. et sp. nov.**					
Host :	***Burhinus***	***Himantopus***	***Himantopus***	***Burhinus***	***Himantopus***	***Himantopus***
Sex :	♂	♂	♂	♀	♀	♀
Length in mm. :	62	52	23	145	142	135
Breadth in mm. :	1.78	1.72	1.44	4.9	2.8	4.0
Scolex—diameter in μ :	440	455	405	520	455	430
Suckers—diameter in μ :	112-136	143-156	140-143	144-150	110-154	136-158
length in μ	190-200	188-205	194-205	215-234	184-218	178-205
Rostellum—diameter in μ :	82	75	75	75	65	78
length in μ :	140	136	170	137	140	164
Onchosphere—size in μ :				27 × 20		
Middle shell—size in μ:				31 × 51		
Outer shell—size in μ				41 × 75		

DISCUSSION

The belief that the males and females belong to the same species is based on the fact that two worms were found together, one male and one female, in the Indian Stone-Curlew, and that in each of two Black-winged Stilts a similar pair of worms was found. The probability that the worms of the first pair are male and female of the same species is increased to practical certainty in finding three pairs in three separate hosts. In morphological characters, other than sexual characters and the greater size of the female, the two sexes agree, particularly in the sizes of the scolices, suckers and rostella, hence it is concluded that the two sexes are of the same species.

Only one genus of dioecious cestode, *Dioecocestus* Fuhrmann 1900, has so far been described. This, according to Fuhrmann's most recent classification (1936) finds a place in the family Acoleidae (Acoleinidae Fuhrmann 1907, emended to Acoleidae by Ransom in 1909). The reason for placing *Dioecocestus* in this family is the absence of vaginal aperture associated with an arrangement of muscles similar to that in other genera of the family. An earlier classification which stressed the uniqueness of the character of separate sexes was that of Southwell (1930) who placed the genus *Dioecocestus* in his family *Dioecocestidae*. The dioecious nature of *Infula* would appear to be sufficiently characteristic for it to find a place near *Dioecocestus*, but the fact that it differs from the other genera of the Acoleidae in possessing a vagina, would necessitate the removal of the Dioecocestinae from the Acoleidae and the restoration of Southwell's suppressed Dioecocestidae. The alternatives presented by this problem are; either placing *Infula* in the sub-family Dioecocestinae, and re-defining the family Acoleidae, and in so doing taking away from the Acoleidae the fundamental character of the family, namely the absence of vaginal pore or, promoting Dioecocestinae to family rank and including the new genus in this family. Whichever alternative is adopted must depend on the relative importance from a taxonomic point of view of the dioecious character and the character of absence of vaginal pore. It is considered that the separation of the sexes is a more fundamental character than the absence of vaginal pore, which character is known outside the Acoleidae e.g. in *Aporina*, and that the restoration of the family Dioecocestidae for *Dioecocestus* and the new genus *Infula* represents the more natural classification. It is suggested however that the affinities of the Acoleidae and the Dioecocestidae may be shown by placing these two families, together with the Progynotaeniidae, in the super-family Dioecocestoidea.

It is possible that it may be necessary to transfer to the Dioecocestidae at least one genus of Fuhrmann's sub-family Acoleinae, namely *Shipleya* Fuhrmann 1907 (emended from *Shipleyia*). In his description of *Shipleya inermis* obtained from *Gallinago gigantea* in Brasil, the only species of this genus, Fuhrmann frankly states that testes were not seen, but he assumes their presence in early proglottides and their early degeneration. Later, in 1936, he uses as an argument for the inclusion of *Acoleus*, *Gyrocoelia*, *Diplophallus*, and *Shipleya* in the sub-family Acoleinae, the fact that testes appear in anterior proglottides and disappear early, although their actual presence in *Shipleyia* has never been determined. Fuhrmann also remarks in his description of *Shipleya inermis*, on the large and specialized cirrus, which, however, he says, is without function owing to the absence of sperms. The structure identified as a large and specialized cirrus may correspond to the structure which is considered to be a large and specialized vagina in *Infula*, in which case the two facts, the failure to find testes, and the functionless nature of the so-called cirrus, lend support to the view that *Shipleya inermis*, described as hermaphrodite, is in actual fact the female form of a dioecious species. On these grounds it is considered necessary to transfer *Shipleya* to the family Dioecocestidae.

There are also several points requiring further elucidation in the various species of the genus *Gyrocoelia*, and it may be found on investigation that some of the species are dioecious, or that some of the species really belong to the new genus *Infula* The evidence with regard to the presence of testes is definite in some species, contradictory in some and lacking in others.

Fuhrmann (1899) figures eight testes in a proglottis of *Gyrocoelia perversa* (emended from *G. perversus*, and *G. perverse*), at a stage of development, where the uterus is already formed, although his only reference to the testes is ' Die männlichen Geschlechtsorganen bestehen aus einem grossen Cirrusbeutel and einem vas deferens, das zu wenigen (4) Hoden führt.' There are two other points with regard to *G. perversa*, firstly, that rostellar hooks were not found and were presumed to have dropped off, and secondly, that although testes are figured at a stage of development where the uterus is already formed, the early appearance and early degeneration of the testes is accepted as one of the characters of the Acoleidae. In *Gyrocoelia brevis* Fuhrmann 1900 there is no record of testes either in the original description or in that by Joyeux and Baer (1936), but the presence of rostellar hooks, 40 in number and 0.034 long is recorded by the two latter authors. In *Gyrocoelia fausti* Shen 1933 there are recorded 42 to 48 testes present in the type, which also possesses 66 rostellar hooks 0.0216 to 0.0486 while in another worm, described as the same species, Shen notes that testes were absent, and that rostellar hooks were also absent. Another species in which there is no record of testes is *Gyrocoelia leuce* Fuhrmann 1900, in which species, however, the rostellum possesses 40 hooks 0.033 to 0.036 long. *Gyrocoelia paradoxa* (von Linstow 1906) (syn. *Brochocephalus paradoxus*) possesses, according to the original description, three testes and a crown of six backwardly-directed loops of hooks. According to Southwell (1930), a specimen identified as the same species is recorded to have ' apparently 20 to 30 testes and 78 hooks in a zig-zag row (there are about eight angles).' It has not been possible to trace the type of this species which was one of a collection in the Colombo Museum, but it is apparent that, either von Linstow and Southwell are dealing with different worms, or one or the other is mistaken, or both are mistaken in interpretation of structures as testes, or the testes are variable in number and may even be absent. In this connexion it should be put on record that a *Gyrocoelia*-like worm was obtained from *Leucopolias* (*Charadrius*) *alexandrinus alexandrinus* (Linn. 1758), the Kentish Plover, in Ceylon. This worm possesses a zig-zag row of 72 hooks, 0.024 to 0.033 long, on the rostellum, but testes are definitely wanting, sections through the strobila showing only female glands and a cirrus-like structure. In horizontal sections through this worm, as in similar sections through the female form of *Infula*, those which pass through the dorsal region of the medulla and cut the dorsal tubular acini of the ovary give the appearance of a dorsal field of testes, but their histological appearance, and their connexion with the ovary negative this impression. This is a possible source of error in some descriptions, particularly if the specimens are badly preserved or macerated, and it may account for the discrepancies in the two descriptions of *Gyrocoelia paradoxa* referred to.

The facts, so far as they are known, with regard to the presence of testes and the armature of the rostellum in *Gyrocoelia* may be briefly summarized.

TABLE II. *Testes and rostellar hooks in species of Gyrocoelia*

Species	Author	Testes	Rostellar Hooks
perversa	Fuhrmann 1899	4 ?	not found
australiensis	Johnston 1912	about 5	scolex wanting
brevis	Fuhrmann 1900	not recorded	40 (34 μ)
fausti	Shen 1933	42 to 48	66 (21 to 48·6 μ)
fausti	Shen 1933	absent	not found
paradoxa	Linstow 1906	3	78 (29 μ)
paradoxa	Southwell 1930	apparently 20 to 30	78 (29 μ)
leuce	Fuhrmann 1900	not recorded	40 (33 to 36 μ)
sp.	present paper	absent	72 (24 to 33 μ)

It is not possible to divide these species into two groups, namely, those in which testes and rostellar hooks are recorded, and those in which there is no record of either. It is always possible for rostellar hooks to drop off, particularly in macerated specimens, and likewise the absence of a definite record of the presence of testes does not necessarily imply that these structures are absent. But at the same time, it must be taken into consideration that in the above nine records, two state definitely that testes are absent, in two they are not recorded, in two referring to the same worm the statements are contradictory, in one the statement is contradicted by the text-figure, in one there is an indefinite statement, and in one only is there an uncontradicted definite statement. The evidence then, with regard to the presence of testes, is far from satisfactory, and it is possible that some of the species are dioecious worms in which only the female form has been described. There is too the possibility, which has not been discussed, that *Gyrocoelia* may have dioecious as well as hermaphrodite forms.

The worms described in this paper were obtained in the field from birds shot for their parasites. They were fixed in Bouin's fluid on the spot, hence their state of preservation and fixation is good. Cestodes, collected under these conditions and before fixation allowed to detach themselves from the wall of the gut by placing the opened gut in water, very rarely lose their rostellar hooks. Thus one has little hesitation in accepting the absence of hooks in the six specimens as being a diagnostic character. *Infula* is most nearly allied to *Shipleya* and *Gyrocoelia*, and is distinguished from these, apart from its dioecious character, by the character of the rostellum. The rostellum is absent in *Shipleya*, a fact which was ascertained by Fuhrmann from sections of the scolex; it is present and characteristically armed in *Gyrocoelia;* and present but unarmed in *Infula*.

The following is the revised classification of Fuhrmann's family Acoleidae.

Dioecocestidae Southwell 1930

Cyclophyllidea in which the sexes may be separate, i.e., some strobilæ contain only male, and others only female organs.

Type genus: *Dioecocestus* Fuhrmann 1900.

Dioecocestus Fuhrmann 1900

Dioecocestidae: Dioecious. Scolex usually with armed rostellum. Male with a double set, female with a single set of reproductive organs in each proglottis. Vagina irregularly alternate, reaching almost to the margin of the proglottis. Uterus a transverse sac with dorsal outgrowths. Parasites of Birds.

Type species: *Dioecocestus paronai* Fuhrmann 1900

Infula gen. nov.

Dioecocestidae: Dioecious. Scolex with an unarmed rostellum. Male and female worms each with a single set of reproductive organs in each proglottis. Vitellaria posterior to ovary. Genital pores alternate. Vagina cirrus-like in structure. Uterus annular in shape with numerous diverticula when fully developed, and with dorsal and ventral uterine pores situate in the mid line posteriorly. Parasites of Birds.

Type species: *Infula burhini* gen. et sp. nov.

Shipleya Fuhrmann 1907.

Dioecocestidae: Scolex unarmed without rostellum. Genital pores regularly alternate. Receptaculum seminis very small. Vitellaria dorsal to ovary. Uterus annular with numerous diverticula. Parasites of Birds.

Type species: *Shipleya inermis* Fuhrmann 1908

Gyrocoelia Fuhrmann 1900

(Syn. *Brochocephalus* von Linstow 1906)

Dioecocestidae: Rostellum armed with a zig-zag row of hooks showing six or eight angles. Male and female genital organs single. Cirrus-sacs alternate irregularly. Receptaculum seminis very small. Uterus annular in shape with numerous evaginations, and in gravid proglottides with dorsal and ventral uterine pores situate medio-posteriorly. Parasites of Birds.

Type species: *Gyrocoelia perversa* Fuhrmann 1899

Acoleidae Fuhrmann 1899

Cyclophyllidea: Scolex usually with armed rostellum. Strobila relatively large and thick, formed of proglottides usually broader than long. Musculature strong, two layers of longitudinal muscles alternating with three layers of transverse muscles. Genital glands single or partially double. Cirrus strongly armed. Female genital apertures absent. Parasites of Birds.

Type genus: *Acoleus* Fuhrmann 1899

Acoleus Fuhrmann 1899

Acoleidae: Male and female genital glands single. The male genital apertures alternate regularly. The vagina is represented by a very large receptaculum seminis. Parasites of Birds.

Type species: *Acoleus vaginatus* (Rudolphi 1819)

Diplophallus Fuhrmann 1900

Acoleidae: Male genital organs double, female genital organs single with two atrophied vaginae represented by a large receptaculum seminis. Parasites of Birds.

Type species: *Diplophallus polymorphus* (Rudolphi 1819)

REFERENCES

FUHRMANN, O. 1899.—Mitteilungen über Vogeltaenien, II. Zwei eigentümliche Vogeltaenien. *Centrbl. f. Bakt. u. Parasit. I Abt. Originale*, vol. 26, pp. 618—620 figs. 1—8

1899.—Deux singuliers ténias d'oiseaux. *Rev. suisse de Zool.*, vol. 7, pp. 342—347, pl. 17, figs. 1—9

1900.—Zur Kenntnis der Acoleinae. *Centrbl. f. Bakt. u. Parasit. I Abt. Originale*, vol. 28, pp. 371—373, figs. 10—12

1908.—Nouveaux ténias d'oiseaux. *Rev. suisse de Zool.*, vol. 16, pp. 70—73, figs. 58—60

1932.—Les ténias des oiseaux. *Mémoires de l'Université de Neuchatel*, VIII, pp. 167—175

1936.—Un singulier ténia d'oiseau, Gynandrotaenia stammeri n. g. n. sp. *Ann. de Parasit. Humaine et Comparée*, vol. XIV, Nr. 3, pp. 261—271, 11 figs.

JOHNSTON, T. H. 1910.—On Australian Avian Entozoa. *Jour. and Proc. of the Roy. Soc. of N. S. Wales*, vol. 44, p. 95.

1912.—On a Re-examination of the Types of Krefft's Species of Cestodes in the Australian Museum. Pt. I *Rec. Australian Museum*, vol. IX, pp. 28—32, Pl. V

JOYEUX, C. H. et BAER, J. G. 1936.—*Faune de France, 30, Cestodes*, Paris, pp. 61, 305—306, figs. 328, 329

VON LINSTOW, O. 1906.—Helminths from the Collection of the Colombo Museum. *Spolia Zeylanica*, vol. III, p. 183, Pl. II, figs. 38, 88, Pl. III, figs. 35, 37

RANSOM, B. H. 1909.—The Taenioid Cestodes of North American Birds. *Smithsonian Institute U. S. Nat. Mus. Bull.* 69, p. 103

SHEN, TSENG, 1933.—Studies on Avian Cestodes from China Pt. II. Cestodes from Charadriiform Birds. *Parasitology*, vol. XXIV, pp. 508—509, figs. 47—53

SOUTHWELL, T. 1930.—*The Fauna of British India, Cestodes II*, p. 202

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

New Cestodes of the Genus Paronia

BY

D. R. R. BURT, B.Sc., F.L.S., F.R.S.E.
Professor of Zoology, Ceylon University College

(With Four Text Figures)

Paronia coryllidis sp. nov.

Host: Coryllis beryllinus (Forster 1781). The host died in captivity.

Locality: Colombo, Ceylon.

External: This species is 70 to 75 * in length and has a maximum breadth of 1.2. The strobila in the region of the mature and gravid proglottides is more or less uniform in breadth. The relative proportions of length to breadth of the proglottides vary according to the state of contraction of the worm, but mature proglottides are almost as long as broad and occasionally the length exceeds the breadth.

Scolex : The diameter of the scolex varies from 0.305 to 0.315, but as there is no sharp line of demarcation between scolex and neck the length cannot be determined. There are four suckers, circular in outline, and measuring 0.11 to 0.136 in diameter. The scolex and neck together measure 1.4 to 1.45 and the breadth of the neck is 0.165 to 0.17.

Genital ducts: The genital apertures are bilateral and are situated on the lateral margin two-thirds the length of the proglottis from the anterior end. The genital ducts pass dorsal to the longitudinal excretory vessels and the vagina lies posterior to the cirrus-sac.

Male genitalia: There are 70 to 80 testes which attain a diameter of 0.068 and are arranged dorsally in a single layer bounded by the

---

* All measurements, unless otherwise indicated, are in millimetres.

excretory vessels. They lie dorsal to the ovary but are absent from the region dorsal to the vitelline glands. The cirrus-sac is elongate and narrow lying obliquely in an antero-median, posterio-lateral direction; it is 0.325 long, and its proximal end lies just median to the longitudinal excretory vessels. There is no external seminal vesicle, but the ductus ejaculatorius is enlarged within the base of the cirrus-sac to form a small internal seminal vesicle. The vas deferens is convoluted and expanded before it enters the cirrus-sac and its walls are surrounded by prostate cells.

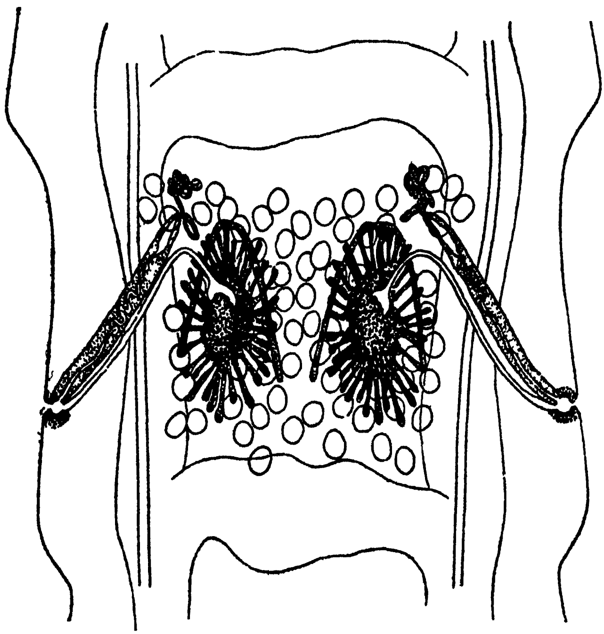


Fig. 1. *Paronia coryllidis* sp. nov. Mature proglottis × 105

Female genitalia: The ovaries are rosette-shaped and composed of numerous acini radiating from the centre of the gland. The outlines are circular or oval and in extended proglottides the greatest diameter lies in an antero-posterior direction, the length being 0.52 and the breadth 0.235. They lie ventrally in the centre of the lateral halves of the proglottis, and when fully formed both ovaries approximate in the mid line. The vitellaria are oval, 0.12 long and 0.07 broad, and lie dorsally above the centre of the ovaries. From the opening into the genital atrium posterior to the cirrus, the vagina continues just posterior to the cirrus-sac as far as the proximal end of that organ where it bends posteriorly and dorsal to the ovary enlarges into an almost spherical receptaculum seminis measuring 0.102 in diameter. There are two uteri in each proglottis which originate as tubular structures bent almost into a horse-shoe shape with the convexity directed anteriorly. As they enlarge they lose their smooth outline becoming more sac-like, and the median limbs then unite to form a single M-shaped uterus. The eggs measure 0.021 to 0.024 and the onchospheres 0.01 to 0.0135 in diameter. A rudimentary pyriform apparatus is present.

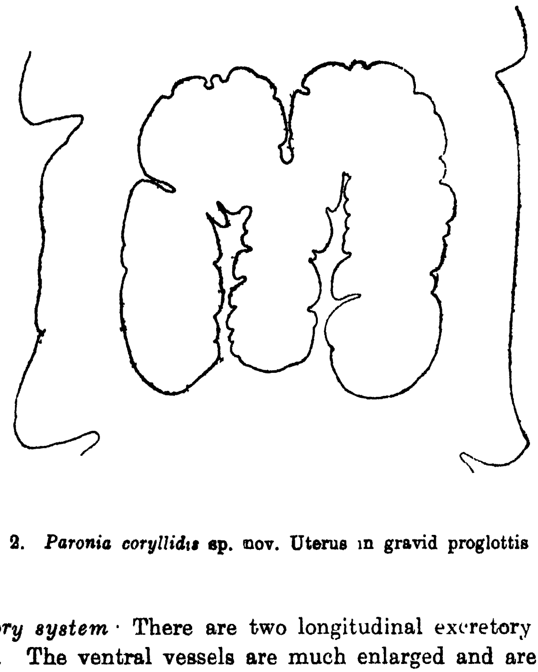


Fig. 2. *Paronia coryllidis* sp. nov. Uterus in gravid proglottis × 84

Excretory system · There are two longitudinal excretory vessels on each side. The ventral vessels are much enlarged and are connected posteriorly in each proglottis by a transverse vessel. Just anterior to the transverse vessel the longitudinal vessels are constricted. The dorsal longitudinal vessels are more uniform measuring 0.01 in diameter.

Musculature: The arrangement of the muscles is typical of the Anoplocephalinae.

Paronia biuterina sp. nov.

Host: Coryllis beryllinus (Forster 1781)

Locality: Uragaha, Southern Province, Ceylon.

External: Only one specimen of this worm was obtained. The length is 55 and the greatest breadth 2.25. The proglottides are all much broader than long with salient posterior margins which overlap to a slight extent the next proglottis.

Scolex : The scolex has a diameter of 0.265 and is provided with four suckers 0.16 in diameter. The scolex and neck together measure 0.96 and the breadth of the neck is 0.174.

Genital ducts: The genital pores are bilateral situate near the centre of the lateral margins of the proglottis. The genital ducts pass dorsal to the longitudinal excretory vessels. The vagina usually opens into the atrium dorsal to the cirrus-sac on the right side of the proglottis and ventral to it on the left side.

Male genitalia: There are 65 to 75 testes which reach a maximum size of 0.038 in diameter. They are arranged in a single dorsal field bounded by the excretory vessels. The vas deferens is enlarged close to its entry into the cirrus-sac, and this region is surrounded by prostate cells and thrown into tight convolutions. The cirrus-sac is long varying in length from 0.215 to 0.272; it lies obliquely extending median to the excretory vessels, and its base almost reaches the anterior margin of the proglottis. There is no internal seminal vesicle.

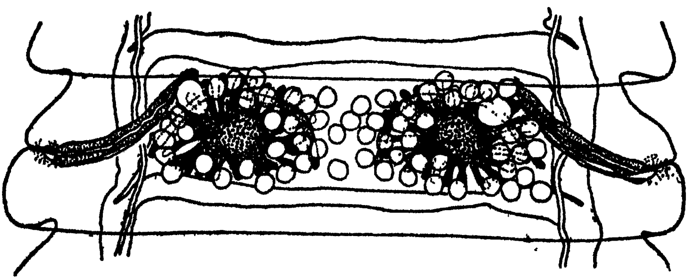


Fig. 3. *Paronia biuterina* sp. nov. Mature proglottis × 77

Female genitalia: The ovaries are rosette-shaped, formed of many radiating acini, and they lie ventrally in the lateral halves of the proglottis. In outline they are oval, and the greatest diameter, 0.44, lies in the direction of the breadth of the proglottis. The vitellaria, dorsal in position, lie above the centre of the ovaries and measure 0.12 to 0.136 in diameter when fully formed. The receptaculum seminis is almost spherical and varies in size from 0.074 in diameter (in early mature proglottides) to 0.178 in diameter in proglottides just anterior to those in which eggs appear in the uteri. The uteri are crescent-shaped, the convexity being directed anteriorly; as they enlarge they become sac-shaped, remaining separate and not uniting to form a single uterus. The eggs measure 0.027 to 0.03 and the onchospheres 0.012 in diameter. A rudimentary. pyriform apparatus is present.

Excretory system: Two excretory vessels are present on each side. The ventral vessels are enlarged with a constriction to form a valve-like structure just anterior to the transverse vessel which connects the ventral vessels in the posterior region of each proglottis. The dorsal longitudinal vessels have a diameter of 0.02.

Masculature: The arrangement of the muscles is typical of the Anoplocephalinae.

Paronia calcaruterina sp. nov.

Host: Molpastes haemorrhous haemorrhous (Gmel. 1789), the Madras Red-vented Bulbul.

Locality: Uragaha, Southern Province, Ceylon.

External : The length of the strobila is 126 and the greatest breadth 2.1. The proglottides are broader than long with rounded salient posterior margins which overlap the next proglottis, and which show a few longitudinal grooves. In gravid proglottides the length is almost equal to the breadth. The most anterior proglottides are 0.6 broad by 0.059 long; mature proglottides increase from 1.86 to 1.96 in breadth and from 0.572 to 0.76 in length; and gravid proglottides increase in length to 1.5 while a few terminal gravid proglottides are 2.1 broad.

Scolex: The scolex 0.69 in diameter, is armed with four strongly muscular suckers which are almost circular in outline, their greatest diameter being 0.269 to 0.272. It is not sharply marked off from the neck, the length of scolex and neck being 1.4, while the neck has a breadth of 0.67.

Genital ducts: The genital apertures are bilateral and situate on the lateral margins two-thirds the length of the proglottis from the anterior end. The vagina opens into the genital atrium posterior to the cirrus but the greater part of the vagina lies ventral to the cirrus-sac. The genital ducts pass dorsal to the longitudinal excretory vessels.

Male genitalia: There are approximately 112 testes, the number varying from 102 to 120. They are arranged in a field of one layer which extends dorsally throughout the whole medulla except in the region of the vitelline glands. They increase in size to a maximum diameter of 0.085 but occasionally a diameter of 0.1 is reached. The vas-deferens is tightly convoluted in the neighbourhood of the base of the cirrus-sac. The cirrus-sac is elongate and narrow. It leads from the genital atrium almost transversely but slightly anteriorly, and median to the excretory vessels it bends anteriorly, the proximal end of the sac lying one-third of the length of the proglottis from the anterior margin. A small internal seminal vesicle, measuring about 0.05 long by 0.027 in diameter is present in the base of the cirrus-sac.

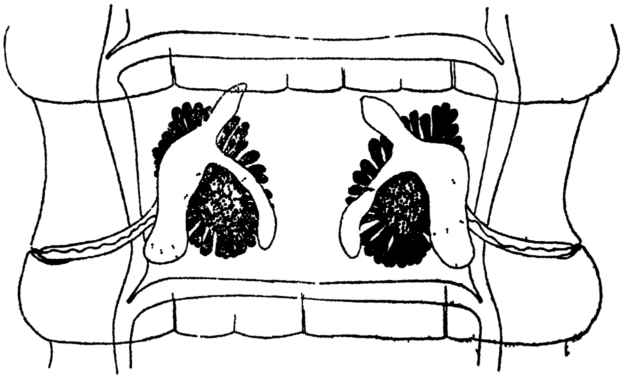


Fig. 4. *Paronia calcarutenna* sp. nov. Early gravid proglottis × 43

Female genitalia: The ovaries are rosette-shaped and oval, formed of slender radiating acini, and lie in the centre of the lateral half of the medulla. Their greatest diameter is in an antero-posterior direction, and in mature proglottides measures 0.56. The vitelline gland is dorsal, lying above the centre of the ovary, and is formed of blunt, rounded lobes. The vagina lies ventral to the cirrus-sac throughout most of its length, but just internal to the longitudinal excretory vessels it bends medianly to expand into a small, almost spherical receptaculum seminis. The latter has a diameter of 0.062 to 0.085 and lies median to the longitudinal excretory vessels in the middle of the length of the proglottis. There are two uteri in each proglottis and they remain separate. Each is formed at first of three lobes, arranged roughly in the shape of a military spur. Two lobes form a horse-shoe shaped structure and from the convex surface which is directed anteriorly a third lobe arises and projects in an antero-median direction. As the uteri develop they give off numerous out-pocketings, but the fully formed uteri are smooth in outline the walls of the out-pocketings remaining as septa which project into their cavities. The eggs measure 0.031 to 0.0325, and the onchospheres 0.017 in diameter. A pyriform apparatus is wanting.

Excretory system: Two longitudinal excretory vessels are present on each side. The dorsal vessel has a uniform diameter of 0.014 but the ventral vessel is enlarged and varies in diameter. As in other species of this genus there is a valve-like constriction of the ventral vessel immediately anterior to the connexion with the transverse vessel.

DISCUSSION.

In the genus Paronia there have been described five species: *P. carrinoi* Diamare 1900, *P. variabilis* (Fuhrmann 1904), *P. beauforti* (Janicki 1906), *P. ambigua* (Fuhrmann 1902), and *P. columbae* (Fuhrmann 1902). The first two are from South American parrots, the third is from a parrot in New Guinea, while *P. ambigua* is South American from the Rhamphastiformes and *P. columbae* is from Sumatran Columbiformes. *P. carrinoi* is the type of the genus and is the only one of these five species in which the two uteri remain separate. Of the new species described in this paper *P. biuterina* and *P. calcaruterina* agree with *P. carrinoi* in the common character of the possession of persistent double uteri, hence it is only necessary to show in what respects these two new species differ from each other and from the latter species.

P. biuterina is actually and relatively a smaller worm than *P. carrinoi;* it measures about half the size, which cannot be considered as due to differences in fixation, as various structures which vary but little in size when fixed with different reagents are actually smaller.

The scolex in *P. biuterina* has a diameter of 0.265, which is half that of *P. carrinoi* (0.53); the cirrus-sac varies between the limits 0.215 and 0.272 in *P. biuterina*, while in *P. carrinoi* the length 0.45 to 0.7, is more than double; and the number of testes, 65 to 75, found in *P. biuterina*, is practically half the number found in *P. carrinoi*.

P. calcaruterina can be distinguished from all other species by the shape of the uterus which possesses a lobe projecting from the anterior surface. In this respect it resembles the genus *Triuterina* Fuhrmann 1921, although in the latter genus the genital organs are single in each proglottis. The character of the shape of the uterus is not considered sufficient to warrant the creation of a new genus as in other respects *calcaruterina* possesses the characters of *Paronia*. The number of testes in *P. calcaruterina* is intermediate between the numbers found in *P. carrinoi* and *P. biuterina*, but they attain a greater size than in the latter two species. The scolex of *P. calcaruterina* is larger than that of any species so far described, while the cirrus is intermediate in length between those of *P. carrinoi* and *P. biuterina*. It is worthy of note that *P. calcaruterina* is the first species of the Anoplocephalidae recorded from the Passeriformes.

P. coryllidis shares with four species the common character of the fusion of the two uteri to form a single uterus, but the shape of the double uterus varies in different species. In *P. variabilis* the posterior ends of the median limbs of the two uteri fuse to form a single uterus of the form of a double C; in *P. ambigua* the anterior regions of the median limbs of the uteri unite to give a pectinate appearance to the double organ; while in *P. columbae* the uteri unite and give off numerous digitiform processes; while in the new species *P. coryllidis* the median limbs of the two uteri unite along their median borders to give an M-shaped double organ. With regard to other characters, *P. coryllidis* has fewer testes, for the number, 70 to 80, although it approaches that found in *P. ambigua* and *P. variabilis* (100), is much smaller than the 360 found in *P. beauforti* and the 200 found in *P. columbae*. The scolex of *P. coryllidis*, 0.305 to 0.325 in diameter, is smaller than that of *P. variabilis*, 0.43 in diameter; and the cirrus-sac, 0.352 long in *P. coryllidis*, is about twice the size of that organ in *P. ambigua*.

The three new species differ specifically from each other and from the other described species of the genus. The essential diagnostic differences between the species of the genus are shown in the accompanying table.

TABLE I. *Diagnostic differences between the species of the genus Paronia.*

	P. carrinoi Diamare 1900 Psittaciformes Australia and New Guinea	*P. ambigua* (Fuhrmann 1902) Rhamphastiformes Brasil	*P. variabilis* (Fuhrmann 1904) Psittaciformes S. America	*P. beaufortі* (Janicki 1906) Psittaciformes New Guinea	*P. columbae* (Fuhrmann 1902) Columbiformes Sumatra, Bengal	*P. coryllidis* sp. nov. Psittaciformes Ceylon	*P. biuterina* sp. nov. Psittaciformes Ceylon	*P. calcaruterina* sp. nov. Passeriformes Ceylon
Strobila—length : breadth :	70-120 mm. 3-5 mm.	60-80 mm. 1.5 mm.	70 mm. 2.5 mm.	18 mm. 3 mm.	— 1 mm.	70-75 mm. 1.2 mm.	55 mm. 2.25 mm.	126 mm. 2.1 mm.
Scolex—diameter :	530 μ	—	450 μ	—	—	305-515 μ	265 μ	690 μ
Testes—number size :	140-150 45 × 10 μ	100 6 μ	100 40 μ	360 —	200 —	70-80 68 μ	65-75 38 μ	102-120 85 μ
Cirrus-sac—length :	450-700 μ	120 μ	270 μ	600 μ	90 μ	325 μ	215-272 μ	380-420 μ
Gravid uterus :	double	single	single	single	single	single	double	double
Eggs—diameter :	30 μ	30 μ	43 μ	—	30 μ	21-24 μ	27-30 μ	31-32.5 μ
Onchospheres—diameter :	12 μ	—	16-19 μ	—	—	10-13.5 μ	12 μ	17 μ
Pyriform apparatus :	rudimentary	absent	absent	—	absent	rudimentary	rudimentary	absent

REFERENCES.

BAER, J. G. 1927. *Monographie des Cestodes de la famille des Anoplocephalidae. Bull. Biologique de France et de Belgique.* Supplément X, pp. 86—93.

DIAMARE, V. 1900. Paronia carrinoi n. g. n. sp. von Taenioiden mit doppelten Geschlechtsorganen, *Centrbl. f. Bakt. u. Parasit.*, I Abt., Originale, vol. 28, pp. 846—850, 4 figs.

FUHRMANN, O. 1902. Die Anoplocephaliden der Vögel. *Centrbl. f. Bakt. u. Parasit.*, I Abt., Originale, vol. 32, pp. 128—132, figs. 7—12.

1904. Neue Anoplocephaliden der Vögel. *Zool. Anz.* vol. 27, pp. 384—388.

1921. Einige Anoplocephaliden der Vögel. *Centrbl. f. Bakt. u. Parasit.*, I Abt. Originale, vol. 87, pp. 438—451, figs. 17—21.

1932. Les Ténias des Oiseaux. *Mémoires de l'Université de Neuchatel*, VIII, pp. 68—71.

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

The Genus Zumala Walker, (Insecta, Orthoptera) with description of a new species

BY

G. M. HENRY, F.R.E.S.
Assistant in Systematic Entomology, Colombo Museum

(With Four Plates)

The Genus *Zumala* was erected by F. Walker (1869 p. 413-416), for the accommodation of four species of robustly-built Pseudophyllinae from Ceylon, and another, doubtfully included by him in the genus, from Malabar. Two of his Ceylonese species, viz., *Z. exaltata* and *Z. mutilata* (actually the two sexes of one and the same species) have been removed to the genus *Brochopeplus* Pict. and Sauss. while his *Z. ?oleifolia* from Malabar is identified by Kirby (1906) as *Morsimus oleifolia* F. This leaves in *Zumala* the genotype, *Z. robusta*, and *Z. cingalensis;* a third species is described in this paper.

The genus belongs to the subfamily Pseudophyllinae and the tribe Phyllomimi. So far as is known at present it is confined to the more humid parts of Ceylon, both low-country and hills. The recent British Museum—Colombo Museum Expeditions to South India (1936, 1937 and 1938) failed to discover any representative of the genus, but it seems likely, when the vast hill forests of Travancore, Cochin and Malabar have been properly explored entomologically, that the genus will be found to inhabit South India as well as Ceylon.

Genus **Zumala** Walker

Zumala Walker, 1869. *Cat. Derm. Salt. Brit. Mus.* Pt. II, p. 413
Scutotribonia Pictet & Saussure, 1892. *Icon. Saut. Vertes*, pp. 11 and 24
Scutotribonia Brunner von Wattenwyl, 1895. *Monog. Pseudophyll.* pp. 11 and 49

Large and stoutly-built, green. Antennae less than twice the length of body. Head broad, deeply sunk in the prothorax (Plate XVI, fig. 2). Fastigium conical, longitudinally sulcate or pitted, much narrower than first antennal joint. Face smooth. Clypeus somewhat swollen. Eyes not prominent.[1] Ocelli absent.

Pronotum sharply rounded in front, very obtusely and roundedly angled behind, broadest at or behind the middle; tectiform in front, flattened or bi-concave on posterior lobe, with two well-marked transverse sulci of which the posterior is at or behind the middle; covered almost all over with small, hemispherical, glassy tubercles which are most strongly developed along the lateral margins—where they form a crenulated edge—and along the middle line.

Prosternum armed on each side with a strong spine. Meso- and meta-sternal plate broader than long, with a raised tuberculated border in front and on the sides (Plate XVI, fig. 4 and XVIII, fig. 6). Mes- and met-episterna and epimera tuberculated, the tubercles most strongly developed above the coxal acetabula. Limbs stout and rugged in surface. Genicular lobes either rounded or acutely pointed, but not spinous. Tibiae nearly square in section. Fore coxae with a strong spine. Fore femora with a few small tubercles or spinules on the pre-axial ventral carina; either unarmed or with one to three small tubercles or spinules on the post-axial ventral carina. Fore tibiae with very small spinules on the two ventral carinae only. The auditory organ is almost closed on each side by its opercula, which are flattened and do not form a swollen 'bulla' (Plate XVI, fig. 3). The mid femora bear a few small spines or tubercles on the pre-axial ventral carina, more and larger ones on the post-axial. Hind femora not very stout; but little incrassate proximally; without spines on the dorsal carina but with some strong tubercles on its proximal end. A row of short but stout spines on each ventral carina along its whole length. Hind tibia with small spines on the outer and inner ventral carinae, at most very minute ones on the dorsal carinae.

Tegmina well-developed, coriaceous, costal area lobately produced proximally, apex rounded, posterior (inner) margin rounded and arched. Venation as in Plate XVII, figs. 2 and 4 and Plate XVIII, fig. 2. Micro-venation tending to run in longitudinal, close-set lines more or less parallel with the long axis of the tegmen. Tympanal area in male tegmina well developed in the known males. Wings rudimentary or fairly well developed.

Male genitalia as shown in Plate XVIII, figs. 3, 4, 7, 9. The tenth tergite forms a transverse lamina which has its margin produced

---

1 Walker in his generic diagnosis describes the eyes as prominent, but in the genotype, *Z robusta*, in *Z. cingalensis* Walker, and in the new species described below, they are certainly not prominent as compared with related genera.

on each side into a broad down-curving lobe. The supra-anal plate, subovate in shape and very thin dorso-ventrally, is attached to the anterior part of the ventral surface of the tenth tergite so as to be quite concealed, in dorsal view, by the latter. The cerci are short and stout; contained in the genital cavity. The subgenital lamina is transverse at base; medially produced into a cylindrical rod which divides into two cylindrical columns, each of which supports an oval style.

Female genitalia as shown in Plates XVI to XVIII. Ovipositor more or less curved; evenly tapering from base to apex; minutely serrated on both edges.

Zumala robusta Walker

Plate XVI, figs. 1 to 5

Zumala robusta Walker, 1869. *Cat. Derm. Salt. Brit. Mus.* Part II, p. 413
Zumala robusta Kirby, 1906. *Syn. Cat. Orthopt.* Vol. II, p. 298

The male of this insect is not known and there is little to add, concerning the species, to the above generic diagnosis, except to state that it is considerably larger than the other species of the genus detailed below, and differs from them in the possession of fairly well-developed wings, which, however, appear ill adapted for flight and are probably never used for that purpose.

The fore femur bears 2-3 small pre-axial spines, 0-2 still smaller post-axial; the fore tibia bears 3-4 pre-axial, 2-3 post-axial minute spinules. The mid femur bears 0-2 pre-axial, 3-6 post-axial, small spines; the mid tibiae are armed like the fore tibiae. The hind femur bears 7-9 short but strong spines on its outer ventral carina, 6-8 on its inner. The hind tibia bears 4-8 small spines on its outer ventral carina, 2-3 on its inner.

The limb spines in some specimens are self coloured (green) in others more or less black. The genicular lobes are rounded and but little produced in this species.

The female supra-anal plate is ovate; the cerci are straight, cylindrical, almost evenly tapering, and about two-thirds the length of the supra-anal plate; the subgenital lamina is very similar to that of *Z. intermedia*, sp. nov. (see Plate XVIII, fig. 8), but less angularly excavated in the middle.

Coloration. This description of the coloration was drawn up from a living example captured at Labugama, W.P. (see below); in preserved examples the coloration naturally suffers great changes. Dark leaf-green above. pale green below. Antennae green, annulated black and becoming greyish-black distally with pale green annulations. Eyes pale green, suffused greyish and with dark mottlings. An opaque white, suffused line, with a dark line below it, along sides of head from the eye. Clypeus and labrum pale green, the latter buff and brown at margin. Mandibles pale green on exposed portion. Palps yellow-green. Lateral tubercles of pronotum pale brown. Fore and mid femora and tibiae dark green above, lighter below; more or less suffused with purple on the dorsal and external aspects. Hind femora paler green than the others, suffused dark green and purple dorso-distally. Hind tibiae rich pinkish purple darkening distally. Tarsi green, much suffused with purple except on the broad pulvilli of the third segments.

Tegmina rather rich dark green, more glossy than the pronotum, with a very narrow costal edge of whitish yellow, tips narrowly chestnut. Ovipositor pale green, nearly black at tip, dorsal, sutural and ventral margins.

Measurements.

	♀ mm.
Length of body (minus ovipositor)	42.0 to 46.0
Length of pronotum	11.5 to 13.0
Width of pronotum	12.75 to 14.0
Length of tegmen	38.0 to 44.5
Breadth of tegmen	16.0 to 18.0
Length of fore femur	10.5 to 13.0
Length of hind femur	19.0 to 22.2
Length of ovipositor	19.5 to 21.0

Material examined. Walker's type female in the British Museum; three females collected by me at Woodside, Urugalla, 12-ix-1922; 4-iv-1923 (in the British Museum); and 14-iv-1923; a female from Mousakande, Gammaduwa, viii-1935, presented to the Colombo Museum by Mr. W. W. Phillips; a female collected at Labugama, on 9-vi-1938.

Bionomics, &c. The specimens captured by me were found sitting by day on the upper surface of cardamom leaves in forest. The Labugama specimen above-mentioned was said by my Collector, K. L. A. Perera, who captured it, to have been sitting on a leaf of *Ochlandra stridula*, the broad-leaved bamboo which forms the main undergrowth at Labugama; it was kept alive for a month and a half in the hope of obtaining eggs, but none were laid, although it was regularly supplied with a variety of plant stems of various degrees of hardness and also with a pan of soil. It fed sparingly on tender stalks of the

Bowitiya plant (*Osbeckia* sp.) and was strictly nocturnal and very sluggish in habits. Its resting attitudes were varied; sometimes it sat flat on a leaf with the mid-legs concealed beneath the tegmina; at other times it stood high on the fore and hind legs with the mid legs raised and laid along the body beneath the margins of the tegmina. This curious attitude was adopted whenever the insect was exposed to direct sunlight. The fore-legs were usually widely separated and the antennae were extended straight in front of the head and closely apposed together.

It seized, Zumalas, in common with other Pseudophyllinae, endeavour to hook their spinous hind femora around the fingers of their captor and so to manoeuvre themselves into a position where they can inflict a bite.

Zumala cingalensis Walker

Plates XVII, figs. 1 and 2 and XVIII, figs. 1-4

Zumala cingalensis Walker, 1869. *Cat. Derm. Salt. Brit. Mus.* Pt. II, p. 415
Scutotribonia humbertiana Pictet and Saussure, 1892. *Icon. Saut. Vertes*, p. 24, Pl. III ff. 18, a, b
Scutotribonia humbertiana Brunner von Wattenwyl, 1895. *Mon. Pseudophyll.* p. 50, Pl. II, f. 16
Scutotribonia cingalensis Kirby, 1906. *Syn. Cat. Orthopt.* Vol. II, p. 298
Zumala humbertiana Uvarov, 1927. *Ceylon J. Sc.* (B) Vol. XIV, p. 93 (*Syn. nov.*)

A comparison of Pictet and Saussure's description and figures of their *Scutotribonia humbertiana* (♀) with a series of specimens of both sexes, including Walker's type (♂) of *Zumala cingalensis* leaves no doubt that *S. humbertiana* is the ♀ of *Z. cingalensis*. Therefore, as pointed out by Uvarov (*loc. cit.*), *Scutotribonia* Pict. and Sauss. is a pure synonym of *Zumala* Walker. Uvarov, working with two female specimens, correctly identified these with *humbertiana* Pict. and Sauss. but did not recognize that this was the female of *Z. cingalensis* Walker. Having captured a number of specimens of both sexes I am in a position to establish the above synonymy beyond question.

Although Brunner's figure (*loc. cit.*) is poor, yet, taken together with his description and measurements, it is clear that he was dealing with the female of the present species and not with *Z. intermedia*, sp. nov. described below.

This is the smallest of the three known species of this genus and appears to be confined to elevations over 5,000 feet, whereas the other two have not been found above 4,000 feet.

The figures given (Plates XVII and XVIII) sufficiently indicate the structural features and I will therefore merely mention the salient points.

The pronotum is much less strongly tuberculated or raised in the middle line than in *Z. intermedia*, sp. nov. (see below) and has its principal transverse sulcus nearer the middle, especially in the male. The genicular lobes are acute and somewhat produced, especially in the hind femora. The fore and mid femora are practically unarmed, bearing only a few feeble tubercles respectively on the pre-axial and post-axial ventral carinae. The hind femora bear 7 to 12 tubercles or spines on the outer ventral carina and 6 to 9 longer ones on the inner.

The male tegmina have the stridulatory area better developed than in *Z. intermedia.* The subcostal vein is greatly expanded anteriorly in its proximal half and this expansion, which forms a definite area, is strongly punctured (Plate XVIII fig. 2). The file vein on left tegmen measures about 5.25 mm. and is very finely striated.

The wings in both sexes are rudimentary, reaching to only about half the length of the tegmina.

The abdominal tergites are obtuse-angulately produced in the middle. The ♂ genitalia are as figured in Plate XVIII, figs. 3 and 4. The ♀ supra-anal plate is ovate, angulate at the apex, tectate and medially carinate, at least in preserved specimens. The ♀ cerci are cylindrical, unevenly tapering, incurved at the apex and about half the length of the supra-anal plate. The ♀ subgenital lamina is very similar to that of *Z. intermedia* (Plate XVIII, fig. 8); the ovipositor shows hardly a trace of the oblique ridges towards the tip that are found in that species.

Coloration. This account of the coloration is drawn up from living specimens recently captured at Hakgala; preserved specimens show varying degrees of deterioration. Rather dark leaf-green dorsally, pale dull yellowish green ventrally, brightest on venter of abdomen. Antennae self green, darkening and faintly annulated with pale rings distally. An opaque, whitish suffusion on the sides of head and lateral lobes of pronotum, which appears in dried specimens, is not present in life. Lateral marginal tubercles of pronotum, buff; costal margin of tegmina narrowly buff with a dull red, narrow, inner line which distally becomes the marginal line. Small spots at the following articulations black: cephalo-antennal, coxo-trochanteric, femoro-tibial. Limbs dull, dark green, lighter ventrally; small, dull-black specks in rows on outer surfaces of femora and pre-axial faces of tibiae; hind femora paler green than the others, their spines pale green. Proximal two tarsal segments purple-brown above, lighter purple beneath; distal two segments self-green, claws darkening at tips.

Measurements.	♂ mm.	♀ mm.
Length of body	23.0 to 25.0	31.0 to 35.0 (minus ovipositor)
Length of pronotum	7.5	8.0 to 8.2
Width of pronotum	7.6 to 7.8	8.5 to 9.2
Length of tegmen	22.0 to 23.0	28.0 to 29.0
Breadth of tegmen	8.5 to 10.0	10.7 to 12.5
Length of fore femur	7.0 to 7.5	8.0 to 8.2
Length of hind femur	12.0 to 12.2	13.0 to 13.5
Length of ovipositor	—	14.3 to 16.0

Material examined. Walker's type ♂ in the British Museum; two females, also in the British Museum, Nuwara Eliya, August, collected by E. E. Green, and Nuwara Eliya, 24-vii-1924, collected by me. In the Colombo Museum: two males and a female, without data, belonging to an old collection; one male and one female, Ohiya, 6,500 feet, 26-iv-1928; one female, Goatfell Estate, Kandapola, 13-17-iv-1933; one female, Parrawella Ride, Nuwara Eliya, 16-v-1938; one male, Sita Eliya, 14-v-1938; eleven males and three females, Hakgala, 31-viii-1929 and iv- and v-1938.

Bionomics, &c. During a collecting trip to Hakgala (*ca* 5,500 feet) in April and May, 1938, I was enabled to observe something of the habits of this insect. Previously, I had regarded it as a rarity, but, on learning to recognize the song of the males, it was found to be a common insect. The song is a chirp, audible at least 25 yards away, resembling the sound " chi chi chi chi chi — — — " — the i very short; and, by following up the sound, a number of males were located and captured. However, even when one had ascertained the position of a specimen to within a foot or two, it was by no means easy to detect, being well concealed by its leaf-like colour and form as it sat motionless in the midst of a mass of foliage. They were strictly nocturnal and, once seen, were not at all difficult to catch owing to their sluggish nature. Females were captured rarely as they do not betray their whereabouts by singing. One individual was observed at night eating tender, young leaves of *Toddalia asiatica* Lamk. Others were found feeding on the flowers of *Osbeckia* sp. growing in jungle. Several individuals of both sexes were brought to Colombo and kept alive in a cage in the hope of obtaining some information as to their breeding habits, but, although some of them lived over a month, no eggs were laid and copulation was not observed; the males occasionally stridulated however. In captivity they were fed on flowers of *Osbeckia* sp.

Zumala intermedia, sp. nov.

Plate XVII, figs. 3 and 4 and XVIII, figs. 5-10

Intermediate in size between *Z. robusta* Walk. and *Z. cingalensis* Walk. The pronotum in this species is proportionately much more strongly raised in the middle line than in either of the two species above mentioned and the tubercles along this line are very large. The principal transverse sulcus is well behind the middle in both sexes.

The genicular lobes, particularly those of the hind femora, are acutely pointed and produced. The fore femora are almost unarmed on the post-axial ventral carina—sometimes with one or two small tubercles—and bear 3 to 5 small tubercular spinules on the pre-axial carina. The mid femora bear 3 or 4 very small spinous tubercles on the pre-axial carina and 4 or 5 slightly larger ones on the post-axial. The hind femora bear 8 or 9 spinous tubercles on the outer ventral carina and 9 or 10 stout spinules on the inner.

The tegmina are shaped as shown in Plate XVII, figs. 3 and 4. The venation, as is to be expected in an organ which has lost its original function, shows considerable variation and the point of divergence of *Rs* from *R* is much more distal in many specimens than in the one shown in Plate XVII, fig. 4. The male tympanal organ (Plate XVII, fig. 3) is not so well developed as in *Z. cingalensis*, and the basal portion of *Sc* is less expanded anteriorly. The striations on the ventral surface of the file-bearing vein in the left tegmen are exceedingly fine, requiring a high power of the dissecting microscope to resolve them. I have counted between 70 and 75 striations to one mm., and the length of the file is about 3.25 mm.

The wings are quite rudimentary, not more than 2/7ths the length of the tegmina.

The tergites are angulately produced medially.

The male genitalia are figured in Plate XVIII, figs. 7 and 9. The tenth tergite is more narrowly excavated in the middle, between the two deflexed lateral lobes, than in *Z. cingalensis*, and forms, in posterior view, an arch of more than half a circle. The cerci are narrower at the base than in *Z. cingalensis*.

The ♀ supra-anal plate is ovate-angulate, tectate and medially carinate in preserved specimens. The ♀ cerci are stout at the base, suddenly narrowed at about half, incurved at the tips, and reach to about half the length of the supra-anal plate. The ovipositor bears, near the apex, two or three oblique ridges which are much less well developed in *Z. robusta* and *Z. cingalensis*. (Plate XVIII, fig. 10). The subgenital lamina is as in Plate XVIII, fig. 8.

Coloration (dried specimens). Dull green of rather a lighter shade than *Z. robusta*. Antennae green at base, gradually shading into light brown with no dark annulation. The face, and under surfaces generally, are whitish green. The lower border of lateral lobes of pronotum is suffused with opaque, chalky white.

Measurements.	♂ mm.	♀ mm.
Length of body	26.0 to 27.0	30 0 to 38 0 (minus ovipositor)
Length of pronotum	8.5 to 8.7	9 2 to 9.5
Breadth of pronotum	8.7 to 9.0	10.5 to 11 3
Length of tegmen	23.0 to 25.0	32 0 to 32.6
Breadth of tegmen	8.9 to 9.5	14.0 to 15.0
Length of fore femur	8.5 to 9.0	9.5 to 10 5
Length of hind femur	14 0	16.0 to 18.0
Length of ovipositor	—	16.0 to 17.5

Material examined. Nine males and eight females, all collected at Mousakanda, Gammaduwa, at an elevation of about 3,500 feet by Mr. W. W. A. Phillips and myself. They were taken in 1932-35, and in the following months: March, July, September, October, November, December; and were obtained by beating the branches of small jungle trees on the edge of a small patch of 'patana'—open grass land—surrounded by wind-swept forest. One or two were kept alive for a short time in Colombo and fed on leaves of *Eugenia jambolana,* which they ate quite readily although this tree does not grow at the elevation where they were captured. The photograph (Plate XIX) was taken of one of these living individuals on leaves of *Eugenia jambolana.*

The type, a male taken on 8-x-1932 will be deposited in the British Museum (Natural History). My grateful thanks are due to Mr. Phillips for his assistance in obtaining a good series of this interesting species.

REFERENCES TO LITERATURE

WALKER, F. 1869—*Cat. Derm. Salt. Brit. Mus.* Part II, pp. 413 416

PICTET, A. and DE SAUSSURE, H. 1892—*Icon. Saut. Vertes.*, pp. 11 and 24, Pl. III, figs. 18, a, b.

BRUNNER VON WATTENWYL, C. 1895—*Mon. Pseudophyll.*, pp. 11 and 49, 50, Pl. II, fig. 16

KIRBY, W. 1906—*Syn. Cat. Orthopt.* p. 298

UVAROV, B. P. 1927—Some Orthoptera of the Families Mantidae, Tettigoniidae, and Acrididae from Ceylon—*Ceylon J. Sci.* (B) XIV, p. 93

EXPLANATION OF PLATES

PLATE XVI *Zumala robusta* Walker, ♀

- Fig. 1. × 1½
- Fig. 2. face × 3
- Fig. 3. fore tibial organ, left, × 8
- Fig. 4. sternal plate × 5
- Fig. 5. ovipositor × 3

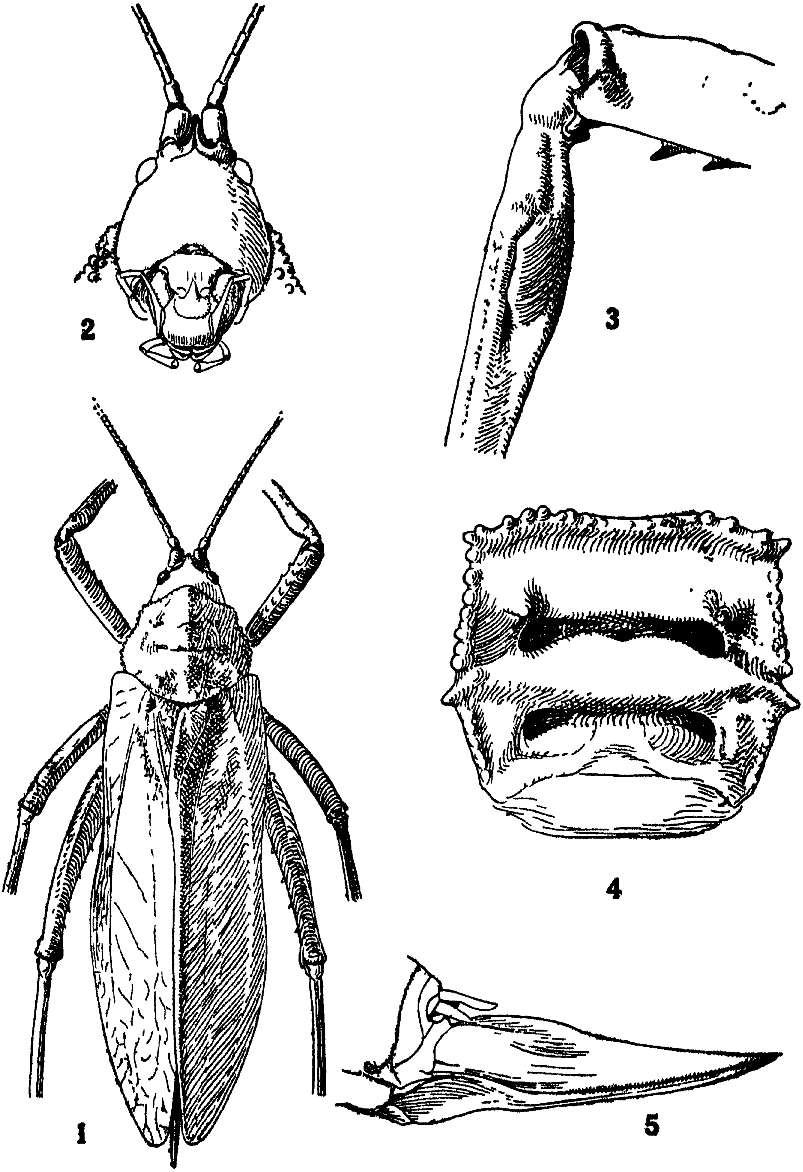
PLATE XVII

- Fig. 1. *Zumala cingalensis* Walker, ♂ × 2
- Fig. 2. „ „ „ ♀ × 2
- Fig. 3. *Zumala intermedia*, sp. nov. ♂ × 2
- Fig. 4. „ „ „ „ ♀ × 2

PLATE XVIII

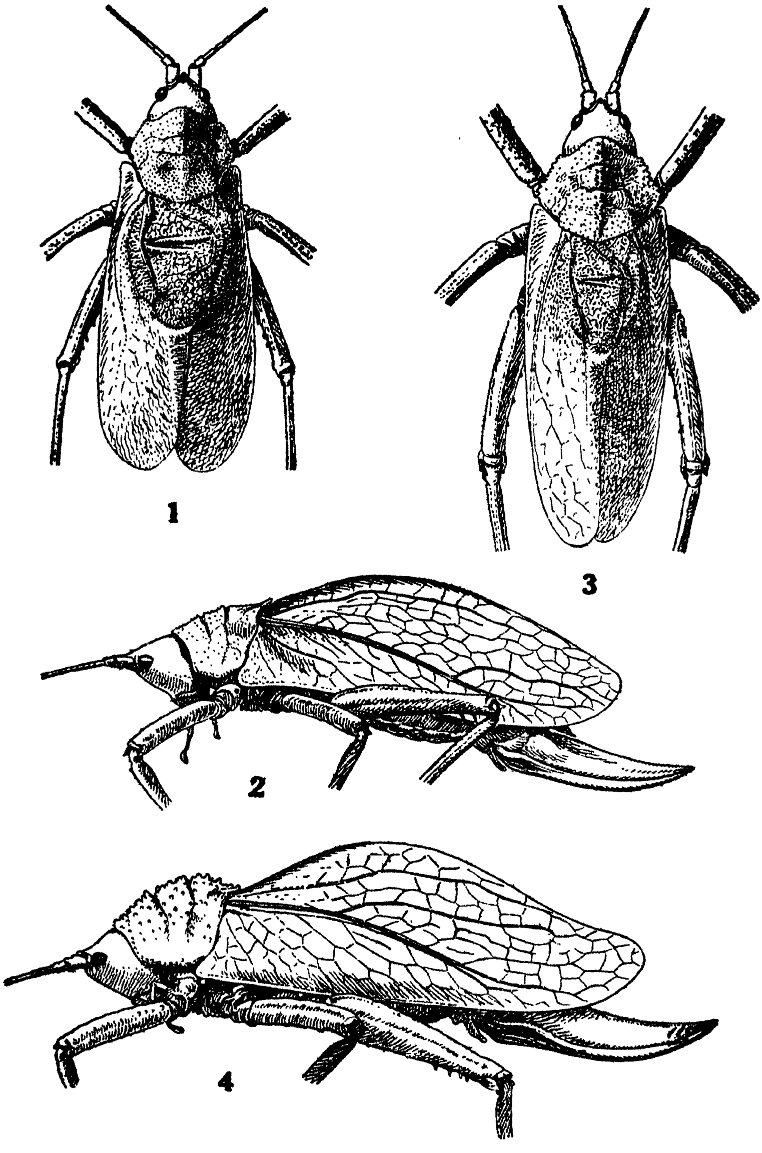
- Fig. 1. *Zumala cingalensis* Walker, ♂, head × 5
- Fig. 2. „ „ „ „ ♂, right tegmen × 3
- Fig. 3. „ „ „ „ ♂, genitalia, posterior × 5
- Fig. 4. „ „ „ „ ♂, right cercus × 18
- Fig. 5. *Zumala intermedia*, sp. nov. ♂, head × 5
- Fig. 6. „ „ „ „ ♀, sternal plate × 5
- Fig. 7. „ „ „ „ ♂, genitalia, posterior × 5
- Fig. 8. „ „ „ „ ♀, subgenital lamina × 5
- Fig. 9. „ „ „ „ ♂, right cercus × 18
- Fig. 10. „ „ „ „ ♀, terminal 5 mm. of ovipositor × 10

PLATE XIX *Zumala intermedia*, sp. nov., ♀ from life × 1



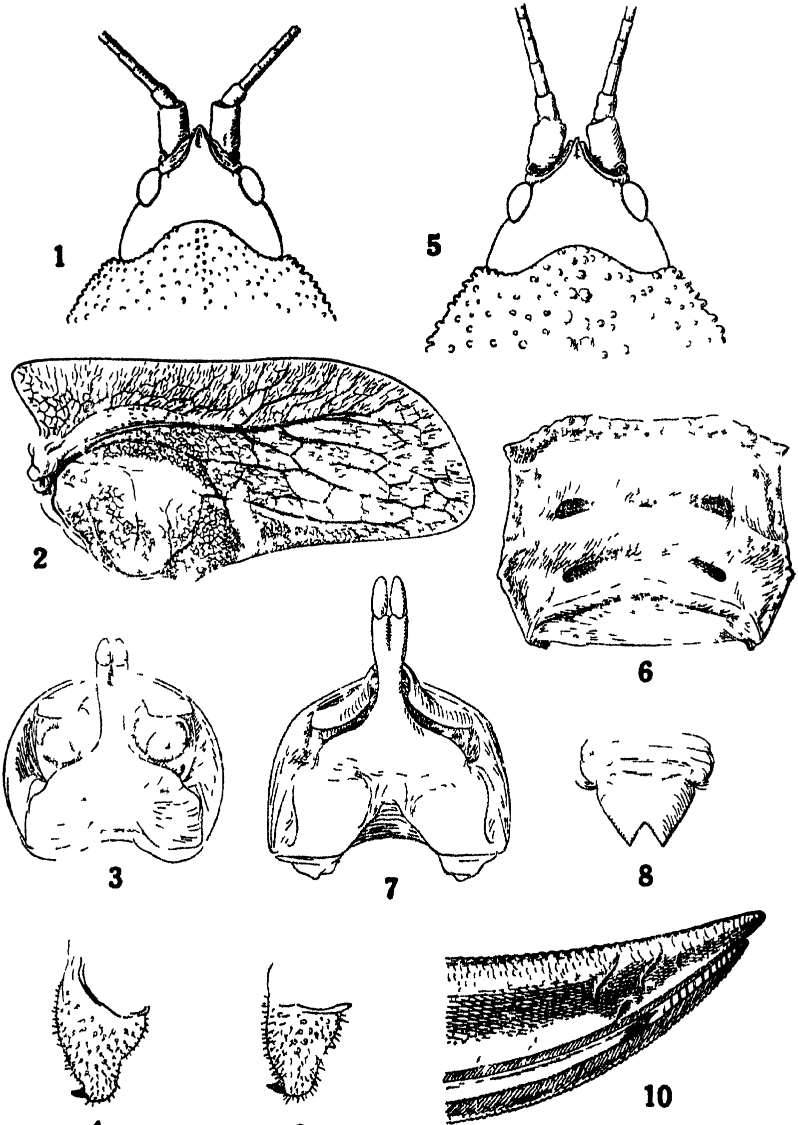
G M Henry del

Zumala robusta Walker



G. M. Henry del.

1 and 2. *Zumala cingalensis* Walker × 2
3 and 4. *Zumala intermedia*, sp. nov. × 2



G. M. Henry del

1-4. *Zumala cingalensis* Walker
5-10. *Zumala intermedia*, sp nov.

Zumala intermedia, sp. nov.

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

A New Tettigoniid Genus and Species from Ceylon

BY

G. M. HENRY, F.R.E.S.

Assistant in Systematic Entomology, Colombo Museum

(With One Plate)

The insect described in this paper belongs to the subfamily Pseudophyllinae and the tribe Phyllomimi.

Temnophylloides, gen. nov.

Related to *Temnophyllus* Redt. and *Zumala* Walk. but distinguished from both by the structure of the male tegmina which show no trace of stridulatory specialization.[1] From *Zumala* it is furthermore distinguished by having the prosternum unarmed and the tegmina truncate at apex.

Antennae much longer than the body, their basal joint comparatively long. Head as in *Zumala* but not so stoutly built. Fastigium of vertex sulcated, extending but little beyond the antennal scrobes.

Pronotum sharply rounded in front, very obtusely angulated behind; subtectiform; shaped much as in *Zumala*; not medially sulcate; covered with small tubercles which do not tend to form a biserial line along the middle. Lateral margins with a rather irregular row of strong, rounded tubercles. Two transverse sulci of which the posterior is well behind the middle.

Prosternum unarmed. Meso- and meta-sterna as in Plate XX, fig. 3. Mes- and met-episterna and epimera tuberculate. A series of strong tubercles on lower margin of mes-episternum just above coxal insertion.

[1] For description and figure of the male tegmen of *Temnophyllus speciosus* Brunner (genotype of *Temnophyllus*) see Hebard, 1922, *Proc. Acad. Nat. Sci. Philadelphia*, LXXIV, p. 194, Pl. XVII f 1.

Tegmina similar in both sexes with no stridulatory specialization in the male; the costal margin strongly lobate proximally as in related genera; apex truncate. Venation of both sexes as in Plate XX, fig. 5. Wings as in Plate XX, fig. 5.

Limbs resembling those of *Zumala*, but comparatively long. Fore coxae with a stout spine. All femora with rugged surface; their dorsal carinae tuberculate; their knee-lobes only moderately produced, not acute. Fore femora with a few small spinous tubercles on their pre-axial ventral carina; none on the post-axial. Mid femora with a few similar spinous tubercles on the pre-axial ventral carina, more on the post-axial. Hind femora little incrassated proximally, with each ventral carina armed, almost throughout its length, with a row of strong spines.

All tibiae roughly quadrangular in section; their spinulation sparse. No dorsal apical spines. Fore-tibial auditory organ conchate on both sides the opening fairly wide (see Plate XX, fig. 4). Tarsi as in above-named, allied genera.

Male genitalia as in figs. 8 and 9. Female supra-anal plate ovate, not bilobed. Ovipositor stout, shaped as in Plate XX, fig. 6, with strong oblique ridges on the distal portion.

Genotype: *Temnophylloides astridula*, sp. nov., described below.

Temnophylloides astridula, sp. nov.

Plate XX, figs. 1-9.

Head: Antennae twice (nearly three times in the male) the body length minus genitalia; green at base, changing to brown and then to black, with widely-spaced whitish annulae distally. Surface of head smooth.

Pronotum: Shaped as shown in Plate XX, figs. 1 and 2; covered fairly evenly, except in the middle of disc of lateral lobes, with small, shiny tubercles which are slightly larger along the median ridge than elsewhere. Margins of lateral lobes with an irregular row of much larger, rounded knobs; the ventral portion of pronotum, just below this row of knobs, is conspicuously shiny black in both sexes. The metazona is slightly concave on each side.

Meso- and meta-sternal plate as shown in Plate XX, fig. 3; this represents the female condition, but the male is very similar, only slightly narrower in proportion to the length.

Limbs: fore femur with 2-4 small spines on the distal part of pre-axial ventral carina. Fore tibia sparsely armed with small spinules on the two ventral carinae. Auditory openings much wider than in *Zumala robusta*, their opercula somewhat bullate (see Plate XX, fig. 4) the inner one slightly larger than the outer. Mid femur with 0-3 small spines on pre-axial ventral carina, 4-6 on the post-axial. Mid tibia with 3 or 4 very small spines on each of the lower carinae and one or two on the postero-dorsal carina. Hind femur comparatively slender, little incrassated proximally, its dorsal carina rather strongly tuberculate near the base; armed with 9-11 strong spines on the lower outer carina and 7-9 shorter ones on the lower inner carina, both rows extending almost the entire length of the femur. Hind tibia sparsely armed with small spines on the two lower carinae and with 4 or 5 very minute ones on the inner dorsal.

Venation and shape of tegmina and wings as shown in Plate XX, fig. 5.

Male genitalia as shown in Plate XX, figs. 8 and 9; supra-anal plate broadly ovate, very thin dorso-ventrally; Cerci cylindrical, stout, conical, straight until the apex where they curve inwards and terminate in a sharp chitinous hook· subgenital lamina broadly trough-shaped at base, curving upwards and with sides converging to form a pair of contiguous, short, cylindrical columns, each of which bears a large oval style (see Plate XX, fig. 6).

The female genitalia are as shown in figs. 6 and 7.

Coloration. Dull, rather dark green, paler below. A diffused, chalky white stripe on sides of head from the eye to pronotum. A black patch, which includes one or two colourless tubercles, on the ventral surface of the lateral margins of pronotum. The apical third of the ovipositor is black, the remainder pale chestnut.

Measurements in mm.	♂	♀
Length	40.0 to 45.0	50.0 (minus ovipositor)
Width of head at eyes	5.7	6.0
Length of pronotum	10.0	11.0
Width of pronotum	11.0	11.5
Length of tegmen	43.0 to 48.0	52.0
Width of tegmen near middle	14.0 to 15.0	18.0
Length of fore femur	13.0	14.0
Length of hind femur	21.5 to 23.0	23.0
Length of ovipositor (from middle of base laterally)	—	16.3

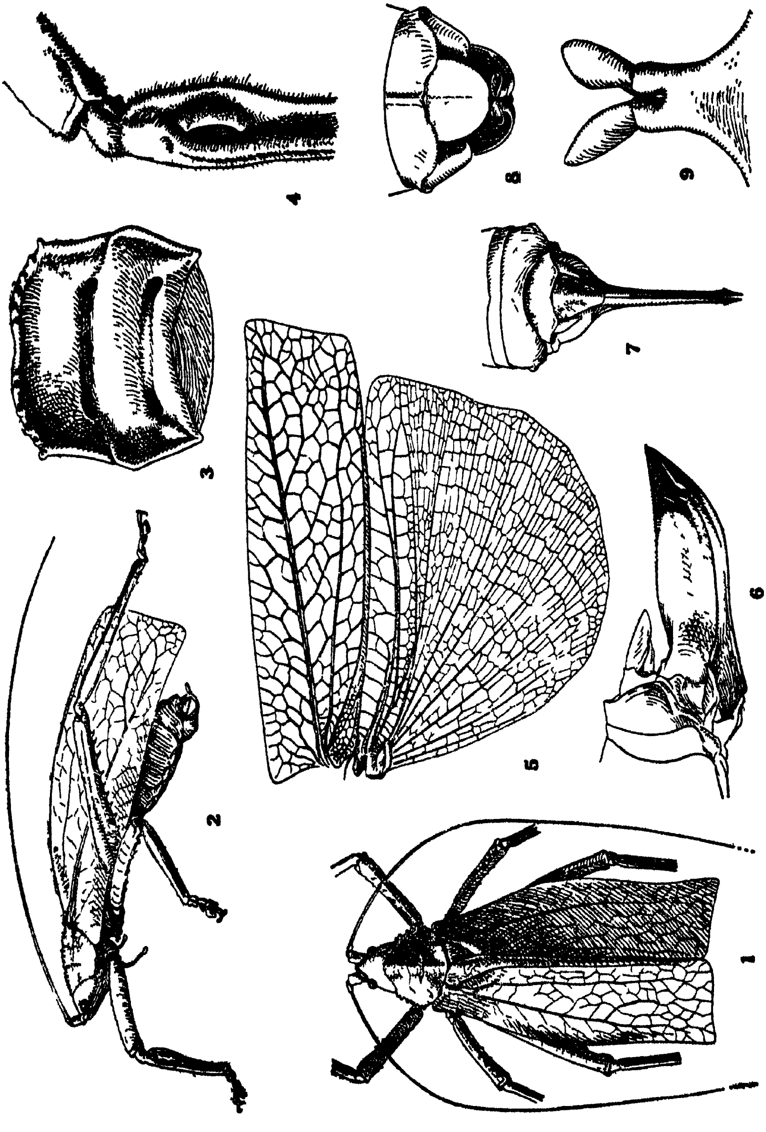
Material examined. Type ♂ Kitulgala (Province of Sabaragamuwa) circa 200-500 feet, 26-29-xii-1934; 2 ♂♂, Rakwana (Province of Sabaragamuwa) circa 1,200 feet, 30-iv-and 4-v-1929; 1 ♂ and 1 ♀, without locality labels, from an old collection made, probably, during the time when Mr. A. Haly was Director of the Colombo Museum (1875-1901). The type will be deposited in the British Museum (Natural History) on publication of this paper.

Ecology, &c. Both Kitulgala and Rakwana are situated in the wet zone in hilly country and receive a high and well-distributed rainfall. All the specimens taken by me were found among undergrowth in tall forest. During the day they flatten themselves on the upper surface of a leaf and are very inconspicuous.

EXPLANATION OF PLATE

PLATE XX *Temnophylloides astridula*, gen. et sp. nov.

Fig. 1. ♂ dorsal × 1
Fig. 2. ♂ lateral × 1
Fig. 3. ♀, sternal plate × 3
Fig. 4. ♂, left auditory organ × 5
Fig. 5. ♂, right tegmen and wing × 1·5
Fig. 6. ♀, ovipositor × 2·5
Fig. 7. ♀, genitalia, dorsal × 2·5
Fig. 8. ♂, genitalia, dorsal × 4
Fig. 9 ♂, subgenital lamina × 8



Temnophylloides astridula, gen. et sp. nov.

G M. Henry del

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

A New Colour Variety of Cobra from Ceylon & South India

BY

P. E. P. DERANIYAGALA, M.A. (Cantab.); A.M. (Harvard); F.L.S.; F.Z.S.

Acting Director, Colombo Museum, and Marine Biologist

(With One Plate)

The subdivision of the Indian Cobra *Naia naia* (Linné) has been based principally upon colour. Boulenger (1896) described six such Indian subspecies, but Stejneger (1907) disputed the accuracy of this method and based his classification upon pholidosis. Wall (1913) after examining many hundreds of Indian specimens was unable to improve upon Boulenger's system which is adhered to by others, for example de Rooij (1917), while Pope (1935) states that ' while the coloration is nearly everywhere variable, yet this variation can be correlated with geographical areas '. These opinions support the view that colour, although subject to a certain degree of individual variation, is of considerable subspecific value in *Naia naia*.

The majority of subspecies lack ocellate marks upon the dorsal surface of the hood, but three variations of such markings are known. One of them is modified into a spectacles shaped figure, which characterizes the cobras of peninsular India and Ceylon, and for this reason Boulenger (1896) assigned these cobras to the forma typica, at the same time drawing attention to the existence of two varieties he termed (*a*) and (*b*).

According to Wall (1913, pp. 248, 568) the spectacled cobra possesses a range of thirty ventral scales (170 to 200), *Naia naia oxiana* a range of eighteen (195 to 213), and *Naia naia fasciata*, a range of fourteen scales (179 to 194). The proportionately high range of ventrals in the first named supports Boulenger's view, and investigation reveals differences in colour, and other scale counts, which suggest that the spectacled cobra forms a northern as well as a southern race.

Averages of scale counts over a large series show that the scales across the hood are fewer in the northern than in the southern race. Apart from differences in scale counts, the latter race possesses individuals with ocelli between the head and the ' spectacles ' mark of the hood, markings hitherto unrecorded. Enquiries in India revealed that neither the Bombay Natural History Society nor the Indian Museum, Calcutta, possessed such individuals, but the Madras Government Museum contained two, which Dr. F. H. Gravely the Director kindly lent me for examination. In Ceylon such a cobra is known to the Sinhalese as a ' Bamunu Naia ' or Brahmin caste cobra, and such individuals are not uncommon, as will be seen from the following list :—

(1) One of a collection of eight from Veyangoda; (2) two of seven collected by the late Mr. Drummond Hay from several inland localities; (3) eight of sixteen in the Colombo Museum.

The following is a description of the new colour variety :

Naia naia colour variety **polyocellata** Plate XXI.

Dorsally varying shades of brown with or without dark transverse bands, and with thin, irregular, transverse, double bands of white[1], which are better defined posteriorly than anteriorly, and are more distinct in some specimens than in others. Expanded hood lighter anteriorly than remainder of body, and terminating posteriorly in a dark band bounded by a diffuse white band. The postoccipital ocelli, which are sometimes present, are seven to nine scale rows behind the head and usually three transverse scale rows anterior to the nuchal ' spectacles ' mark upon the hood. These ocelli are either circular (Plate XXI. fig. a.), transversely elongate (Plate XXI. fig. b.), slant posteriorly towards the sides, or are confluent, as many as five sometimes uniting to form a transverse bar (Plate XXI. fig. c). In females the ocelli are generally less distinct than in males and tend to be confluent. The white ' spectacles ' mark is nuchal in position and margined with black. It encloses two or more black spots, of which two form terminal ocelli. Ventrally *Naia naia* c. v. *polyocellata* is white with two to sixteen chocolate brown cross bands. When there are only a few such bands the ventrals are dusted with chocolate. In some Ceylon specimens, these dark bands are continued dorsally, a variation unknown in Indian cobras (Wall, 1924). The male is generally lighter in colour than the female.

---

[1] The relative positions of the ocelli, ' spectacles ' and white collar mark (Pl. XXI.) suggest that they are all derived from these white bands modified by the expansible hood.

Type. A female deposited in the British Museum. Total length 1550 mm.; tail 235 mm.; scale counts 31-21-15; ventrals 196; subcaudals 59; locality, near Polonnaruva.

Distribution. Ceylon and South India, probably as far north as 16° N. latitude. Specimens are known from Veyangoda, Rajagiriya, Matugama (Western Province); Polonnaruva (North-Central Province); near Elephant Pass (Northern Province); Kumbukätiya near Vällava (North-Western Province), Ceylon; and Madras, South India.

REFERENCES TO LITERATURE.

BOULENGER, G. A. 1896. *Cat. Snakes in Brit Mus*. p. 382.

DE ROOIJ, N. 1917. *Reptiles of the Indo-Austral Archipel*. 11. Leiden pp. 380-385.

POPE, C. 1935. *Herpetology of China*. Am. Mus. Nat. Hist.

STEJNEGER, L. 1907. *Herpetology of Japan*. pp. 394-396.

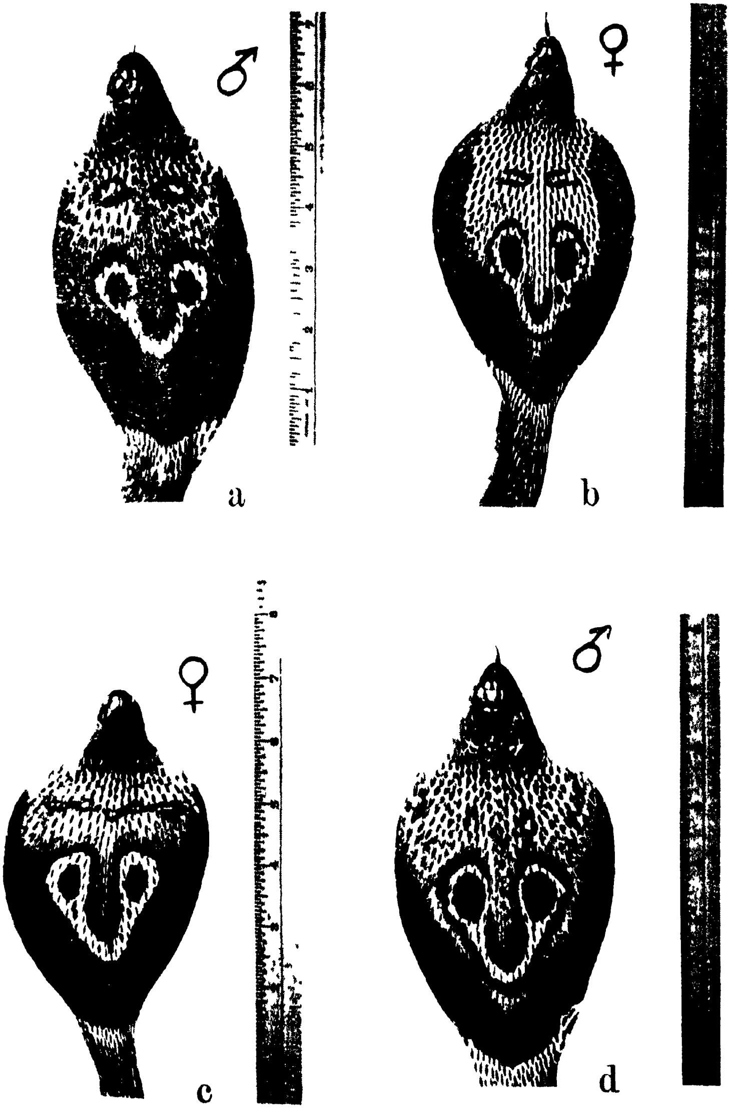
WALL, F. 1913. The Common Indian Snakes. *J. of Bomb. Nat. Hist. Soc.* Vol. XXII., No. 2. pp. 243-259.

WALL, F. 1924. Snakes collected at Annasigalla Estate. *Spolia Zeylanica* Vol. XII, p. 269.

EXPLANATION OF PLATE

PLATE XXI.

Expanded hoods of *Naia naia* colour variety *polyocellata*, displaying variation in the postoccipital ocelli (a) ♂, (b) ♀, (c) ♀, (d) ♂



Hood of *Naja naja* colour variety *polyocellata*, a new colour variety of cobra

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

Nests and Eggs of Ceylon Birds
Part II.

BY

W. W. A. PHILLIPS, F.L.S., F.Z.S., M.B.O.U.

(With Ten Plates)

Order PASSERES

Family Timaliidae

Subfamily LIOTRICHINAE Bush and Green Bulbuls

No. 14. **Ægithina tiphia multicolor** Gmelin (Plate XXII)

The Ceylon Iora

Iora tiphia. Common Bush-Bulbul. Legge 1880, p. 490

Ægithina tiphia zeylonica. Ceylon Iora. Wait 1931. No. 14, p. 29

Ægithina tiphia multicolor. Ceylon Iora. Stuart-Baker 1932. No. 363, Vol. 1, p. 319

The dainty little Iora is not uncommon throughout the lowlands and lower hills, to altitudes of about 2,500 feet, but it is rarely seen at higher elevations. It is essentially a bird of the open woodlands—a lover of large trees and tall hedge-rows. It may commonly be seen in roadside shade-trees and in large trees on jungle-boundaries, around paddy-fields, in clearings, in parks and in gardens, both in the wet zone and the dry. It is also found in South India, while allied races occur in Central and Northern India.

This bird builds a beautiful little nest that is in keeping with its own daintiness, but it is a nest that is difficult to find. Records of nests discovered in Ceylon are, therefore, not as numerous as one could wish.

Wait (p. 28) states that it ' appears to breed, intermittantly, from December to June ' and Legge (p. 493) that ' if different districts are considered, I believe it breeds all the year round '. I am, however, inclined to think that, in Ceylon, it generally conforms to the usual nesting seasons of the majority of the passerine birds, as commonly observed in the various zones.

In the Hill Zone, at Gammaduwa (2,500 ft. C. P.) I have seen a nest, containing fresh eggs on May 10th and Tunnard found a nest, with eggs, in the Gampola District (2/3,000 ft. C. P.) on the 3rd June. In the Kalutara District (W. P.) of the Wet Zone, Felsinger has found two nests towards the end of April, while in the Dry Zone I, have seen near Dambulla (C. P.) a nest, ready for eggs in March and Legge records one in the north of the Island in July. It seems probable, therefore, from this evidence, that, in common with so many other species, the Iora breeds chiefly during March, April and May, while it may continue nesting into June and July.

The nest is placed on the upper face of a slender, horizontal branch or in a small, upright fork, usually some 10 to 15 feet from the ground, in a leafy tree or a tall bush. Any suitable site from 6 ft. to 20 ft. from the ground may, however, be selected. Generally the site chosen is at the junction of one or more smaller twigs with a larger stem, the nest being attached by its base to the main stem and by its sides to the uprights. Although the nest may not be especially well concealed by the surrounding foliage, it is so small and compactly built that it is difficult to discover. One nest, that I closely examined, was some 10 feet from the ground on a horizontal branch in a tall open bush growing amongst thorn-scrub and lantana at the head of a paddy-field. It was a beautifully symetrical, flimsy-sided, deep cup, attached to the branch and surrounding twigs by bindings of cobwebs. The foundations of the nest enclosed the branch, a few bits of fibre and cobwebs being carried from side to side underneath, thus ensuring a firm anchorage to the structure. The inside of the cup, which measured 1¾ inches across and 1¼ inches in depth, was lined with very fine. dead grass-stems.

Another nest, described to me by Tunnard, was placed about 15 feet from the ground, between three upright twigs of an Accacia tree. It was more or less concealed by the leaves of a species of *Loranthus* parasite which was growing beside it. This nest was a deep cup of very fine grasses, beautifully swathed and coated with cobwebs. The material of the sides was woven round the three supporting twigs forming the fork in which the nest was lodged. In shape, this nest was a beautifully neat, rather deep cup, not unlike a miniature nest of the Paradise-Flycatcher (*Tchitrea paradisi ceylonensis*).

The Iora often sits very closely on her nest and is loathe to leave her eggs or young. She generally returns and settles down to brood again, immediately. Two eggs only are laid. They are slightly pointed or blunt ovals very pale creamy-grey in colour, with longish streaks of brownish-grey or bluish-grey running longitudinally down the egg.

Six eggs, in Stuart-Baker's collection, average 17.4 × 13.4 mm ; maxima 18.0 × 13.9 mm. and minima *16.3* × 13.9 and 17.8 × *12.9* mm.

No. 15. **Chloropsis aurifrons davidsoni** Stuart-Baker

The Malabar Chloropsis

Phyllornis malabaricus. Malabar Green Bulbul. Legge 1880, p. 488
Chloropsis aurifrons davidsoni. Malabar Chloropsis. Wait 1931. No. 15, p. 30.
Chloropsis aurifrons davidsoni. Malabar Chloropsis. Stuart-Baker. No. 369. Vol. I, p. 325

The Malabar Chloropsis is so like the Green-winged Chloropsis (*Cholorpsis jerdoni*) that, unless one has the opportunity to examine the birds closely it is extremely difficult to distinguish them. In Ceylon, the present species is the rarer of the two, though it is found, scattered in small numbers, throughout the hills, as well as over the whole of the low-country. It occurs also throughout the west coast of India, as far north as the Bombay presidency.

The nest appears to have been found once only in Ceylon, on January 25th in the Ratnapura District (Sab.), but Felsinger tells me that he has, on two occasions during February, observed the young in the Kalutara District (W. P.). It would seem likely, therefore, that, in the low-country wet zone, this bird nests unusually early in the year—that is during January and February. Possibly this habit may be a contributory cause of the scarcity of records of its nesting, the chief reason being the care with which the bird conceals the nest amongst the foliage of the tree in which it is built.

Stuart-Baker (p. 325) thus describes the nest that was discovered by Mr. W. A. T. Kellow in the Ratnapura District, on January 25th.

" The nest is a pendent cradle of tiny twigs, a leaf or two, roots and grass with a few scraps of moss on the outside. The lining consists merely of a few roots rather finer than the rest of those used in the construction of the nest. The materials are well put together, a few cobwebs being used to help bind them and also to attach them to the prongs of the small fork in which it was built. The branch was an outer one of a small tree and about 15 feet from the ground. the tree standing in comparatively open forest but close to much heavier, bigger forest ".

The eggs numbered two only. They were very pale cream, one very faintly blotched with pale reddish, the second with rather darker spots and irregular blotches of red-brown.

These two eggs average 21.0 × 15.05 mm.

No. 16. **Chloropsis Jerdoni** (Blyth) (Plate XXIII)

The Green-winged Chloropsis

Phyllornis jerdoni. Green Bulbul. Legge 1880, p. 485
Chloropsis jerdoni. Jerdon's Chloropsis. Wait 1931. No. 16, p. 31
Chloropsis jerdoni. Malabar Green-winged Chloropsis. Stuart-Baker 1932. No. 374, Vol. I, p. 327

The Green-winged Chloropsis is considerably more common than the Malabar Chloropsis and is, in fact, a relatively common species, but owing to its vivid green colouring, it often escapes notice amongst the foliage of the trees in which it seeks its food, and hence appears to be more uncommon than it really is. It is well distributed throughout the heavily wooded areas of the low-country and in the lower hills to about 3,500 feet altitude or occasionally a few hundred feet higher. Like the Malabar Chloropsis, it is generally seen in large, densely-foliaged trees, in gardens and parks, along roads and river-banks, around paddy-fields and village tanks, and on the outskirts of forests. It occurs, also, quite commonly, over the greater part of India.

Wait (p. 31) states that this species appears to have several broods, nesting operations beginning in November and December as soon as the north-easterly rains have set in and continuing until as late as May. I presume, however, that he refers, in this passage, chiefly to the dry zone. As in the case of the Malabar Chloropsis, the nest is very well concealed and not easy to find; authentic records of nests are, therefore, difficult to obtain.

In the Kalutara District of the low-country wet zone, Felsinger found nests with eggs, on the 4th and 11th February, respectively, and another nest, very recently vacated by the young, on March 16th. Legge (p. 486) states that he ' imagines ' it breeds in the Western Province in April and May. From this evidence it seems probable that it commences to breed, in the wet zone, in late January or early February and continues nesting until the arrival of the south-westerly monsoon rains towards the end of May.

In the hills, I have never come across a nest, so possibly the birds seen there usually descend to the low-country for breeding purposes. In the dry zone, I have found several nests, recently vacated by the young, in April and I think that, in this zone, from November or December until about March and April is the general nesting season.

The nest is suspended by the rim in a slender, lateral fork, generally some 6 to 20 feet from the ground in a dense-foliaged tree. It is usually well concealed by the surrounding foliage and is most difficult to see while the leaves remain on the tree. Two nests, found by Felsinger in the Kalutara District, were in the tops of tall rubber trees (*Hevea brazillensis*); they were well shielded from view by the foliage.

The nest is a small, neat cup, of strips of fine, towlike, inner bark, dead grass and fibres suspended in a slender fork. The strips of soft inner bark, which help to form the outer cup, are carried over and round the twigs of the fork and then built into the sides of the nest, thus suspending it from the supporting twigs. The lining is of fine grass or fibre and generally quite scanty. The inside cup measures about 3 inches in diameter by 1½ inches in depth.

Although three eggs have sometimes been found in nests on the Indian mainland, I do not think that more than two have ever been seen in a nest in Ceylon.

The eggs are like miniature oriols eggs, slightly pointed, glossless ovals. The ground colour is pure white or creamy-white, marked with small dark-brown or purple-black dots mixed with a few short, hair-like lines, always more numerous at the larger end and sometimes forming an indefinite ring. In a few eggs, the spots and lines are reddish-brown instead of black and in all there are a few secondary spots and marks of inky purple or very dark grey, nearly as dark as the primary markings.

Thirty eggs, in Stuart-Baker's collection, average 21.1 × 15.1 mm.; maxima 23.1 × 15.8 mm.; minima 19.3 × 14.3 mm.

Family Pycnonotidae Bulbuls

No. 17. **Microscelis psaroides ganeesa** (Sykes) (Plate XXIV)

The Southern Indian Black Bulbul

Hypsipetes ganecsa. Black Bulbul. Legge 1880, p. 469

Microscelis psaroides ganeesa. Southern Indian Black Bulbul. Wait 1931. No. 17, p. 33

Microscelis psaroides ganeesa. Southern Indian Black Bulbul. Stuart-Baker 1932. No. 389, Vol. I, p. 343

The noisy Black Bulbul is common throughout the low-country wet zone, but its chief strongholds are the forests in the ravines and valleys of the foot hills of the hill zone. On a warm sunny morning, in their favourite haunts, their raucus calls echo throughout the jungles, while they fly, with undulating flight and noisy chatter, from tree to tree or congregate in numbers to feed in some wild fig-tree. They ascend, at times, to the mountainous jungles around Nuwara Eliya, but it is doubtful whether they breed at altitudes higher than about 5,000 ft. In the arid jungles of the dry zone, the species is uncommon and very local in its distribution. The Ceylon race of this bird occurs also in South India; it is found in all the hill ranges south of Matheran, in the Garwilgarh hills, in Berar, and in the Nilgiris up to 8,000 ft. Other races occur, further north, in many parts of India and Burma.

This bulbul has, in the hills, two quite distinct nesting seasons. The principal season is in the Spring. Nesting commences during the latter half of March and continues into May, the peak of the season being during April. A break then occurs, while the south-west monsoon is blowing, nesting operation being recommenced towards the end of July and continued into September. The great majority of birds breed during the Spring, the Autumn being much less popular. It would appear likely, therefore, that some birds are double brooded in the Spring, while others await the Autumn before rearing their second broods. In the wet zone (low-country) Legge (p. 471) states that the species breeds from January until March, but I have found nests in April and May, only. Possibly it may occasionally nest in the Autumn, in this zone too, if the weather conditions are favourable and it has failed to rear a brood or broods in the Spring, but I have not yet come across a case.

The nest is generally placed in a fork, some 15 to 25 feet from the ground, in a lateral branch of a tree growing either in a glade or on the outskirts of the forest. Usually a tree in open forest or a clearing is favoured, but I have known a nest to be built in an ornamental tree in a bungalow garden and several in lateral branches in tall *Gravillias* growing, as shade trees, in tea-fields adjourning the jungle.

The nest is a rather untidy, but substantial, shallow cup, loosely constructed and resting rather more in the fork than on it. The foundations are generally of dead leaves, mixed with dry plant and creeper stems, green moss and the mid-ribs of decayed leaves. Often dead bamboo leaves, or bits of ribbon grass, are selected and on one occasion a large piece of dead cardamom leaf was the chief component. The outside is frequently decorated with green moss and in the more humid jungles the nest may be composed chiefly of this material. I have also seen a few strands of cobweb used to decorate the outer walls, and one nest had a length of small fleshy-leafed creeper bound round it. The inner cup is generally rather scantily lined with mid ribs of decayed leaves, wiry leaf-stalks, or *Casurina* needles. The nests vary but little from the typical and usually measure about 5 to 6 inches in diameter, by 3 to 4 inches in height; while the inner cup is 3½ inches in diameter, by 1½ in depth. The walls of some nests measure as much as an inch in thickness.

The eggs invariably number two only. They are rather long ovals with somewhat obtuse small ends. The general colour is white or slightly pinkish-white, speckled with smallish red brown or purple-brown spots, or occasionally with purplish-grey. As a series, Stuart-Baker remarks that, they differ in being less boldly and handsomely marked than those of other members of the same genus. Blotched eggs are quite exceptional, but eggs with a distinctly pinkish ground colour are met with occasionally. Some eggs are considerably more densely spotted than others.

Forty-five eggs, in Stuart-Baker's collection, average 26.6 × 19.6 mm.; maxima *29.0* × 19.4 mm. and 27.0 × *20.0* mm.; minima *23.8* × 18.5 mm. and 24.2 × *17.6* mm. A very small egg, one of a pair taken at Mousakande, Gammaduwa (altitude 3,000 feet) on 7th August. 1930, measures only 23.8 × 18.5 mm.

No. 18. **Molpastes cafer cafer** (Linn.)

The Ceylon Red-vented Bulbul

Pycnonotus haemorrhous. Madras Bulbul. Legge 1880, p. 482

Molpastes haemorrhous haemorrhous. Madras Red-vented Bulbul. Wait 1931. No. 18, p. 83

Molpastes cafer cafer. Ceylon Red-vented Bulbul. Stuart-Baker 1938. No. 398, Vol. I, p. 353

The Red-vented Bulbul is one of the most common birds in the Island; its confiding, and at times aggressive, habits are continually bringing it to our notice. It habitually seeks the companionship of man and his dwellings, and thrives in his vicinity. Throughout the cultivated areas of the whole Island, with the exception of the highest hills, it is very well distributed but it avoids the wilder, uninhabited areas and denser forest tracts. The Ceylon race of this species is found also in South India, up to altitudes as high as 6,000 feet in the Nilgiris.

Being a most adaptable bird, it breeds more or less all the year round, but the Spring and the early Autumn are, as with other species, the most popular seasons. Each pair will raise, or attempt to raise at least two, if not three or more broods during the year. At medium altitudes in the hills, the nests are to be found chiefly during March, April and May and again during July, August and September, but I do not think that there is any month throughout the year in which I have not seen at least one nest. Likewise in the low-country wet zone, in the Kalutara and Colombo Districts, the months of February, March and April, and July and August, are the most popular, but, again, nests may be found occasionally in all the other months. In the dry zone, November until April is the chief nesting season, but I have found nests, in the driest weather, during June, and do not doubt that individual pairs may occasionally be found nesting at any time of the year.

The adaptability of the species is well illustrated by its varied choice of sites in which to build its nest. Undoubtedly, the most usual choice is in a fork of a branch in a bush or low, bushy tree in a garden, hedge-row, chena or scrub jungle, but I have seen nests in creepers, on buildings, in or close to verandahs and amongst the slender branches of trees, some twenty feet or more from the ground. In gardens, a favourite site is the top of a pergola, or on a metal arch covered with creepers or roses, but a small fork in a lime-tree or flowering shrub is also a very frequent choice. Generally, little care is taken to conceal the nest from view, and for this reason, as Stuart-Baker remarks (p. 354) many of them are robbed by other birds, snakes or lizards.

One unusual site, observed quite recently, was in a small lateral fork, some fifteen feet from the ground, of a tree standing in a group in the middle of a dry paddy-field. This nest was more solidly built than usual and was shaded from the heat of the sun by a dead palmyrah-palm leaf which had lodged in the foliage immediately above the nest. Another nest was built at the base of a shield-like frond of a clump of ferns, attached, some twenty feet from the ground, to the trunk of a large jungle tree growing on the outskirts of a village. This nest rested on one shield-like frond and was shaded from sun and rain by another immediately above it.

Just as the sites vary greatly so do the nests themselves. Many are well built, solidly-made cups, others, however, are so flimsy and carelessly put together that the eggs are easily visible through the bottoms. Again, some are moderately deep, well-shaped cups while others are shallow and irregular. Between these extremes we may find many graduations. Speaking generally, however, the nest is a fairly deep, loosely-built cup of grass, rootlets, midribs of leaves and fern-stems, lined with the finest, wiry, grass-stems or fern-roots. Often, I have seen nests constructed chiefly of fine rootlets and bits of dead plant-stems, but the most popular material is certainly wiry grass. Frequently the outside of the nest is bound with a spray or a runner of *Desmodium*, with the clover-like leaflets still attached, while often it is decorated with a small cobweb which both decorates and holds it together. Although the cup is usually lined with finest grass or rootlets, the reddish or black root-fibres of ferns are also a very popular material. Sometimes the lining is generous, but more usually somewhat scanty.

The total diameter of the nest varies between 3 and 4 inches and the height between 2 and 3 inches, the inside diameter of the cup being usually 2⅛ inches and the depth 1¼ inches, but I have seen nests as deep as 1¾ inches and others as shallow as one inch only.

Both sexes help to build the nest and both take their turn at incubating the eggs. The period of incubation is said to be 13 days.

Legge (p. 484) is in error in stating that the eggs are three or four in number. I have examined scores of nests of this species but have never yet met with more than three eggs, and I have never heard of four being seen by any one else. Either three or two is the usual full clutch, but it is interesting to note that, out of thirteen nests from the Kalutara District (W. P. Wet Zone) of which I have kept records, ten have contained two eggs each and three three eggs each, while out of twenty-seven from Gammaduwa 3,000 feet (C. P. Hill Zone) ten have contained two each and seventeen three each. It would seem likely therefore, from this evidence, that in the cooler climate of the hills, this Bulbul generally lays three eggs, while in the hotter climate of the lowlands it usually lays two only. The eggs vary much in size and shape as well as in colour. Stuart-Baker states " The ground-colour ranges from a pink or cream, so pale as to appear almost white, to a fairly warm pink or creamy buff. In most eggs the markings consist of numerous small blotches, or specks, or small spots scattered freely over the whole egg, nearly always more numerous at the larger end and often forming rings or caps on that half.

These markings may be of almost any shade of red, red-brown or purple-brown but, in the great majority of eggs, there is a decided purple tinge. In addition to these primary markings, nearly all eggs have secondary blotches of pale lavander or inky grey, in some sparse, in others so numerous as to give a purple-grey tint to the larger end. In some eggs the markings form very definite rings and caps, and in these eggs they are generally scanty over the smaller half of the egg. In a few eggs the small blotches become larger and bolder and, as these are nearly always proportionately fewer in number, such eggs are very handsome. Two extreme specimens of these latter type have in one instance a salmon ground with bold blotches of deep red and purply black with clouds of inky grey; the other has a cream ground with irregular splashes and blotches of deep red, running into one another, mixed with small secondary marks of grey ".

A very unusual pair of eggs, found near Kalutara, has the ground-colour a pale cream-grey minutely freckled with lilac-grey in one egg and with lilac-red in the other. Another pair has a warm pink ground freely speckled with bright pale brick-red and more heavily speckled at the larger end, where the speckles are mixed with the secondary markings of grey.

One hundred eggs, in Stuart-Baker's collection average 21.1 × 15.5 mm.; maxima *24.3* × 16.5 mm.; and 20.2 × *16.9* mm.; minima *19.0* × 15.1 mm.; and 21.4 × *15.0* mm.

No. 19 **Iole icterica.** Strickland.

The Yellow-browed Bulbul

Criniger ictericus. Forest Bulbul. Legge 1880, p. 472
Iole icterica. Yellow-browed Bulbul. Wait 1931. No. 19. p. 34
Iole icterica. Yellow-browed Bulbul. Stuart-Baker 1932. No. 419 Vol. I, p. 386

Unlike the Red-vented Bulbul, which is a bird of cultivated areas and clearings, the Yellow-browed Bulbul is essentially a forest dweller. It is common throughout the forests of the low country, both in the dry zone and in the wet, but outside the heavy forest tracts it is rarely encountered. It ascends the hills to altitudes of about 3,500 feet, or sometimes a little higher, but it is not generally so common in the mid-country forests as it is in those of the lowlands.

In India, Stuart-Baker (p. 386) states that it is found almost throughout the South-Western side, from about Mahableswar to Cape Cormorin, and that it occurs from almost the level of the plains up to 6,000 or perhaps 7,000 feet in some of the hills.

Although a common resident in certain areas, records of the nesting of this bulbul are not numerous. From the little evidence available, it would appear that, like so many other species in Ceylon, the Yellow-browed Bulbul has two definite nesting seasons, the one in the Spring (March and April) and the other in the early Autumn (August and September). In the Kalutara and Colombo Districts (W. P.) of the wet zone, Felsinger has found nests in March and April while I have found one, near Kitulgala (Sab.), in early September. The only nest recorded by Legge was found by him in the Pasdun-Korale (W. P.) forests in August. At Gammaduwa (3,000 feet C. P.) in the hill zone, I have found nests only during August, but I feel convinced that the birds breed in that area in the Spring also. From the Dry Zone, no definite records are available, but I have seen vacated nests in May and June after many of the leaves have commenced to fall and from this evidence it seems probable that the chief season must be during March and April or perhaps even earlier. It is doubtful whether any nests are to be found during the dry period between June and October in this Zone.

The nest is generally suspended, by its rim, from two horizontal twigs or in a small lateral fork, some five to ten feet from the ground, in a small bushy tree or sapling. One nest, that I examined, was placed some eight feet from the ground level, in a tall seed-bearing tea bush growing besides a patch of jungle; another was in a fork in the branch of a small tree growing in the open close beside a large river, while a third, in a most unusual position, was about nine feet up in a feathery-leafed creeper growing on the trunk of a tree in tall but rather open forest. Usually, the nest is on or close to the bank of a stream.

Generally, the nest is composed of dead leaves, strips of tow-like inner bark and plant or creeper stems felted together into a fairly compact but light, shallow cup; moss is also sometimes used. The inner cup is usually lined with fine, blackish fern roots and stems, but occasionally a little grass is used, either alone or in addition to fern roots. Sometimes, also, the outside of the nest is decorated and bound with a few lengths of cob-web, sometimes used also to strengthen the binding of the rim to the supporting twigs.

The nest is often rather longer than broad and measures about $3\frac{3}{4} \times 3\frac{1}{4}$ inches in diameter by about 2 inches in height, while the inner cup is about $2\frac{1}{2} \times 2\frac{1}{4}$ inches in diameter, by $1\frac{1}{4}$ inches in depth.

In Ceylon, the full clutch of eggs invariably numbers two only. The eggs are rather long ovals, attractively coloured and are all of one type. The ground colour varies, according to Stuart-Baker, from a very pale creamy-pink, almost white, to a warm salmon-pink. The markings consist of innumerable specks, freckles, or, in a few cases, of very small irregular blotches ranging in colour from pale reddish-pink to a rich light red. The markings cover the whole egg and are generally slightly more numerous at the larger ends, though very rarely forming a cap. One pair of eggs, taken by me near Kitulgala in the Kelani Valley, are unusual. They are bright salmon pink with deep chestnut spots and inky secondary blotches. Stuart-Baker remarks that these are very extraordinary eggs and can be matched by some of those of the Indian Rusty-vented Babbler a species not found within 1,000 miles of Ceylon.

Thirty-six eggs in Stuart-Baker's collection average 23.1 × 16.6 mm.; maxima 25.0 × 17.2 mm.; minima *21.3* × 16.3 mm. and 22.0 × *15.5* mm.

No. 20 **Pycnonotus melanicterus** (Gmelin).

The Black-capped Bulbul

Rubigula melanictera. Black-headed Bulbul. Legge 1880. p. 477
Pycnonotus melanicterus. Black-capped Bulbul. Wait 1931. No. 20, p. 34
Pycnonotus melanicterus. Black-capped Bulbul. Stuart-Baker No. 429, Vol. I, p. 394

This attractive little bulbul is peculiar to Ceylon. It is fairly common throughout the greater part of the low-country, on the outskirts of forests, in low scrub-jungle, in glades, clearings and shady ravines and in other well-wooded localities. In the arid tracts of the south-east and the extreme north, however, where the rainfall is under 40 inches per annum, it is rare, if not entirely absent. In the Hills, it occurs in suitably wooded localities to altitudes of 5,000 feet, but is not generally so common in the highlands as in the lowlands.

Nests are generally found during March and April in the Kalutara and Ratnapura Districts of the low-country wet zone, but, as a nest was found near Kalutara on the 19th July, the season would appear to extend well into the south-west monsoon period. It is doubtful, however, whether in this zone, there is a subsidiary season later in the year. In the hills, there are either two distinct nesting seasons or breeding is carried on during the greater part of the year, which is not unlikely. The majority of nests have been found during March and April, but breeding either continues on into September or re-starts towards the end of June and continues into that month. At Gammaduwa (2,500/3,000 ft. C.P.) I have found nests during June and Legge (p. 479) records the finding of one " in the Kandyan Province " during September. Authentic records of nests in the low-country dry zone are almost non-existant, but breeding probably commences in February, or possibly earlier in the year, and continues until April or early May.

The nests are placed in a variety of positions. I have generally found them amongst twigs, at the top of small trees and saplings, growing either in or near the jungle. One nest was in the topmost twigs of a small rubber tree growing in a clearing bounded by forest; another was some ten feet from the ground in a bundle of thorns tied to the trunk of a coconut palm to deter unauthorised climbers; another was in a creeper covering a tree trunk and others have been in low trees and bushes in scrub-jungle and on the outskirts of forests. Legge records the finding of a nest of this species, built on the top of a stump in the jungle; a most unusual site.

In shape, the nest is of the usual bulbul type; a small, rather flimsy shallow cup, measuring about 3 inches in diameter by 3½ inches in height with an inside measurement of 2½ inches in diameter and 1½ inches in depth. It is generally placed in a small lateral fork or among twigs and is well concealed by the surrounding foliage.

A variety of materials are used in its construction, the most popular being leaf, or fern-stalks, but rootlets are also frequently used. In the base of the nest there are almost invariably one or more withered leaves assisting to form the foundation; a dead leaf or two may, in fact, be said to be a characteristic feature of the nest of the Black-capped Bulbul. The lining, generally scanty, is usually of a finer quality of the same materials used in the construction of the nest, but occasionally a little fine dead grass is added. The materials are rather loosely and casually assembled, the finished nest, although neat inside, being rather an untidy and often a somewhat flimsy structure.

It has been stated, by Stuart-Baker and others, that the number of eggs laid is either two or three, but I am doubtful whether, normally, more than two are laid. I think that it is possible that some of the nests and eggs referred to this species have, in reality, belonged to the Red-vented Bulbul and hence confusion has arisen, both with regard to the number of eggs laid and also to their colour and markings. Certainly all those nests that I have authenticated, without any shadow of doubt, have contained two only.

The eggs are rather short, elliptical ovals, considerably smaller than those of the Red-vented Bulbul. In colour, they are typically, dull pink, densely speckled and occasionally blotched with light-red-brown. Stuart-Baker (p. 394) describes other types of eggs as belonging to this species but, as stated above, I think that in some cases abnormal eggs of the Red-vented Bulbul have been mistaken for, and confused with, the eggs of this species.

One curious but authentic pair of eggs, taken by me and sent to Stuart-Baker, are described by him as being a beautiful pale salmon, one egg with great purple-red blotches at the small end, the other boldly splashed and speckled with purple-red over the whole surface.

Twenty-eight eggs, in Stuart-Baker's collection, average 20.9 × 15.7 mm.; maxima *22.0* × 16.2 mm.; and 21.1 × *17.0* mm.; minima *19.0* × 16.0 mm. and 21.9 × *14.2* mm.

No. 21. **Pycnonotus luteolus** (Lesson) (Plate XXV.)

The White-browed Bulbul

Ixos luteolus. White-eyebrowed Bulbul. Legge 1880. p. 475
Pycnonotus luteolus. White-browed Bulbul. Wait 1931. No. 21, p. 86
Pycnonotus luteolus. White-browed Bulbul. Stuart-Baker. No. 433, Vol. I, p. 398

The White-browed Bulbul is another of our very common birds. It is not quite so common as the Red-vented Bulbul, in gardens and enclosed areas in towns and villages, but, in bush-country, lantana and other scrub jungles, in glades and clearings and along roads and stream-beds in forest areas, especially in the dry zone, it is often much the commoner of the two species. It occurs very plentifully, in suitable country, throughout the whole of the low-country and ascends the hills to 3,000 feet or occasionally higher.

On the mainland, it is found throughout the greater part of the plains and lower hills of South India, northwards to Baroda on the west and Midnapore in the east.

In keeping with so many other birds in Ceylon, this bulbul generally commences to lay in February or March. In the low-country wet zone I have found nests chiefly in March but the season evidently may extend from about January or early February until well into May or perhaps later if the weather remains favourable. In the dry zone, the main stronghold of the species in Ceylon, nests have been found in each month from December until June, but the most popular months are undoubtedly February and March. On the morning of February 16th, 1936, while walking along a footpath through a few hundred yards of scrub jungle in the North-Central Province, although I was not searching for nests, I came upon four of this species, one after the other, all containing eggs. Two of these nests were in small thorny bushes and two were among the foliage of low, overhanging branches of large trees. An occasional nest may also be found during other months of the year, but the White-browed Bulbul does not appear to be so irregular in its breeding as a Red-vented Bulbul.

Although I have but few records from the Hills, it would appear that the favourite season in that area is during March, April and May.

The nest of this Bulbul is a shallow cup, very similar to, but generally slightly larger than that of the Red-vented Bulbul. It is, however, rarely placed more than a few feet from the ground. I cannot recollect having seen a nest placed higher than six or seven feet from the ground, the majority having been between three and four feet, with an occasional one even lower.

The nest is often more or less suspended in a small fork, or placed amongst a few twigs or a fork in an upright branch, and it is frequently attached to one or more twigs by bindings of cobweb. A small fork in the centre of a low thorn bush, growing rather in the open, is perhaps the most favoured site and road sides, village gardens and beside tracks through scrub the favourite haunts.

Fine plant, flower or creeper stalks, grass-stems and rootlets are the most popular materials for the construction of the nest, which is loosely and irregularly put together, the outside of the nest being untidy, but the inside quite a neat, though flimsy cup. The lining is scanty and is generally of fine grass, but I have seen fine rootlets and wiry fern-stalks, quite red in colour, used. Occasionally a few dead leaves may be used in the foundations, but sometimes the nest is so flimsy and the material so scanty that the eggs may be seen through the bottom. The nest measures about 3 inches in diameter by 2 inches in depth.

Normally two eggs only are laid. I have never met with more although Legge gives the number as being " from two to four ". In shape the eggs are decidedly long, longer and generally slightly larger than those of the Red-vented Bulbul. In colour they are very similar to those of the Red-vented Bulbul but, taken as a series, they give an impression of a difference that is hard to define. Heavily blotched eggs are very exceptional, most eggs being speckled rather than blotched, while the markings are more evenly distributed. The brown-tinted eggs, with profuse strippling of reddish-brown, so typical of the Pycnonotus group, are common but these eggs are browner and more reddish than in most of the eggs of this genus.

Sixty eggs in Stuart-Baker's collection average 22.9 × 9.15 mm.; maxima *25.5* × 15.6 mm. and 24.6 × *17.0* mm.; minima *19.0* × 15.6 mm. and 23 8 × *15.0* mm.

No. 22. **Kelaartia penicillata** (Blyth) (Plates XXVI and XXVII)

The Yellow-eared Bulbul

Kelaartia penicillata. Yellow-eared Bulbul. Legge 1880, p. 480
Kelaartia penicillata. Yellow-eared Bulbul. Wait 1931. No. 22, p. 37
Kelaartia penicillata. Yellow-eared Bulbul. Stuart-Baker 1932. No. 443, Vol. I, p. 408

The Yellow-eared Bulbul is another species that is peculiar to our Island. It is confined to, and generally common in, the forests and well-wooded areas throughout the hills of the Central Mountain zone. Although plentiful at high altitudes it rarely descends below 3,000 feet.

This Bulbul has two well defined nesting seasons, the one in the Spring and other in the early Autumn. Of the two, that of the Autumn appears to be the most general. I have examined upwards of a hundred nests of this bird and of seventy-four of them have kept detailed records. These records show that, of this number, thirty were found during the Spring months and forty-four during the Autumn. The distribution, by months, was as follows:—February (late) two; March twelve; April fourteen; May (early) two, both with young; July (late) two; August, sixteen; September, eighteen; October, seven, mostly with young; November (early) one, with young. From this evidence, it is clear that the Spring season commences in late February and early March, and finishes in late April, while the Autumn season commences in late July and early August and ends in late September or early October. These times coincide with the usual seasons of many species that nest twice in a year in our hills. It seems probable that each pair of birds nests during both seasons, rearing at least two broods during the year.

The most favoured sites for the nests are upright forks or collections of twigs some ten or fifteen feet from the ground amongst the denser foliage towards the tops of tall, small-leafed shrubs or bushy-saplings in, or on the outskirts of, dense forests. Cups formed by twigs, sprouting from pollarded branches or stems, are also very popular sites I have often, however, found the nests in quite open situations in low shrubs in the jungle, placed not more than four feet from the ground. I have also seen nests built in 'nillu' shrubs under heavy forests shade. On a tea-estate, where I resided for some year, there were several plantations of unpruned tea-bushes, reserved for seed, on the outskirts of the reserve forest land. These bushes, being closely planted, had grown to heights of fifteen to twenty feet and were very popular as nesting resorts of the Yellow-eared Bulbuls.

The nest itself is much more substantially built than that of any other species of bulbul that I have seen. It is quite a solid cup, measuring about 4½ inches in diameter and 3 inches in height, built largely of green moss. In the foundations there are often a few pieces of semi-decayed leaf-matter, bits of dead grass and plant stems, with some rootlets amongst the moss, while the lining of the cup is generally composed of fine fern and other rootlets, mid-ribs of decayed leaves or fern stems, usually either black or reddish-brown. With the exception of the lining, some nests are composed almost entirely of green moss, while others have a large amount of other materials mixed with the moss. The inner cup measures about 2½ inches in diameter and 1½ inches in depth.

Invariably only two eggs are laid. They are of the usual bulbul type, but slightly larger than the eggs of the Red-vented Bulbul. In colour, the ground is usually pure white, with moderate-sized blotches, spots and specks of purple-brown and secondary markings of the same character, of deep inky grey, always subordinate to the primary markings and sometimes practically absent. In some eggs, the markings are scattered all over the surface and are scarcely more numerous at the larger than at the smaller end but in the majority they form zones around the larger end. Eggs with a pale pinkish ground and the whole surface blotched and speckled with reddish-brown, with purple secondary markings are also not uncommon. In the majority of eggs of this type, the markings coalesce to form a ring or zone round the larger end.

Forty eggs, in Stuart-Baker's collection, average 23.4 × 16 7 mm.; maxima *26.1* × 16.5 mm. and 23.2 × *17.33* mm.; minima 21.1 × 15.5 mm. Stuart-Baker remarks that his smallest egg is exceptionally small; the next smallest measure 22 0 × 15 7 mm. and 23 2 × 16.0 mm.

Family Turdidae Thrushes

Subfamily BRACHYPTERYGINAE Blue Chats

No. 23. **Larvivora brunnea brunnea** Hodgson

The Indian Blue Chat

Larvivora brunnea. Indian Wood Chat. Legge 1880. p. 446
Larvivora brunnea Himalayan Blue Chat. Wait 1931. No. 28, p. 45
Larvivora brunnea brunnea. Indian Blue Chat. Stuart Baker 1933. No. 484, p. 4 Vol. II

The Blue Chat comes as a north-east monsoon migrant, in October and November and leaves again towards the end of March and in April. During its visit, it is moderately common in the dense, humid forests of the hills above 3,000 feet and, in the Ratnapura District in the south-west of the main ranges, at altitudes as low as 1,000 feet.

The majority of the birds arrive in their yearling plumage. On a misty night, when migration has been in progress, as many as seven have come into my bungalow, attracted by the lights. All have been either females or birds of the year.

According to Stuart-Baker, this species nests, during May and June, in the Himalayas from Kashmir and Garhwal to Sikkim and Bhutan. The nest is placed on the ground, generally well concealed in a bank, often close to some jungle-path, or in a natural hollow or a ditch.

Most nests are made chiefly of dead leaves, moss and a few rootlets and lined with hair, often with a few feathers. The eggs are a beautiful unspotted, pale-blue.

Subfamily SAXICOLINAE Chats

No. 24. **Saxicola caprata atrata** (Kelaart) (Plate XXVIII.)

The Southern Indian Pied Bush-chat

Pratincola bicolor. Hill Bush-Chat. Legge 1880, p. 480

Saxicola caprata atrata. Southern Indian Pied Bush Chat. Wait 1931, No. 23, p. 39

Saxicola caprata atrata. Southern Indian Stone Chat. Stuart-Baker 1933, No. 493, p. 17, Vol. II

The Pied Bush-Chat is quite a common bird within its range, but, in Ceylon, its habitat is restricted to the grasslands of the central mountain ranges of the Uva and Central Provinces; it is rarely seen below 3,500 feet. It is found only on some of the few remaining patanas or grass-lands in the Dimbula district, on the downs of the Bopats and the Horton Plains, on the grassy patanas and rocky hill-sides around Nuwera Eliya and beyond, to Uda Pussellawa and the slopes of the Uva hill-basin.

In South India, it occurs in Travancore, South Mysore and the Palni and Nilgiri hills, above 3,500 feet.

The Bush-chat is an attractive little bird, whose habit of perching on the topmost twig of a bush, the tip of a mana-grass stem, a post or a telegraph wire, brings it to common notice. Its nest however does not appear to have been discovered, very frequently, in Ceylon. Yet, it is not difficult to find if looked for, in suitable places and at the proper time of the year.

So far as I have been able to ascertain, there is only one breeding season, during the year, and that season is rather more restricted than that of the majority of our birds.

Unless the north-east monsoon weather is unusually prolonged, nest building generally commences during the latter part of February or early in March. Towards the end of March, nests may be expected to contain either eggs of advanced incubation or young. The season continues throughout April but occupied nests are rarely found after the first week in May. Probably some early nesting pairs are double brooded, but nothing definite is known.

Wait (p. 40) gives the breeding season for this species as being from February to June, but I do not think that, normally, many occupied nests will be found after the beginning of May.

The nest is generally placed on or near the ground and usually under the roots of a tuft of grass or in a crevice in a grassy bank. It is, as a rule, well concealed by the surrounding grass, which presumably is the reason why nests have not been found more frequently. A nest found by me on March 29th (1938) was placed amongst the roots of a grass-tuft on a steep, roadside bank, bordering the main Hakgalla-Welimada road. It was built so well under the roots of the tuft that the dead grass at the base overhung the nest, sheltering it and concealing it from observation above. It was surrounded by longish grass and was found only through the hen bird flying off it.

In South India, this Chat is reported often to build its nest in holes in garden or retaining walls and even sometimes in crevices in walls of dwelling or out-houses, or tucked away under the eaves; but in Ceylon, I have not heard of any nests being found in like situations. I have, however, a record of one, found by Mr. Felsinger, in a hole in the side of a ditch.

The nest is a fairly substantial, but externally untidy, structure of dead blades of grass and rootlets, swathed round and lined with finer material of the same kind. It measures 3 inches or more across, with a cup in the centre measuring about 2¾ inches across by 1½ inches in depth. The lining is often scanty The nest shown in Plate XXVIII has been somewhat exposed, by parting the grass and removing some of the overhanging blades.

Although in South India three to five eggs are laid by this species, in Ceylon three eggs only is the normal number. Mrs. Lushington has, however, met with four eggs on two occasions, once on the Mattakellie patanas in Dimbula and again at Patipola. The female, only, incubates the eggs.

In shape the eggs are short, broad ovals, only occasionally pointed at the smaller end. The texture is rather fine and close but there is little or no gloss. The ground colour is very pale bluish-green, pale sea-blue, pale creamy or buff-stone, or, occasionally a dull greenish-grey. The markings consist of numerous, small, irregular blotches and speckles of reddish-brown over the whole surface of the egg They often form a well-marked ring at the larger end. Stuart-Baker remarks that clutches of these eggs frequently contain one egg quite different from the rest, a characteristic found in many Turdidæ, whatever the sub-family to which they belong

Fifty eggs, chiefly from South India, in Stuart-Baker's collection, average 19.5 × 15.2 mm.; maxima *21.0* × 15.2 and 20.0 × *16.2* mm.; minima *17.5* × 14.1 and 17.7 × *14.0* mm.

Subfamily PHOENICURINAE Bluethroats and Robins

No. 25. **Cyanosylvia suecica pallidogularis** (Sarudny)

The Eastern Red-spotted Blue-throat.

Cyanecula suecica. Red-spotted Blue-throat. Legge 1880. p. 443
Cyanosylvia suecica pallidogularis. Red-spotted Blue-throat. Wait 1931. No. 24, p. 41
Cyanosylvia suecica pallidogularis. Eastern Red-spotted Blue-throat. Stuart-Baker 1933. No. 537, p. 77, Vol. II

One of our very rare north-east migrants, the Eastern Red-spotted Blue-throat is found occasionally in the hills of the Central Province during the period November to April. Stuart-Baker states that it nests in Western Turkistan and Trans-Caspia, laying four greenish or brownish olive eggs in a nest of dead grass, leaves and rootlets, lined with grass and placed amongst the roots of grass-tufts or bushes growing on a bank or in a piece of swampy land.

No. 26. **Saxicoloides fulicata fulicata** (Linn) (Plates XXIX and XXX)

The Black-backed Indian Robin

Thamnobia fulicata. Black Robin. Legge 1880. p. 440
Saxicoloides fulicata fulicata. Black-backed Indian Robin. Wait 1931. No. 25, p. 42
Saxicoloides fulicata fulicata. Black-backed Indian Robin. Stuart-Baker 1933. No. 556, p. 93, Vol. II

Of our many familiar birds, the little ' Black Robin ' is one of the best known. Like the Common Bulbul, it appears to seek the companionship of man and the doubtful protection afforded by his close proximity. It commonly frequents gardens and compounds in towns and villages, often entering the verandahs and perching on the walls and roofs of dwellings. Frequently, however, it is also found in ' chenas ', clearings and waste-lands away from the vicinity of habitations, but it avoids the depths of the jungle and stretches of wide open country. Throughout the greater part of the whole of the low-country and lower hills, it is a familiar species, but it is even more common in the dry zone, especially in the North-Central Province, than in the damper districts. In the Central and Uva Provinces, it rarely ascends the hills above about 5,000 feet where, in the grass-country, its place is taken by the Pied Bushchat (*Saxicola caprata atrata*). It is not however uncommon in some of the tea growing districts at nearly that altitude.

In South India, this sub-species is also common, its territory extending northwards, according to Stuart-Baker (p. 93, Vol. II.), roughly to a line drawn across the Peninsula from Ahmadnugger in the west to the Godaveri river in the east. Northwards of this line another race is found.

Stuart-Baker states that the breeding season in Ceylon may be said to be all the year round, for there is no month in which eggs have not been taken. It is, however, in my experience, exceptional to find a nest during the period November to the end of February. My records show that, in the hills, egg-laying normally commences towards the end of March and continues in full swing during April, May and June. There is then a lull, nesting recommencing early in August and continuing until towards the end of September. Of sixty nests, found in the hills, of which I have records, the monthly distribution is as follows:—March (end) 3; April 10; May 12; June 10; July 2; August 12; September 7 (mostly with young) and October 1 (young about to fly). This evidence goes to show that, in common with so many other birds in Ceylon, the chief nesting season is during April, May and June, and this is followed by a supplementary season during August and September. The majority of pairs nest at least twice and I think that many of them, as well as nesting twice during the main season, breed again during the secondary season—that is to say they nest three or more times during the year.

In the low-country wet zone, egg-laying seems to commence at about the same time as in the hills but, in this zone, I have not found the species nesting again during the second half of the year. My records show that the season commences in March and continues into July, with the peak during May. Possibly however, further research will show that nests may also be found later in the year.

In the dry zone also, I have not met with nests later than July. April, May and June seem to be the most popular months, but probable egg-laying often begins in March—if not earlier—in this zone.

In the choice of sites for its nests, the taste of the Black-Robin are truly catholic; it will commonly build in recesses and crevices in banks, rocks, walls and tree-stumps, beneath rocks and boulders, in niches in buildings and in holes amongst roots. It will, in fact, place its nest in any odd corner that it considers suitable to receive it.

In the hills, the almost vertical banks of road cuttings provide many popular sites, both in the earth banks and in the rock faces, but numerous nests may also be found in the sides of, or almost beneath boulders, behind roots in banks, in stumps and in niches in old buildings and retaining walls. In towns and villages, both in the low-country and in the hills, niches and ledges in walls and buildings are favourite sites but nests are also common in stumps and rocks in the gardens and compounds.

In the dry zone, I have frequently found nests of this bird in cavities in the sides of tall termite hills, especially those that have been cut away, vertically. I have also seen nests built in behind the sticks in the walls of mud and wattle dwellings. Unusual sites have been in a young coconut palm, growing in a compound, the the nest being placed in the angle formed by the junction of one of the fronds with the main stem; another nest was in a fold in an upright leaf of a palmyrah palm seedling, growing near a chena; another was in a 'chattie' or small water-pot, hung in the verandah of a village dwelling house and another was in the old nest of a Jungle Wren-Warbler (*Prinia sylvatica valida*) built in the crown of a low-growing, wild date-palm, in scrub jungle.

Often the nest is on, or almost on, the ground and very rarely is it more than a few feet above the ground level—unless it is in a vertical bank of a cutting, when it may sometimes be as much as nine or ten feet above the road level. Generally, little effort is made to conceal the nest from human eye, though occasionally, it is quite cleverly hidden. The species suffers greatly from the depredations of snakes, rats and carnivorous animals, which attack both eggs and young and I am doubtful whether even five per cent. of the eggs laid produce adult birds. Very occasionally two broods may be raised in the same nest, but often the second brood is raised in a new nest built in the vicinity of the old one.

The nest is a ragged collection of rootlets, bits of dead grass, decaying leaves and other vegetable matter, loosely put together so as almost to fill the niche in which it is placed if the niche be a small one, or, if large, to form a pad some three or four inches across. In the centre of this collection is the cup for the eggs, neatly lined with finer grasses or rootlets and about an inch, or rather more, in depth. The whole collection is often so loosely put together that it will fall apart if it be handled. In many nests, I have found a piece or pieces of cast snake-skin amongst the vegetable matter, apparently included as a decoration; occasionally also one or two feathers or bits of white paper are included, probably for the same reason. The male bird helps to build the nest and to feed the young, but never assists in the incubation of the eggs.

The eggs usually number two only but sometimes three are laid. Three seems to be a more common number in the hills than in the lowlands. Of fifty-five nests examined in the hills, forty-two have contained two eggs or young only, and thirteen, three; while in the low-country, only two of eighteen nests contained three eggs each and one, four. As however, one of the latter was infertile and stale, it may have been of a previous brood. The newly hatched young are naked and black skinned.

The eggs are rather long ovals; the texture is only moderately fine, the shell fragile and either glossless or only faintly glossed. The ground colour is pale greenish, greyish or yellowish-white—never pure white. The markings vary from rather large specks to small blotches of various shades of reddish-brown, or, less often, greyish-brown, with others underlying them of a neutral or lavender tint. Both primary and secondary markings are distributed fairly evenly and densely over the whole surface, but not so densely as to hide the ground-colour. They are generally more numerous towards the larger end than elsewhere, but seldom form distinct rings or caps. In most eggs, the secondary markings are scarcely visible but in some they are dominant and give a very grey tone to the whole colour of the egg.

One hundred eggs, in Stuart-Baker's collection, average 20.8 × 14.8 mm.; maxima *23.9* × 15.0 and 21.3 × *15.9* mm.; minima *18 3* × 14.5 and 20. 6 × ***14.0*** mm.

No. 27. **Copsychus saularis ceylonensis** Sclater (Plate XXXI)

The Ceylon Magpie-Robin

Copsychus saularis. Magpie-Robin. Legge 1880. p. 433
Copsychus saularis ceylonensis. Ceylon Magpie-Robin. Wait 1931. No. 26, p. 43
Copsychus saularis ceylonensis. Ceylon Magpie Robin. Stuart-Baker 1933. No. 560, p. 101, Vol. II.

The Magpie—or Pied-Robin is another of our very familiar birds. It is common to altitudes of 5,000 feet and occasionally higher altitudes. Within its range, there are few gardens, either in town or country that are not haunted by a pair. Further afield, it is more frequently met with around cultivation than in the purely jungle areas where, in the depths of the forests, its place is taken by the next species—the Shama.

Although magpie-robins, of one race or another, are common over the greater part of the Indian area, this sub-species is confined to Ceylon, except possibly for a small area in the extreme south of Travancore, where the robins appear to be more akin to the Ceylon form than to the Indian.

In the hills, the nesting season generally commences during the latter part of February or early in March, varying by a few weeks according to the duration of the north-east monsoon. The peak of the egg-laying season is during April and throughout this month and during May nests may be commonly found with eggs or newly hatched young. During June and July an occasional nest containing eggs or young, may be found and again during August and early September they are rather more common. After the end of September however, I have no records of occupied nests.

The nesting season in the low-country wet zone is similar to that in the hills. Nests with eggs may be found from February until early August, but in this area also the peak of the egg-laying season is during March and April.

I think that there can be no doubt that the Ceylon Magpie-Robin, is double-brooded. But, as so many nests are destroyed by lizards, snakes, rats and small carnivorous animals, it is always difficult to decide whether a pair under observation are raising a second brood or are making a second attempt to rear their first family. Probably much less than 20 per cent. of the eggs laid by this species ever hatch out and are successfully reared to maturity. I have known nest after nest to be destroyed by some enemy, and often the adult bird falls a victim together with her eggs or young.

In the dry zone, the season is rather earlier. Legge (p. 435) states that ' In the North it nests as early as November and continues breeding throughout the North-East monsoon '. This statement appears to be correct; nests may be found, especially in the very dry districts of the extreme North, during November and December, but in the North-Central Province, I have also commonly found occupied nests during April and May and on two occasions I have found nests, the one containing eggs and the other young, in July. In this zone, probably two and possibly three clutches are laid; breeding seems to go on intermittently during nearly seven months.

Although the nest is normally placed in a natural hole or small cavity in the trunk or a large branch of a tree, at a height of ten to fifteen feet from the ground, the Magpie-Robin does not always confine itself to such sites. Often the nest is in a hollow post or decayed tree-trunk not more than four or five feet from the ground; sometimes it is in a roof, or a cavity in a wall or a niche in a building and, on several occasions, I have found it in a hole in the side of a termite mound and in the sides of roadside borrow-pits

In the lowlands, a hollow, often started by a Woodpecker, in the trunk of a coconut palm is a very favourite site, while sometimes a hole in the thatch of a village hut is used. Although the nesting hole is as a rule not more than fifteen to twenty feet from the ground, I have occasionally seen nests quite thirty feet up. Sometimes this bird will select curious positions for its nest; I once found one, containing three young, in an old chatty or water-pot, hanging on the wall of a village dwelling, another, recorded by Legge, was built in a plaited coconut-leaf basket, such as is commonly used by villagers to protect their ripening plantains. In favourite sites, Mrs. Lushington, has on more than one occasion found a new nest built on the top of an old one.

The nest is a loose, untidy pad shaped to fit in the bottom of the hole in which it is placed. Sometimes this pad is fairly thick and bulky, with a slight depression in the centre to hold the eggs, but usually it is a mere scanty lining to the hole.

The materials used are generally those that come handiest in the particular locality in which the nest is situated. In the hills, bits of roots, rootlets, plants, fern stems and the mid-ribs of decayed leaves are in general use while, in the lowlands, coconut and kitul-palm fibres are favourite materials. Occasionally bits of paper and other refuse have been found in nests near dwellings. The material is loosely put together and will rapidly fall apart if the nest is taken from the hole.

The full compliment of eggs is generally three, but four are not uncommon. In the hills, two of eight nests examined recently, contained four eggs while the remainder contained three each. Of nineteen nests in the lowlands, however, only two contained four eggs or young; seven three eggs, four, two only (in one case incubated) and five, one only. In common with the general tendency, therefore, this species would appear to produce larger clutches in the cooler climate of the hills than in the heat of the lowlands. Both birds are believed to take part in the incubation.

The egg is normally rather a long oval, the texture fine and close, and the shell stout and moderately glossy. The ground-colour varies from pale sea-green, pale blue or pale yellowish-green to a darker shade of the same colours. In the majority of clutches the eggs are boldly and profusely blotched, over the whole surface, with primary

14——J. N. 81289 (1/39)

markings of light to dark, reddish-brown, or dark amber-brown, with underlying colours of pale lavender and purple grey. In most eggs the markings are numerous, distinct and with the ground-colour showing up well; in others the markings are even more numerous but less well defined and obliterating nearly all the ground-colour, whilst in others again the blotches are reduced to small spots or even specks. In nearly all, the markings are more numerous at the larger end than elsewhere, but rings or caps are rare.

Fifty eggs, in Stuart-Baker's collection, average 23.1 × 17.3 mm.; maxima *25.4* × 16.3 and 24.2 × *18.0* mm.; minima *21.0* × 17.1 and 21.4 × *16.0* mm.

No. 28. **Kittacincla malabarica indica** Stuart-Baker

The Indian Shama.

Cittocincla macrura. Long-tailed Robin. Legge 1880. p. 437
Kittocincla macroura indica. Indian Shama. Wait 1931. No. 27, p. 44
Kittacincla malabarica indica. Indian Shama. Stuart-Baker 1933. No. 563, p. 104, Vol. II

The Shama, one of our best songsters, is unfortunately of very retiring disposition; it is rarely seen near human habitation and, in the jungles, its song is much more frequently heard than the bird seen. It is, however, quite a common bird throughout the forests of the dry-zone. It is found in both scrub jungle and heavy forest, but appears to prefer the dense undergrowth of the latter.

In the wet-zone jungles of the south-west districts, it is not nearly so common; it is, in fact, rare in, if not altogether absent from, many of the forest tracts in the Kalutara and Galle areas. In some districts, it ranges into the hills to altitudes of over 3000 feet, but is generally uncommon above about 1500 feet and undoubtedly prefers the hot, dry lowlands.

It is found over the greater part of India, Burma and Tenasserim, to Siam, Yunnan and North China.

The Shama appears to have a much more restricted breeding season than the Magpie-Robin. Wait (p. 44) states that he has found eggs from February to June but the majority breed during March, April and May. I have found young almost ready to fly on the 1st May, but I have also found fresh eggs in a nest on the 10th of the same month. It is probable that, normally, this species is single brooded; no indications of a second brood have been noticed and probably birds found with eggs late in May or in June have lost their first clutch.

The nest is generally placed in a hole in a tree-trunk, dead stump or similar situation amongst the undergrowth in dense forest. Usually a hole between four and six feet from the ground is selected, but I once came across one, some ten feet from the ground, in a hollow branch of a tree growing beside the path on which I was riding. Externally, there is rarely any evidence that a hole is occupied, the great majority of nests being discovered through the hen-bird suddenly flying out. It is believed that only the hen-bird incubates the eggs, though it is possible that the cock-bird may brood them at night. Both birds feed the young.

The nest is much like that of the Magpie-Robin, with the exception that many more dead leaves are used in its construction. The cavity in the trunk or a stump is generally filled within about four inches of the entrance hole, with dead leaves, bits of dead plant stems, grasses and rootlets, then a rough pad or lining of rootlets, midribs of decayed leaves or like material is added and the nest is complete. Shallow holes have often just a slight pad, roughly shaped in the bottom, while deep cavities are filled with material, chiefly composed of dead leaves, before the lining pad is added.

While in India, the eggs generally number four and occasionally five, in Ceylon three is almost the invariable rule. I have never seen, or heard of more than three eggs in a nest of this species.

In appearance, they are like small, dull-coloured eggs of the Magpie-Robin. In shape they are rather short, blunt ovals, varying to moderately long ovals but always blunt at the small end. Normally, the colour is a pale greyish-white to pale, dull, greeny-blue ground, heavily blotched or freckled with reddish or umber-brown and with numerous secondary markings of lavender and grey.

Sixty-four eggs, from Ceylon and India, in Stuart-Baker's collection, average 22.0 × 17.2 mm.; maxima *24.1* × 17.— and 22.0 × *18.0* mm.; minima *18.2* × *15.4* mm.

EXPLANATION OF PLATES

PLATE XXII.

Nest of Ceylon Iora (*Ægithina tiphia multicolor*)

PLATE XXIII.

Green-winged Chloropsis (*Chloropsis jerdoni*) on nest.

PLATE XXIV.

Nest and eggs of the Southern Indian Black Bulbul (*Micoscelis psaroides ganeesa*)

PLATE XXV.

White-browed Bulbul (*Pycnonotus luteolus*) at nest

PLATE XXVI.

Yellow-eared Bulbul (*Kelaartia penicillata*) feeding young in nest

PLATE XXVII.

Nest and eggs of the Yellow-eared Bulbul (*Kelaartia penicillata*)

PLATE XXVIII.

Nest of South Indian Pied Bush-chat (*Saxicola caprata atrata*)

PLATE XXIX.

Cock Black-backed Indian Robin (*Saxicoloides fulicata fulicata*) feeding young (two) in nest.

PLATE XXX.

Two eggs of the Black-backed Indian Robin (*Saxicoloides fulicata fulicata*) laid in an old nest of a Jungle Wren-Warbler (*Prinia sylvatica valida*)

PLATE XXXI.

Cock Ceylon Magpie Robin (*Copsychus saularis ceylonensis*) entering nesting hole

Nest of Ceylon Iora (*Aegithina tiphia multicolor* [illegible])

Green winged Chloropsis (*Chloropsis jerdoni*) on nest

Nest and eggs of the Southern Indian Black Bulbul (*Microscelis psaroides ganeesa*)

White-browed Bulbul (*Pycnonotus luteolus*) at nest

Yellow-eared Bulbul (*Kelaartia penicillata*) feeding young in nest

[illegible]

Nest of South Indian Pied bushchat (*Saxicola caprata atrata*)

[illegible]

Two eggs of the Black-backed Indian Robin (*Saxicoloides fulicata fulicata*) laid in an old nest of a Jungle Wren Warbler *Prinia* [illegible]

Cock Ceylon Magpie Robin (*Copsychus saularis ceylonensis*) entering nesting hole

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

A new Leaf-monkey Hybrid (*Trachypithecus obscurus flavicauda* ♂ × *Semnopithecus priam thersites* ♀)

BY

W. C. OSMAN HILL, M.D.
Anatomy Department, Ceylon Medical College, Colombo

With Two Plates and Three Text-figures

I have in previous papers (Hill, 1935, 1937*b*) pointed out that the Leaf-monkeys are comparatively poor breeders in captivity, the most fertile forms, so far studied, being *Trachypithecus pileatus* (London Zoological Gardens; Zuckerman, 1931, and *Semnopithecus priam*, Hill, 1937*b*). Of the latter I have, up to the present, made observations upon six successful normal pregnancies. I have also previously (1936) alluded to the fact that, if Leaf-monkeys breed at all in captivity, it is quite as, if not more, likely to occur between males and females of different species as between true pairs of one species. In the case about to be described, breeding took place between species now referred to separate genera. The result is of considerable general interest, and has special importance to the student of Primate genetics.

The hybrid baby was born in my private collection at 9.30 A.M. on 1-X-38. It was born alive, apparently at, or very near, full term, but died shortly after as its umbilical cord was bitten off too short, and a small wound was made opening into the abdominal cavity. Although the menstrual history of the mother is somewhat confusing, I consider the baby to have been mature, or nearly so, from its general state of development, which was quite up to that observed in my experience with normally born infant Leaf-monkeys. The only character in favour of immaturity was a poorness in the development of the subcutaneous tissues, causing the skin to be thrown into large folds, especially on the dorsal surface.

PARENTS

The father was a well developed male of the race of the Dusky Leaf-monkey (*T. obscurus*) inhabiting the middle portion of the Malay

15——J. N. 81289 (1/39)

Peninsula, having been collected at Sritamarat in Peninsular Siam. He had been kept with the mother of the baby since September 1937, and copulation was frequently observed.

The mother was a young adult of the Ceylonese race of the Grey or Crested Langur (*S. priam*). To my knowledge she had not reached puberty when she was first put with the male. It is not quite certain when she first commenced menstruation, because this process is usually quite inconspicuous in this group of monkeys; and there is no accompanying or antecedent pudendal swelling, or discolouration. Her first recorded menstrual bleeding was on 27-XII-37, and this lasted for a few days. She again menstruated on 29-I-38, and at least once between this and 10-IV-38 when she bled again. This last period was an unusual one in respect to the amount of bleeding which took place, which was much greater than previously, and also lasted for a longer period (four days instead of the usual two or three) I am inclined to think that this last was not a menstrual bleeding, but one similar to those sometimes occurring during the first three months of human pregnancy. This view is supported by the fact that her baby was born only five and a half months later, whereas my previous estimate of the period of gestation in the Grey Langur was seven months at the minimum (Hill, 1937*b*). Copulation occurred on a few occasions during the pregnancy.

DESCRIPTION OF THE HYBRID

See Plates XXXII and XXXIII

Before giving a detailed account of the characters of the hybrid, it is well to outline briefly the main characteristics, so far as they are known, of pure-bred infants of the two parental species. The new born infant of *Semnopithecus priam* has been described in a former paper (Hill, 1937*a*) and was shown to agree with other known *Semnopitheci* in having a black coat. It also possesses the frontal whorl behind the brows. It is specifically identified, however, by the hair arrangement behind the vertex, where the rudiment of the sagittal crest is noticeable. The new born of *Trachypithecus obscurus* has not been described, but it is presumed to agree with other members assigned to that genus in respect of the orange or buff colouration of its new born young. This peculiarity is known, according to Pocock (1928, 1934,) to affect the species *T. pyrrhus*, *T. pileatus* and *T. potensiani*. The hair arrangement on the head in all these forms is a simple one; there is no frontal whorl and no attempt at a median sagittal crest on the vertex, all the hair streaming backwards in a simple manner.

Stiff brow hairs, which are prominent in *Semnopithecus* are comparatively poorly developed in *Trachypithecus*, in adults as well as newborn infants.

The general form and appearance of the hybrid infant resembles that of a specimen of *Kasi vetulus* of corresponding age, rather than of a *Semnopithecus*. This applies to facial expression; general shape of head; proportions of trunk to limbs, and arrangement of hair. This is undoubtedly due to the paternal influence, for, as I have shown previously (1934) *Trachypithecus* is more like *Kasi* than the latter resembles *Semnopithecus*.

(*a*) Metrical Characters

The following are the measurements of the hybrid infant. They should be compared with measurements of infants of *Semnopithecus* and *Kasi* given in my previous publications referred to above:

TABLE I.— Measurements of newborn female Hybrid Leaf-monkey (*Trachypithecus obscurus* × *Semnopithecus priam*)

1.	Body weight (fresh)	250 gm.
2.	Crown-rump length (extended)	180 mm.
3.	Tail length	228
4.	Thoraco-abdominal height	108
5.	Symphysion-thelion	89
6.	Symphysion-omphalion	40
7.	Bisacromial breadth	54
8.	Bimamamilliary breadth	18.5
9.	Bitrochanteric breadth	32
10.	Transverse diameter of thorax	31
11.	Sagittal diameter of thorax	31
12.	Thoracic girth	113
13.	Length of brachium	52
14.	Length of antebrachium	53
15.	Length of hand	47
16.	Length of thumb	8
17.	Breadth of hand	16
18.	Length of thigh	61
19.	Length of crus	60
20.	Malleolare-sole	5.5
21.	Length of foot	63
22.	Breadth of foot	14.5
23.	Glabella-maximum occipital point	51
24.	Maximum-cranial breadth	46
25.	Auricular height	33
26.	Nasion-inion	54.5
27.	Biauricular breadth	40
28.	Circumference of cranium	185
29.	Sagittal arc	95
30.	Transverse arc	

31.	Total head height (gnathion-vertex)	47
32.	Total facial height	25
33.	Upper facial height	21
34.	Bizygomatic breadth	41
35.	Nasal height	12
36.	Nasal breadth	9.5
37.	Septal breadth	2.0
38.	Interocular breadth	7.5
39.	Palpebral fissure	12
40.	Breadth of mouth	22
41.	Ear length	23
42.	Ear breadth	20.5

TABLE II.— *Indices of Hybrid Leaf-monkey*

Index	
Relative bisacromial diameter	50
Relative bitrochanteric diameter	29.6
Relative circumference of chest	104
Thoracic index	100
Relative bimammillary diameter	61
Relative position of nipple	83
Relative position of umbilicus	37
Relative length of upper extremity	141
Humero-radial index	98
Forearm-hand index	88.5
Relative length of thumb	17
Hand index	34
Relative length of lower extremity	116
Femoro-tibial index	98
Leg-foot index	104
Foot index	23
Intermembral index	120
Femoro-humeral index	85.5
Tibio-radial index	88
Foot-hand index	74.75
Relative size of head	87
Head-trunk index	40
Cephalic index	82
Length-height index of head	42
Sagittal-vault index	57.5
Face-trunk index	28.2
Relative size of upper face	18.4
Vertical cephalo-facial index	76
Upper face index	51.25
Relative nasal height	57
Relative nasal breadth	22.5
Nasal index	79
Relative interocular breadth	18.3
Ear index	89
Relative size of ear	18.9

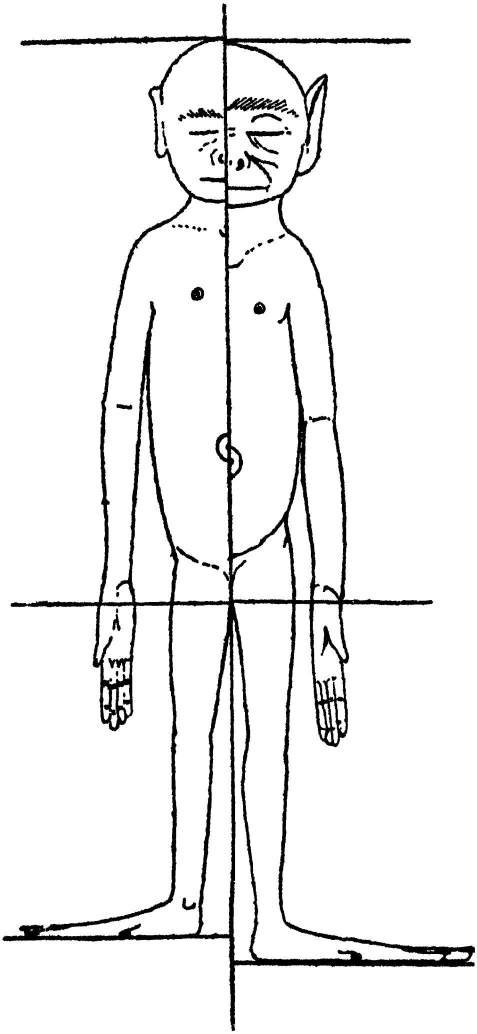


Fig. 1. Diagrammatic representation of the body proportions of the hybrid Leaf-monkey discussed in this paper compared with that of another hybrid previously described (Hill, 1936). The new hybrid is depicted in the left half of the drawing.

The outstanding features which come to light by a perusal of the above tables and the schematic drawing in Fig. 1 are as follows. The head is relatively slightly larger than in the hybrid previously described, but forms a smaller proportion of the total height. Therefore the head must be relatively larger in its transverse and antero-posterior diameters, though absolutely the measurements are slightly less. This is further corroborated by the higher cephalic index,—the skull being definitely brachycephalic for a new-born Leaf-monkey. The sagittal-vault index is low compared with Leaf-monkeys previously recorded, due to the more rounded contour. The facial portion of the skull forms almost the same ratio with the trunk height as in other Leaf-monkeys of similar age, as does also the relative size of the upper face. The total face height, however, forms a lesser share of the auricular height of the cranium than in the formerly described hybrid. Other notable features in the head are the lower nasal index, more average relative interocular breadth, more rounded and smaller relative size of the external ear.

In other regions of the body, the most noteworthy features are the lesser relative bitrochanteric width; diminished relative girth but more rounded thorax; shorter relative length of both upper and lower limbs, affecting all the segments to some extent, though the absolute measurements of brachium and antebrachium are identical with those of the earlier described hybrid, and those of the thigh and crus are very similar so that the intermembral indices are much alike in the two specimens.

(b) Non-metrical Characters

(a) *Hairy covering.* The specimen is well clothed with the usual lanugo coat, but this differs in its arrangement, as well as in colour from that of the parents.

The stiff brow hairs are present, but feebly developed compared with these of a pure bred *Semnopithecus priam.* They are shorter, especially at the sides, and are directed more upwards than forwards. Behind the brow-hairs the hairs of the scalp are directed mainly backwards, but those at the sides pass laterally to some extent. Farther back all the hairs proceed cranio-caudally and continue to do so all down the dorsal surface. The face is comparatively hairless. Eye-lashes are well developed (see Plate XXXII, b) and there is a median tract on the nose, with the usual reversal on the bridge. There are some downwardly directed hairs on upper and lower lips and on the chin. The cheek hairs do not encroach on the malar bones. The hair on the sides of the head forms prominent whiskers which are directed laterally.

On the throat all the hairs are directed caudally and in the mid-line this caudal trend extends as far as the umbilicus. Laterally the lower neck hairs diverge towards the shoulder, but below the nipples the hairs of the ventral aspect of the thorax have a median trend, proceeding from the axilla in a direction towards the umbilicus. Still more caudally the hairs of the flanks proceed medially, also pointing towards the umbilicus. Caudal to the umbilicus the hairs are reversed in varying degree so as to maintain the umbilical drift. A divergence occurs in the inguinal region, the hair on the abdominal side partaking in the umbilical drift, those on the femoral side being directed distally. The pubic region is naked, but farther back the hairs are short and directed towards the margin of the callosities. As far as the trunk is concerned, therefore, the hair-streams are much as in the foetus of *Semnopithecus*. The same applies to the limbs which, therefore, need not specially be described. Certain peculiar features of the hairy covering of the ears and genitalia will be alluded to in connection with those parts subsequently.

The coloration of the hair appears to be intermediate between that of the new born of *Semnopithecus* and *Trachypithecus*, resembling the latter more than the former. The general colour on the head and dorsal and lateral aspects of the trunk is a deep brownish-orange, becoming paler to buff on the ventral aspect of the body, and almost yellow in the whiskers. The brow hairs are black, and there is a fair sprinkling of darker hairs on the back of the neck and along the mid-dorsal region and dorsal aspect of the tail. The ventral aspect of the tail is paler than the dorsal.

(β) *Skin pigmentation.* This is a very important feature in so far as the face of the male parental species possesses a curious particoloured pattern; whilst the face of the maternal species is uniformly sooty black. Unfortunately the pigmentation of the skin in the new born young is incipient, and it is almost impossible to state what the eventual condition would have been, had the baby survived. There is some evidence, however, of lack of pigment in the orbital region which may have persisted, whilst the rest of the face, including the lips, is definitely pigmented, though very lightly, giving a light slaty tinge to the parts. The eyelids are actually darker than the circumorbital skin, whilst the lip margins and neighbouring mucous membrane are darker than the skin on the outer surface of the lips.

Pigment is lacking on the remainder of the head, and also from the trunk, tail, and major part of the limbs. There is some duskiness of the palms and soles, greater in the latter, and this increases on the flexor sides of the fingers and toes.

(γ) *Face and ears.* The facial features, compared with those of a pure-bred full term *Semnopithecus priam* and of a pure-bred *Kasi vetulus philbricki* are depicted in Plates XXXII and XXXIII. The general contour of the face resembles the latter more than the former, but in detailed markings, furrows, etc., it differs from both. Interocular sulci are less pronounced, and the grooves bounding the nose are quite lacking, as also is the circumnasal padding so prominent in *Semnopithecus*. The nares are more like those of *Kasi*. The fine white hairs on the lips are seen only in the hybrid.

The ears are of considerable interest (see Plate XXXIII). In general form they resemble those of the less specialized Leaf monkeys represented by the genera *Trachypithecus* and *Kasi*, and thus differ from the ears of *Semnopithecus*. In general outline they are broadly ovate, with an outer concave and a medial convex surface, but with the uniformity interrupted by an obliquely transverse kinking about one third the distance from the upper extremity. The helix consists of an anterior, or ascending portion and a superior or horizontal portion, with a constriction at the junction of the two parts. The horizontal portion narrows gradually and disappears at the posterior margin. There is no pointed process as in the ear of *Semnopithecus*. The tragus is rudimentary, but the antitragus and antihelix are mostly the same as in *Kasi*. Behind the antihelix the plane of the pinna is not so flattened as in *Kasi*, but is sculptured into an elongated depression which runs parallel to the posterior border. Inferiorly this turns forwards, and becomes narrower and deeper, forming a complicated bursa behind and below the antitragus. This bursa is only represented by a small depression in the other two genera (see Fig. 2).

A B C

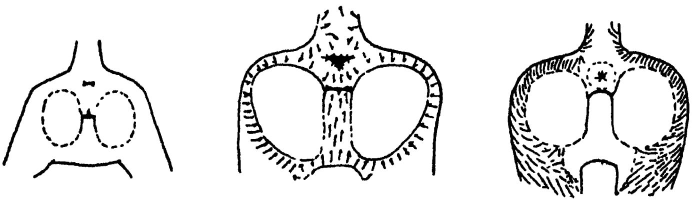
Fig. 2. Drawings of the external ear in three young Leaf-Monkeys.

A. Full term *Semnopithecus priam*; B. Hybrid *Trachypithecus* × *Semnopithecus*, new born; C. Full term *Kasi vetulus philbricki*. The arrows in B. indicate the direction of the hairs.

There is a trace of pigment in the skin of the hybrid's ear, and there are some fine hairs of brownish colour scattered over its lateral surface. Their direction is indicated in fig. 2 b, which should be compared with fig. 8 c, in my paper on the pre-natal development of *Semnopithecus*, where a different arrangement is depicted.

(ꝺ) *Anus, Callosities, Genitalia* (text fig. 3).

Although presenting certain features in common with related Leaf-monkeys, the hybrid has some characters of special note. The callosities are fairly large and oval in contour, with the broader end dorsally. They are quite separate and the external genitalia are situated between them. The anus lies dorsal to them in a relatively naked field of skin. It is not raised on an eminence as in *Kasi*, or as in most adult Leaf-monkeys. It is a triangular opening, broader from side to side than dorso-ventrally, and resembles that of a female foetus of *Semnopithecus* rather than that of a *Kasi* or *Trachypithecus*.



A B C

Fig. 3. Drawings of the posterior end of the body of three young female Leaf-monkeys.

A advanced, but not full term, foetus of *Semnopithecus priam*, B. Hybrid *Trachypithecus* × *Semnopithecus*; C. full term foetus of *Kasi vetulus philbricki* Arrows in B. indicate direction of hairs. The bare patch in C. indicates the white haired, unpigmented pubic area, which is confined to the female.

The genitalia are, as in all foetal and newborn female Leaf-monkeys, inconspicuous, and their details made ~~not~~ out only with difficulty. I briefly described those in *Semnopithecus* in 1937, but some further account is necessary before pointing out the individual peculiarities in the hybrid. In all the forms studied the vulva is a *transverse* slit situated between the callosities, and extending from the inner margin of one callosity to that of the other. The exact level varies in the different specimens studied, being is higher in *Kasi* than in *Semnopithecus*. In the latter it lies opposite the middle of the callosities, but in the other forms it is nearer to the anus. There are no labia, the upper margin of the transverse slit being the lower edge of the perineal body, whilst the lower limit is formed by the praeputium clitoridis. This is composed of relatively thick, and hairy skin and forms a convex prominence running dorsally from the pubic region as far as the vulvar opening. It forms a hood over the clitoris, the glans of which, as well as other details of the vulva, are invisible without dissection. The form of vulva just described seems to be peculiar to foetal and juvenile Leaf-monkeys.

Of the variations noted, those of position are most noteworthy, and have already been discussed. In *Kasi* the slit is more crescentic due to the dorsally convex edge of the praeputium clitoridis. The opening is very near the anus in this genus. In *Semnopithecus* the dorsal margin of the slit is notched in the mid-line. In the hybrid there are several small notches on the upper margin and a larger median one on the praeputial margin.

(*s*) *Extremities*. The only structures needing reference here are (a) nails (b) interdigital webbing. Nails are well developed and more deeply pigmented than the surrounding skin. In this respect they differ from those of all other foetal and newborn Leaf-monkeys that I have examined. In shape they differ on the different digits. On the thumb they are rudimentary, and broader than long. On the fingers they are long and narrow, and convex in both directions. The distal edge is not free, but bends sharply in a palmar direction, concealing the hyponychium. The toe nails on the second to fifth toes are similar to those on the fingers, but only two-thirds as long proximo-distally. The nail on the hallux is broad and flat, and less pigmented than the remainder.

Interdigital webbing is extensive, more so, however, between the toes than fingers. It extends two-thirds the distance to the first interphalangeal joint between digits II and III, and IV and V on the hand, and slightly farther between digits III and IV. On the foot it extends farthest between III and IV, where it gains the proximal interphalangeal joint, but slightly less between the other pairs.

DISCUSSION

In the above account of the external characters of a newborn hybrid Leaf-monkey, it is clear that features derived from both parents have made their appearance, but, on the other hand, in the sum total of its characters the individual resembles its father rather than its mother. Examples are (i) its general form (ii) coat colour (iii) hair pattern (iv) ears and possibly (v) pigmentary distribution. The general trend of its characters is generically towards the type represented by what I regard as the more generalized type of Leaf-monkeys, the *Trachypithecus-Kasi* association, and away from the more specialized and derivative forms represented by *Semnopithecus*. It is interesting to note that the specializations associated with the latter genus are not dominant to the generalized features of *Trachypithecus* in the F' generation, *e.g.*, the cranial hair pattern. The black colour of the lanugo coat is also not completely dominant to the orange of *Trachypithecus*, an intermediate condition developing as in human crosses between pigmented and non-pigmented races. Probably the same explanation is to be given,—namely, that coat colour is the product of several separate factors, some only of which are dominants.

SUMMARY AND CONCLUSIONS

1. A newborn female hybrid monkey, *Trachypithecus obscurus flavicauda* ♂ × *Semnopithecus priam thersites* ♀ has been figured and described in detail, and comparison made with newborn pure-bred examples of *Semnopithecus priam* and of *Kasi vetulus philbricki*.

2. Its measurements and proportions have been recorded in tabular and graphic form compared with those of a previously described full-term hybrid *Semnopithecus priam thersites* ♂ × *Kasi vetulus nestor* ♀.

3. The status of the hybrid has been discussed and its patricline affinities pointed out, and explained as a tendency to the retention of the more generalized characters of the paternal genus, rather than the hereditary transmission of specialized characters associated with the maternal genus.

REFERENCES TO LITERATURE

HILL, W. C. O., 1934, *Ceylon J. of Sc.* (B), XIX, pp. 23-88
1936, *op. cit.*, XX, pp. 135-148
1937, a, *op. cit.*, XX, pp. 211-251
1937, b, *op. cit.*, XX, pp. 369-389
POCOCK, R. I., 1928, *J. Bombay Nat. Hist. Soc.* XXXII, pp. 472-504 and 660-677,
1934, *P.Z.S.*, pp. 895-961
SCHULTZ, A. H., 1924, *Bull. Amer. Mus. Nat. Hist.*, XLIX, Art V, pp. 443-457
ZUCKERMAN, S., 1931, *P.Z.S.*, p. 338

EXPLANATION OF PLATES.

PLATE XXXII.

Front views of the faces of three young Leaf-monkeys.

Fig. 1. Full term foetus (male) of *Semnopithecus priam thersites*

Fig. 2. Hybrid, *S. priam* ♀ × *Trachypithecus obscurus* ♂ (new born female)

Fig. 3. Nearly full term foetus (female) of *Kasi vetulus philbricki*

PLATE XXXIII.

Side views of the heads of the same three Leaf-monkeys arranged in the same order as on the previous Plate. Note especially the size and direction of the brow-hairs and the form and position of the ears.

[Received for publication, November 14, 1938.]

Fac f Nevl in Leaf onkeys

Heads of Newborn Leaf-monkeys

CEYLON J. SCI. (B) VOL. XXI, PT. 3. (October 24, 1939)

An Annotated Systematic List of the Leaf-monkeys

BY

W. C. OSMAN HILL, M.D.

Anatomy Department, Ceylon Medical College, Colombo

(With Five Plates and Two Text Figures)

Most of the groups and genera of Old World Monkeys (*Catarrhini*) have, in recent years, been the subject of revision to some extent, so that it is now possible to compile, with some pretensions to accuracy, a list of the species and subspecies in such groups. Thus we have Schwarz's contribution (1928) on the various African genera, including even the difficult, and little known genus *Colobus*, and Pocock's (1931,b) revisions of the various Macaques. The Leaf-monkeys, however, are in a far less satisfactory state, although, Pocock, in various papers (1928, 1934) and Miller (1934) have both contributed valuable material to our knowledge of these Asiatic forms. I have myself shown (1934, 1936) reasons for treating the Leaf-monkeys as a subfamily of *Colobidae*. Pocock (1934) has suggested certain generic distinctions within the group, and I have adopted these, and added to them (1936 *a*).

I therefore consider that it is now opportune and useful to review our conception of the group so as to bring it into line, with the other Old World Primates. The following annotated list has therefore been prepared. It can of course only be considered as tentative, since our knowledge of some of the forms is still very meagre, and furthermore, different authorities have divergent views as to the status of many of them. Thus, as regards Malayan forms, Miller (*loc. cit.*) treats them nearly all as full species, whilst Pocock tends to lump them into a comparatively small number of species. I personally opine as stated elsewhere (1936 *b*) that there is more than one good species of the Indian *Semnopithecus*, whereas, again, Pocock allows only one species of this genus, with many subspecies. Many of the forms at present allowed, be they species or subspecies, will, in my opinion, with further knowledge, have to be deleted entirely.

MATERIAL

In arriving at the conclusions represented in the list published hereunder, I should like to state that I have personally examined a fairly extensive and representative amount of material, much of which has been placed at my disposal by others. I should like to take this opportunity, therefore, of giving a brief resumé of the material examined, and of expressing my thanks to the various individuals who have assisted me in any way therewith.

In my own collection I have endeavoured to preserve and examine complete cadavers whenever possible. Species so far dealt with in this way include all the forms existing in Ceylon plus the following:—*Kasi johni*, *Trachypithecus cristatus*, *T. obscurus*, and *Presbytis melalophus* (both red and black mutants). For the *T. cristatus* I am indebted to Dr. J. W. Field of Kuala Lumpur. For the *Presbytis* I have to thank Mr. W. J. C. Frost. Some of these have lived in my private collection before being embalmed. Other examples of *T. obscurus*, and *P. melalophus* are still living besides *Semnopithecus entellus* (*vide* Plate A). My collection has undoubtedly housed more varieties of living Leaf-monkeys at one time than any zoological garden.

In the British Museum (Natural History) I have carefully examined all the forms of *Semnopithecus*, and *Kasi* and have also inspected most of the other material of the group in that collection including the rare Indo-Chinese forms. For this valuable opportunity I have to thank the authorities concerned, especially Mr. M. A. C. Hinton. In Genoa, through the kindness of Professor O. de Beaux, I examined the type skin of *Trachypithecus chryogaster* (Licht). In the Royal Scottish Museum, Edinburgh, I noted examples of *T. obscurus*, *T. pyrrhus*, and *Presbytis rubicundus*. To the authorities of the Indian Museum, Calcutta, I am deeply indebted for the loan, at various times, through Dr. J. Pearson, formerly Director of the Colombo Museum, of the type skins of *Semnopithecus albinus*, Kelaart and of *Trachypithecus barbei* (Blyth). To the Natural History Society of Bombay I am similarly indebted for the loan of all their material of Leaf-monkeys, containing a long series of *S. entellus* and *S. priam* and an important skin assigned to *S. anchises*, besides examples of *K. johnii*. I am specially indebted to Mr. H. C. Smith of Maymo, Burma, for the loan of some fine series of skins of the Shan States Leaf-monkey, and of the large Burmese race of *T. pileatus* (*T.p. shortridgei*).

I have further become familiar with all the commoner Indian and Malayan species by virtue of large numbers seen alive at various times in the last eight years on board ships in Colombo Harbour *en route* to

Europe and America. Few of these, I imagine, ever reach their destination alive, or live for long even if they do; though the London Zoo appears to have been successful with *T. pileatus* at any rate, for this species has been successfully bred there. Amongst the species thus seen are *Semnopithecus entellus*, *Trachypithecus obscurus*, *T. pyrrhus*, *T. cristatus* and the dark-mutation of *Presbytis melalophus*. I have also recently seen a young individual of *Rhinopithecus roxellanae* on its way to London.

FAMILY Colobidae

(Old-World Monkeys lacking Cheek-pouches)

Subfamily PRESBYTINAE (Asiatic Colobidae)—Leaf-monkeys

Genus **Semnopithecus** Desmarest 1822

Langurs or Sacred Monkeys

Type. *S. entellus* Dufresne

Distribution. India, from the Himalayas to Cape Comorin, extending also into Thibet and occurring in the dry zone of Ceylon. Does not extend into Burma. The westward range includes Kashmir, Cutch and Kathiawar.

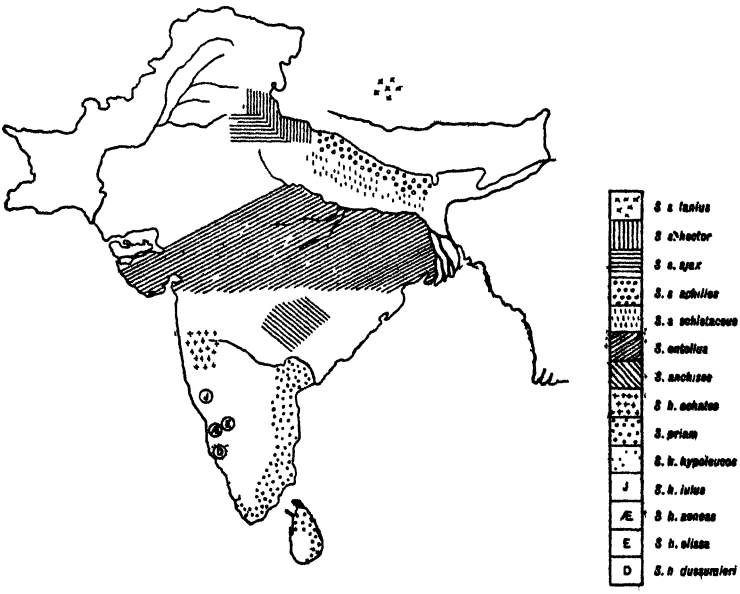


Fig. 1. Map to show distribution of the species and subspecies of the genus *Semnopithecus*.

Generic characters. Hair on crown radiating from a centre on the forehead; dorsal surface darker than ventral; hair on lower back not different in character from the rest. Skull with well developed brow ridges; orbital plane sloping from above downwards and backwards; muzzle prominent for a Leaf-monkey. New born young uniformly black, changing to adult colour with the shedding of the lanugo coat.

1. **Semnopithecus schistaceus** Hodgson, *J. Asiatic Soc. Bengal*, IX, 1212, 1841.
   Himalayan Langur

Distribution. India, north of the Ganges, and Thibet.

Remarks. I include here all the Entelloids confined to the region north of the Ganges. They all agree in having long whiskers concealing the ears and the colour of the crown and whiskers strongly contrasted with that of the back.

(*a*) *S. s. schistaceus* Hodgson, 1841

Terai Langur

Distribution. Nepal Terai

Remarks. A slaty-grey race, with shorter, less woolly coat than those found at higher altitudes.

(*b*) *S. s. hector* (Pocock), *J. B. N. H. S.*, XXXII, 481, 1928

Kumaon Langur

Distribution. Kumaon, up to 6,000 feet.

Remarks. Closely resembles the preceding, but is larger and has a larger skull, with more prominent nasal region.

(*c*) *S. s. achilles* (Pocock), *J. B. N. H. S.*, XXXII, 478, 1928

Nepalese Langur

Distribution. Nepal, higher altitudes, and possibly Sikkim

Fig. Pocock, *J. B. N. H. S.*, XXXII, Plate XI, 1928

Remarks. Similar to *schistaceus*, but longer haired and with a chocolate coloured coat.

(*d*) *S. s. lanius* (Elliot), *Ann. Mag. Nat. Hist.* (8), IV, 278, 1909

Thibetan Langur

Distribution. Known only from the type locality, Chumbi, Thibet, 10,000 feet.

Remarks. Similar to *S. s. achilles*, but has more grey sheen on upper parts, and a longer, shaggier coat.

(e) *S. s. ajax* (Pocock) *J. B. N. H. S.*, XXXII, 480, 1928
Kangra Langur

Distribution. Northern Punjab, Chamba, Kangra, Kulu (up to 11,000 feet).

Remarks. Differs from all the other preceding races of the Himalayan Langur in the forearms and hands being contrasted in colour with the body. It also has a longer, shaggier coat.

2. **Semnopitheous entellus** Dufresne, *Bul. Soc. philom. Paris*, I, 49, 1797

Common Langur, Entellus Monkey, Hánuman Monkey

Distribution. South of the Ganges this species extends across India from Cutch and Kathiawar to Bengal. Southwards it passes with some gradation of characters into the territory of *hypoleucos* on the west and of *priam* on the east.

Remarks. As I understand it, at present, I see no reason to divide true *entellus* into geographical races, as it appears to be tolerably uniform in its characters throughout its range. It is true that, to the south, there are forms existing with characters intermediate between *entellus* and *priam*, but, until more is known about these, and their distribution, I prefer to regard them as races of the latter and to reserve the name *entellus* for all the Langurs of the plains and of Central India.

3. **Semnopitheous priam** Blyth, *J. As. Soc. Bengal*, XIII, 470, 1844. [Syn. *pallipes*, Blyth 1844 (*nomen nudum*); also of Pocock *J. B. N. H. S.*, XXXII, 495.]

Madras Langur; Priamus Monkey; Coromandel Crested Langur

Distribution. Peninsular India, south of the area occupied by *S. entellus*, with the exception of the northern part of the Malabar coastal tract, but inclusive of the dry zone of Ceylon.

Remarks. Essentially a crested form, with little or no contrast between the colour of the hands and feet and the remainder of the limbs.

(a) *S. p. priam* Blyth, 1844
Madras Langur

Distribution. The Madras Presidency from Nellore southwards to Cape Comorin, inclusive of the Eastern Ghâts. ? Nilgiri Hills.

(*b*) *S.p. thersites* Blyth 1841.
Ceylonese Grey Langur

Distribution. Ceylon, dry zone, and Travancore.

Remarks. These two races of *S. priam* are doubtfully separable at present, the Ceylon form being said to be darker in general colour than the Coromandel race. I am extremely doubtful about the status of the Travancorean specimens. I cannot from available evidence accept Pocock's *priamellus* as distinct.

(*c*) *Semnopithecus priam anchises* (Blyth) *J. Asiatic Soc. Bengal,* XIII, 470, 1844.
Central Indian Langur

Distribution. Deccan, Central India.

Remarks. Intermediate between *priam* and *entellus*, having the hands and feet covered with a mixture of black and white hairs. Pocock (1931 a) has assigned various specimens to this race, though they do not all correspond exactly with the type skin. A skin labelled *anchises* in the Bombay collection is of a general golden tint, an unusual colour for any Indian Leaf-monkey. It may be an erythristic mutation of one of the *Semnopitheci*, though no such mutant has been recorded hitherto. It came from Seetagundy Estate, Kollingode.

4. **Semnopithecus hypoleucos** Blyth, *J. As. Soc. Bengal*, X, 839, 1841
Malabar Langur

Distribution. The Malabar coastal tract, from latitude 14°-15° N to Cape Comorin. Not ascending the Ghâts above 1,200-1,300 feet, and absent from the Wynaad plateau (Jerdon).

Remarks. I use the name *hypoleucos* to cover all the Malabar Langurs with ashy-grey bodies contrasting with the black of the extremities.

(*a*) *S. h. hypoleucos* Blyth, 1841.
Travancore Langur

Distribution. Confined to Travancore, where it is restricted to the drier parts.

Remarks. Known only from the type skin, which is in the Calcutta Museum. It differs from other races of the Malabar Langur in having the inner aspect of the thigh whitish.

(*b*) *S. h. aeneas* (Pocock) *J. B. N. H. S.*, XXXII, 492, 1928.

Coorg Lowland Langur

Distribution. Coorg, from 250 feet up to 2,000 feet altitude.

Remarks. Of the numerous races of the Malabar Langur, this appears to be closest in general characters to the typical form, from which it differs in larger size, more heavily developed pigment, and in having the inner aspect of the thigh black instead of white.

(*c*) *S. h. iulus* (Pocock) *J. B. N. H. S.* XXXII, 490, 1928

Black-legged Langur

Distribution. Known only from the type locality, Jog, Gersoppa Falls, Kanara-Mysore boundary, 1,330 feet.

Remarks. A well defined race with pale body colour strongly contrasted with black arms and hands

(*d*) *S. h. dussumieri* Is. Geoffroy, *C. R. Acad. Sc.*, XV, 719, 1842.

Geoffroy's Langur

[Synonymized with *hypoleucos* by most authors, but retained as separate by Pocock (1928)]

Distribution. " Coast of Malabar " Probably the type locality was Mahé, a French possession on the Malabar coast, where Jerdon (1874) states *hypoleucos* is common.

Remarks. A very doubtful form, possibly not separable from *iulus*, from which it differs only in being paler and in having the cheeks pale like the crown,—described characters probably due to fading of the type skin.

(*e*) *S. h. achates* (Pocock) *J. B. N. H. S.* XXXII, 488, 1928

Northern Malabar Langur

Distribution. Bellary, Dharwar and Kanara, from 1.500 feet to 2,000 feet altitude in the Western Ghâts. Karwar to the west of the Ghâts down to sea level.

Remarks. This race of *S. hypoleucos* approaches nearest to *S. entellus*, as would be expected from its geographical position. It has woollier fur and differs in colour from *entellus*, but has the black hands and feet.

(*f*) *S. h. elissa* (Pocock) *J. B. N. H. S.*, XXXII, 498, 1928
Coorg Highland Langur

Distribution. Known only from Nagarhole, S. E. Coorg, 2,600 feet
Remarks. Closely resembles *achates*, but differs from all the races of *hypoleucos* in having a tuft on the crown.

Genus **Kasi** Reichenbach, 1862

Purple-faced Monkeys or Wanderoos

Type. *K. johni* (Fischer).

Distribution. Confined to the wetter parts of Ceylon and the higher altitudes of the Western Ghâts and their outliers.

Generic characters. Hair on crown semi-erect and cranio-caudal in direction; dorsal surface paler than ventral, except in *johni*, which is dark on both surfaces; hair on lower back shorter than elsewhere, and often differently coloured. A white pubic patch in the females. Skull with less prominent supraorbital ridges; plane of orbital opening sloping downwards and forwards; muzzle flattened. Newly born young pale in *vetulus;* black in *johni.*

1. **K. johni,** (Fischer) *Syn. Mamm.* 25, 1829
Nilgiri Leaf monkey

Distribution. Western Ghâts, from Coorg to Cape Comorin, and their outliers, *e.g.*, Anamalai, Palni and Nilgiri Hills above 3,000 feet.

Remarks. Easily recognized by its black general colour and the fact that the whiskers are brown like the crown. No intermediate forms between this and *vetulus* are known.

2. **K. vetulus** (Erxleben) *Syst. Regn. Amim.*, III, 25, 1777
Purple-faced Monkey

(Syn. *senex*, Erxl; 1777; *kephalopterus* Zimm, 1780); *porphyrops* Link, 1795; *latibarbata* Temm., 1812; *leucoprymnus*, Otto, 1825; *veter*, Wroughton, 1918.)

Distribution. Ceylon; lowland wet zone; highlands and the lowlands of the dry zone flanking the central mountain mass on the north and north-east.

Remarks. General body colour grey or black; crown brown contrasted with white, laterally elongated whiskers.

(a) *K. v. vetulus* (Erxleben) 1777.

Southern Purple-faced Monkey; Black Wanderoo

Distribution. S. W. Ceylon from the Kalu-ganga on the west as far round as Ranna on the south east. Ascends the hills to 2,000 feet.

Remarks. General colour black, with a very pronounced, strongly demarcated light sacral patch. Dorsal surface with grey flecking, ventral surface black.

(b) *K. v. nestor* (Bennett), *P. Z. S.*, 1, 1833.

Western Purple-faced Monkey; Dusky Wanderoo

Distribution. Lowlands of Western Ceylon north of the Kalu-ganga; inland to the foothills and north almost as far as Kurunegala.

Remarks. Like the last, but grey, with a less well marked sacral patch, and no white flecking.

(c) *K. v. monticola* (Kelaart) *J. R. As. Soc.* (*Ceylon*), II, 144, 1840.

Highland Purple-faced Monkey; Bear Monkey

(Syn. *ursinus* Blyth, 1851).

Distribution. Highlands of Ceylon above 3,000 feet. Intergrades with typical *vetulus* below that altitude.

Remarks. A large form, with long, shaggy coat of dark grey and a rudimentary or obsolete sacral patch. Tail short and thick.

(d) *K. v. philbricki* (Phillips), *Ceylon J. Sc.* (B) XIV, 57, 1927

Northern Purple-faced Monkey

Distribution. Lowlands of the dry zone of Ceylon extending in a belt across the island from east to west. Not passing north of a line drawn from Marichchukadi on the west to Nilaveli on the east, but extending up the foothills in the Matale district as far as the Mahaveli-ganga in its early west to east course.

Remarks. Similar to *nestor*, but much larger and with a poorly developed sacral patch, different fur and a long, thin, white-tipped tail in typical individuals. Intergrades with *monticola* and *nestor*.

Genus **Trachypitheous** Reichenbach, 1862

Capped Leaf-monkeys or Lutongs

Type (by selection) *T. pyrrhus* (Horsfield).

Distribution. Assam, Burma, to Indo-China. Malay Peninsula and islands, including Sumatra, Java and Borneo.

Generic Characters. Hair on crown typically as in *Kasi*, occipital hairs longer and forming a mat or transverse crest. Dorsal surface darker than ventral.

Females with a conspicuous white area beneath the callosities. Newborn young uniformly orange or golden. Skull similar to that of *Kasi* as regards supraorbital ridges and the obliquity of the orbital plane. Nasal region wider. Constriction behind orbits greater than in *Presbytis* (see below), from which it also differs in having a less inflated occipital region. The mandible is also more robust, especially in its ascending ramus.

1. **Trachypithecus pileatus** (Blyth) *J. As. Soc. Beng.* XII, 174, 1843.
Capped Leaf-monkey

(Syn. *argentatus* Horsfield, 1851.)

Distribution. Assam; and upper Chindwin, southwards to Tipperah and Chittagong.

Remarks. A large Leaf-monkey with thick, matted occipital cap, sharply defined from short hairs on side of head. General colour above grey, of varying shades, below whitish to buff. Face entirely black.

(*a*) *T. p. pileatus* (Blyth) 1843.
Typical Capped Leaf-monkey

Distribution. Assam; from the Naga to the Garo Hills.

Remarks. Dorsal and ventral surfaces sharply contrasted in colour. No erythristic tendencies in whiskers, throat or other parts of ventral surface, all of which areas are whitish, tinged with buff.

(*b*) *T. p. durga* (Wroughton) *J. B. N. H. S.*, XXIV, 655, 1916.

Red-bellied Capped Leaf-monkey

Distribution. Assam north of Brahmaputra from Lakhimpur to the Naga Hills and Cachar; thence southwards into Tipperah and Chittagong.

Remarks. Similar to typical *pileatus*, but showing erythristic tendencies as far as the inguinal region.

(*c*) *T. p. tenebricus* (Hinton), *J. B. N. H. S.*, XXIX, 21, 1923.
Hinton's Capped Leaf-monkey

Distribution. Resembles the last, but is darker above, with blackish head and grey nape and the erythristic area fading out on the upper abdomen.

(*d*) *T. p. brahma* (Wroughton), *J. B. N. H. S.*, XXIV, 654, 1916.
Brahma Leaf-monkey

Distribution. Assam; Seajuli in the Dafla Hills.

Remarks. Known from the type specimen only, and regarded by its author, and by Hinton (1923) as a distinct species. Placed by Pocock (1928) as a race of *pileatus* with which it agrees in having long side whiskers sharply contrasted with the dark colour of the crown, but differs in having no sharp colour contrast between the dorsal and the ventral surfaces of the body, and outer and inner surfaces of the limbs. The throat and chest are whiter than the belly.

(*e*) *T. p. shortridgei* (Wroughton) *J. B. N. H. S.* XXIV, 56, 1915.
Shortridge's Capped Leaf-Monkey, Chindwin Leaf-Monkey.

Distribution. Upper Chindwin; Homalin (400 feet) Minrin (450 ft.) and Hkamti (500 feet).

Remarks. Differs from all the other races of *pileatus*, in having shorter whiskers not contrasted in colour with the crown. Otherwise resembles *brahma* in colour, and like it, shows no tendency to erythrism anywhere. A very large race.

2. **Trachypithecus pyrrhus** (Horsefield) *Zool. Res. Java*, 1820.
Negro Lutong. Budeng
(Syn. *auratus*, Geoffr, 1812; *maurus*, E. Geoffr. 1812.)

Distribution. Java and Bali.

Remarks. A smaller, darker coloured animal than *T. pileatus*, and lacking the thick matted hairs on the occiput. Crown hairs generally as in *Kasi*. Whiskers long, but blending with hairs on side of crown. Silver spangling occurs in certain parts, varying with the subspecies. This is a very variable animal and its precise limits are at present uncertain.

Pocock (1928) lumped many forms as subspecies of this animal, but later (1935) removed some of them. Miller (1934) considers most of the Malayan forms as full species. For the present I retain *pyrrhus* for the Negro Monkeys of Java and Bali only.

(*a*) *T. p. pyrrhus* (Horsfield) 1820.

Eastern Negro Monkey; Budeng

Distribution. Eastern Java.

Remarks. Typically jet black, with silver spangling on head and limbs; but also occurs as a red mutation.

(*b*) *T. p. sondaicus* (Robinson and Kloss) *Ann. Mag. Nat. Hist.* (9) IV, 374, 1919.

Western Negro Monkey

Distribution. Western Java; type locality Tjibodas.

Remarks. Slightly smaller than the eastern race, and jet black all over, except for slight spangling on the thighs.

(*c*) *T. p. kohlbruggei* (Sody), *Nat. Tijds Ned. Ind.*, XCI, 349, 1931.

Balinese Negro Monkey

(Syn. *stresemanni*, Pocock, 1934.)

Distribution. Bali.

Remarks. Similar to the eastern Javan race, but legs less grey. Skull smaller.

3. **Trachypithecus cristatus** (Raffles) *T. L. S.*, XIII, 245, 1822
Crested Lutong

(Syn. *pruinosus*, Desmarest, 1822.)

Distribution. Type locality, Bencoolen, Sumatra.

Occurs throughout Malay Peninsula and some of the islands, Sumatra, Borneo and some of the smaller islands, but not Java or Bali.

Remarks. Included by some authors as a race of *pyrrhus*, from which it differs in having a pointed crest on the crown and in being more heavily spangled with silver on back and limbs. The ground colour of the fur moreover is not jet-black as in *pyrrhus*.

(*a*) *T. c. cristatus* (Raffles, 1822).

Sumatran Crested Lutong

(Syn. *pruinosus* Desmarest 1822, *rutledgei*, Anderson, 1878, *pullata*, Thos. et Wr., 1909; *ultima*, Elliot 1910 *changensis* Kloss, *vigilans* Miller, 1913.)

Distribution. Sumatra (type locality) Malay Peninsula, Rhio Archipelago, Natuna Is, Banka, Billiton, Borneo.

Remarks. Typically iron grey, with silver spangling on back, flanks and upper segments of limbs. Forearms, hands and feet, and tail nearly black.

(*b*) *T. c. germani* (Milne-Edwards) *Bull. Soc. philom.* XIII, 8, 1877.
German's Lutong

(Syn. *germaini* of most authors; *koratensis* Kloss, 1919; *mandibularis* Kloss, 1916; *margarita*, Elliot, 1909.)

Distribution. Indo-China and Siam.

Remarks. Similar to *cristatus*, but paler, and with plenty of silvery hairs on cheeks, temples and periauricular region. Sometimes these parts tend to yellowish. Tail and forearms are darker than in *cristatus*.

4. **Trachypithecus phayrei** (Blyth) *J. As. Soc. Beng.*, XVI, 733, 1847—Phayre's Leaf-monkey

(Syn. *holotephreus* Anderson, 1877.)

Distribution. Upper Burma south to N. Tenasserim; Siam; Indo-China from Laos and Annam to Cambodia.

Remarks. A crested species with unpigmented areas round eyelids and mouth. General colour usually some shade of grey above and white below, the two colours contrasting on the flanks.

(*a*) *T. p. phayrei* (Blyth) 1847.

Phayre's Leaf-monkey

Distribution. Arakan; Pegu, the Bassein district; Prome; Mt. Popa.

Remarks. General colour above light grey; below white. No occipital pale area or cap.

(*b*) *T. phayrei crepusculus* (Elliot) *Ann. Mag. N. H.* (8) IV, 271, 1909.

Elliot's Leaf-monkey

(Syn. *wroughtoni* Elliot, 1909.)

Distribution. Siam and ?Indo-China.

Remarks. Differs from typical *phayrei* in being greyish below instead of pure white.

(*c*) *T. p. argenteus* (Kloss) *J. N. H. Soc. Siam*, III, 388, 1919.

Silver Leaf-monkey

Distribution. Annam, Tonquin, Laos.

Remarks. An eastern form of the preceding, from which it is only doubtfully separable. Said to be paler and more silvered with no brown tinge.

5. **Trachypithecus barbei** (Blyth), *J. A. S. Bengal*, XVI, ii, 736, 1847.

Barbe's Leaf-monkey

(Syn. *maurus* Helfer, 1838; *atrior*, Pocock, 1928.)

Distribution. Known for certain only from the type locality,—Tippera, Eastern Bengal. Probably has a wider distribution in upper Burma.

Remarks. The status of this form is in doubt. It is certainly distinct, but may have to be treated as a race of *phayrei*, though it has no crest and no sharp contrast between dorsal and ventral colouration on the flanks. It is probably *not* a race of *obscurus* since it seems to lack the pallid circumocular and circumoral areas. I surmise that Pocock's *atrior*, originally treated as a race of *pyrrhus*, and later (1934) referred to *phayrei*, is a synonym. The range of it is given as Northern Tenasserim and neighbouring parts of Siam.

6. **Trachypithecus shanicus** Wroughton *J. Bomb. N. H. Soc.*, XXIII, 465, 1915.

Shan States Leaf-monkey

Remarks. Originally confused with *barbei*, and then with *melamerus*, this peculiar form has been dealt with by Pocock as a subspecies of *pyrrhus*, and later, when he concluded that *phayrei* was a full species, as a race of the latter. It is undoubtedly allied to all these Leaf-monkeys, but, in my opinion, from skins I have examined, it resembles *obscurus* more than any other. It has the facial markings which are characteristic of both *phayrei* and *obscurus*, but it lacks the crest of the former. It differs from all other species of *Trachypithecus* in having a well-defined frontal whorl. On the strength of this I think it should be treated as a distinct species, at any rate for the present.

7. **Trachypithecus obscurus** Reid *P. Z. S.*, 14, 1837.

Dusky Leaf-monkey; Spectacled Monkey

(Syn. *albocinereus* Eydoux et Souleyet.)

Distribution. Malay Peninsula from Tenasserium through Peninsular Siam to Johore.

Remarks. Distinguished, as a species, from all others of the genus *Trachypithecus* (except *T. phayrei*) by having unpigmented circles round the eyelids and mouth. There is, typically, a pale patch of longer hair on the occiput, but no pointed crest.

(*a*) *T. p. obscurus* Reid, 1837.
Southern Dusky Leaf-monkey

Distribution. Southern Malay Peninsula.

Remarks. Dorsal surface dark grey, with a lighter grey occipital cap. Outer surface of thighs not markedly contrasted with back. Tail dark grey.

(*b*) *Trachypthecus obscurus flavicauda* (Elliot) *Proc. U. S. Nat. Mus.* XXXVIII, 1910.

Northern Dusky Leaf-monkey

(Syn. *smithi* Kloss, 1916; *sanctorum*, Elliot, 1910.)

Distribution. Peninsular Siam.

Remarks. Differs from the southern race, with which it intergrades, by the blacker tint of the dorsal surface, which is contrasted with the silvery white of the outer surface of the thighs. The tail and occipital cap have a yellowish wash.

(*c*) *T. o. melamerus* (Elliot), *Ann. Mag. Nat. Hist.* (8) IV, 267, 190.
Burmese Dusky Leaf-monkey

Distribution. Known only from Bhamo, the type locality.

Remarks. The type skin was originally identified by Thomas as a specimen of *obscurus*, but later made into a new species by Elliot. Pocock (1928) assumed it to be identical with *barbei*, which it resembles in colour. It apparently belongs to the *obscurus* group on account of the facial markings. The dorsal colour is black or very dark grey, and there is a buff wash on the occipital cap. It further differs from *barbei* in lacking the silvering on the shoulders and lateral sides of the arms.

(*d*) *Trachypithecus obscurus corax* Pocock, *P. Z. S.*, 1935.
Tenasserim Dusky Leaf-monkey

Distribution. Tenasserim from about lat. 12° N. to near Pechburi in S. W. Siam; also King Island and probably others of the Mergui Archipelago (Pocock).

Remarks. Probably indistinguishable from the preceding, or at least intermediate between it and *flavicauda* if sufficiently known. Separated by Pocock on the strength of a darker belly. It has a light silvery occipital cap as in *flavicauda*.

(*e*) *T. o. halonifer* (Cantor), *Proc. Linn. Soc.*, 285, 1845.

Cantor's Dusky Leaf-monkey

Distribution. Pinang (Prince of Wales Island).

Remarks. Another doubtful form. Said to be distinguished from mainland examples of *obscurus* by having darker back, belly, legs, and tail.

(*f*) *Trachypithecus obscurus carbo* Thomas et Wroughton. *Ann. Mag. Nat. Hist.* (8) IV, 534, 1909.

Terutau Dusky Leaf-monkey

Distribution. Terutau Island.

Remarks. Differs from *halonifer* in being slightly blacker. The mandible is more massive than in the mainland races.

(*g*) *T. o. styx* (Kloss) *Ann. Mag. Nat. Hist.* (8) VII, 116, 1911.

Perhentian Dusky Leaf-monkey

Distribution. Perhentian Island, N. of Trengganu.

Remarks. Another insular form doubtfully separable from the last, but there are said to be cranial differences.

8. **Trachypitheous potenziani** (Bonaparte) *Compt. Rend.* XLIII, 412, 1856.

Red-bellied Leaf-monkey

(Syn. *chrysogaster* Licht.)

Distribution. Mentawey Islands, west coast of Sumatra.

Remarks. This is the first of a group of Leaf-monkeys which are characterized by contrasting black and white areas in the pelage. They are at present all treated as separate species as no annectant forms are known. They are all found in Indo-China, except the present species, which is thus widely separated geographically from its nearest relatives, and is strikingly different from the Leaf-monkeys of the neighbouring geographical areas. It is included in *Trachypithecus* as its new-born young is golden in colour.

T. potenziani is mainly black dorsally, but has a golden-red ventral surface. It differs from the Indo-Chinese species in having white cheeks and throat.

The form of this species inhabiting Siberut Island has been described as a distinct subspecies, on insufficient grounds, by Chasen and Kloss (1927) under the name *T. p. siberu.* The rufous underparts are said to be replaced by brown or black in this race.

9. **Trachypitheous francoisi** (Posargues) *Bull. Mus. Hist. Nat. Paris*, 319, 1898.
Tonkin Leaf-monkey

Remarks. A black monkey with a white stripe from the corner of the mouth extending to the ear. Crested, with the hairs radiating from two occipital whorls.

10. **Trachypitheous laotum** (Thomas) *Ann. Mag. Nat. Hist.* (8) VIII, 271, 1911
Laos Leaf-monkey

Distribution Laos.

Remarks. Has more white in the pelage than *T. françoisi.* The white areas include the forehead, sides of head, checks and neck.

11. **Trachypitheous poliocephalus** (Trouessart) *Ann. Mag. Nat. Hist.* (8) VIII, 271, 1911.
Trouessart's Leaf-monkey

Distribution. Tonkin.

Remarks. Whole head and top and sides of neck golden or buff-white. Throat dusky grey or yellowish grey. Some grizzling on the loins and outer sides of thighs further distinguishes this form from the other related types.

12. **Trachypitheous delacouri** (Osgood) *Field Mus. Nat. Hist. Zool,* XVII, 204, 1932.
Delacour's Leaf-monkey

Distribution. Annam.

Remarks. Resembles *T. potenziani* in absence of whorls on occiput. Loins and outsides of thighs are pure white,—an exaggeration of the grizzling seen in *poliocephalus.* Head colouration is similar to that of *fran çoisi.*

Genus **Presbytis** Eschscholtz, 1821—Surelis

Type. P. aygula (Linn) = *mitrata* Eschsch.

Distribution. Southern Tenasserim through the Malay Peninsula and islands as far as Borneo.

Generic Characters

Hair on crown usually complicated by one or more whorls, and frequently forming a crest or similar structure; dorsal surface darker than ventral, and with a prominent pale stripe down the inner aspect of the thigh in both sexes. New-born young parti-coloured, usually of the "*cruciger* "type; i.e. with a dark median, or two dark paramedian stripes and a cross bar opposite the shoulders. This pattern may be retained partly in the adult. The female genitalia are very distinct, the clitoris being enclosed in sheath separate from the pudendal cleft. Skull has less constriction behind orbits than in *Trachypithecus*, whilst the occipital region is more globose, and with weaker crest. Supraciliary ridges absent or poorly eveloped.

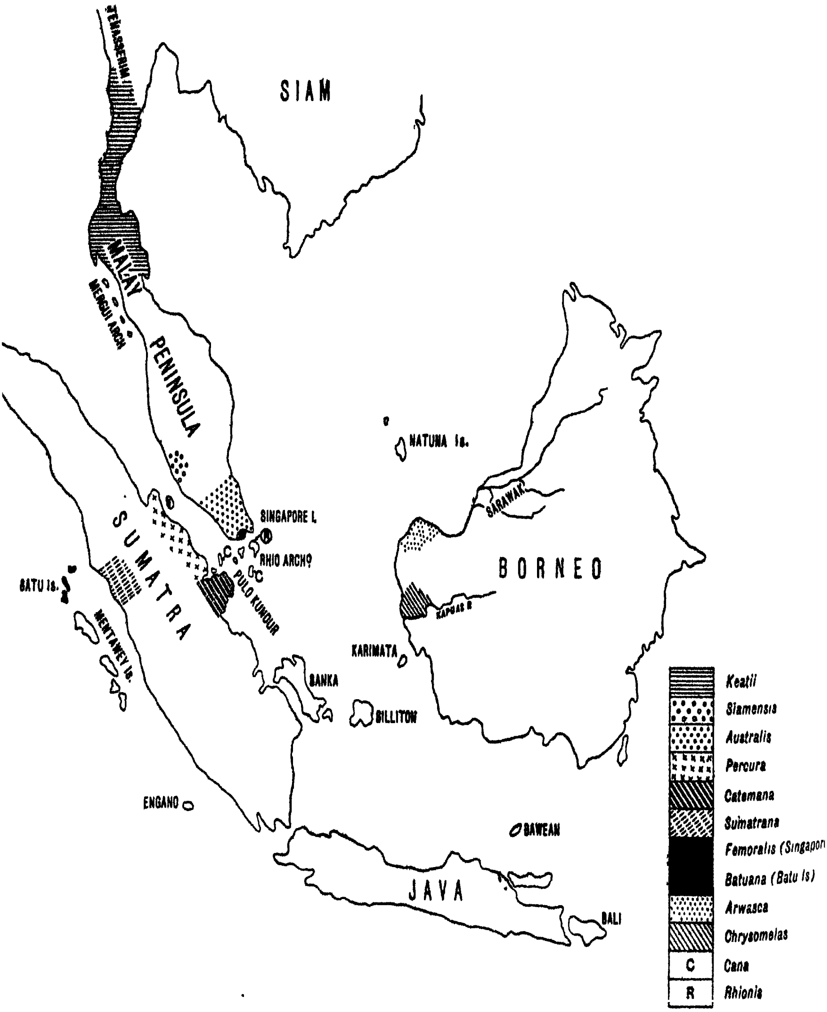


Fig. 2. Map to show the distribution of the races of *Presbytis femoralis*

1. **Presbytis femoralis** (Martin) *Mag. Nat. Hist.* (new ser.) ii, 436, 1838.
Banded Leaf-monkey

(Syn *siamensis*, Müll et Schleg; *cinerea*, Gray; *nigrimanus*, Is. Geoffr; *neglectus*, Schleg; *robinsoni*, Thos.)

Distribution. Southern Tenasserim through Peninsula Siam southwards to Johore; Singapore Island; Rhio-Linnga Archipelago; Sumatra, Natuna Islands and W. Borneo; but *not* Java.

Remarks. Under this head I include all the forms treated by Miller (1934) as of one ' Formenkries ', though he attributed to all of them full specific status. There is no need to do this, as our present knowledge leads us to assume that there is no overlapping of their geographical range; though admittedly, the full range of most of the forms is very incompletely known. (See fig. 2). The chief chracteristics of *femoralis* are the great forward direction of the brow hairs, coupled with the presence of paired whorls on the vertex, with the hair rising to a crest between them, and a thick tuft posteriorly. The general colour dorsally is dark brown, with light grey below. There is the usual thigh stripe, but the tail is uniformly coloured. Whitish mutants are known, but erythristic mutants have not been recorded.

(*a*) *Presbytis femoralis keatii.* (Robinson and Kloss) *J. Fed. Mal. St. Mus* IV, 174, 1911.
Northern Banded Leaf-monkey.

Distribution. S. Tenasserim; Peninsular Siam.

Remarks. A dark race, with the ventral surface dark brown instead of grey, and with no median pale abdominal stripe. The thigh stripe, however, extends to the ankle. *P. robinsoni* (Thos. *P.Z S.*, 1910) is a whitish mutant of *P. f. keatii.*

(*b*) *Presbytis femoralis siamensis.* Muller et Schlegel.

Malaccan Banded Leaf-monkey

(Syn *cinereus* Gray 1843, *albocinereus*, Blyth, 1848, Mivart, 1864; *dilecta*, Elliot, 1909, *nubigena* Elliot, 1909, *nigrimanus*, Is.Geoffr. 1843.)

Distribution. Central part of Malay Peninsula, especially Selangor.

Remarks. An intermediate form between the northern *P. f. keatii* and the southern forms known as *australis* and *femoralis* proper. It possesses the two frontal whorls, but lacks the white temporal patch of some insular races. The entire ventral surface is white, whilst the buttocks and outer aspects of thighs are suffused with white to a varying degree.

(c) *P.f. australis* Miller, *Smiths. Misc. Coll*, LXI, 28, 1913.
Southern Banded Leaf-monkey.

Distribution. Pahang and Johore, S. Malay Peninsula.

Remarks. Doubtfully separable from the typical *femoralis* of Singapore, from which it is said to differ in its larger size. It is, however, smaller than the northern *P.f. keatii.*

(d) *P.f. femoralis* (Martin) *Mag. Nat. Hist.* (n.s.) II, 436, 1838
Singapore Banded Leaf-monkey
(Syn. *neglectus*, Schlegel, 1876).

Distribution. Singapore Island.

Remarks. If the mainland forms are genuinely distinct, the distribution of the typical form must be restricted to Singapore Island. It is characterized by having the throat and chest grey and the abdomen white, the white extending cranially as a median stripe on the chest.

(e) *P.f. rhionis.* Miller, *Smiths. Misc. Coll.*, 64, 1903.
Rhio Banded Leaf-monkey.

Distribution. Bintang Is., Rhio Archipelago.

Remarks. Similar to the mainland *P.f. siamensis*, but having only one frontal whorl, and in the possession of a white temporal patch, bordered by black.

(f) *P.f. cana* Miller, *Proc. U.S. Nat. Mus.* XXXI, 275, 1906.
Miller's Banded Leaf-monkey.

Distribution. Pulo Kundur, Rhio Archipelago.

Remarks. Distinguished from the preceding by its larger size and more grey in the deeper fur of the head,—very doubtful characters if a sufficiently large series be examined.

(g) *P.f. catemana* Lyon, *Proc. U.S. Nat. Mus.*, XXXIV, 672, 1908.
Lyon's Banded Leaf-monkey.

Distribution. Sumatran mainland opposite Rhio Archipelago.

Remarks. Another form doubtfully separable from *rhionis*. The buttocks are greyish and not strongly contrasted with surrounding parts, but this character would appear to be too variable for reliable diagnosis.

(*h*) *P.f. percura* Lyon, *Proc. U.S. Nat. Mus.*, XXXIV, 671, 1908.

East Sumatran Banded Leaf-monkey.

Distribution. Coastal region of east Sumatra, north of the area occupied by *P.f. catamana*, and neighbouring islands.

Remarks. This race resembles the one on the opposite mainland (i.e. *P.f. australis*) from which it differs in having a narrow skull and a whiter throat, contrasting with the darker grey of the lower neck.

(*i*) *P.f. sumatrana.* (Muller et Schlegel) *Verhand. Nat Ges. Nederl. Overzee. Bezitt., Zool., Mamm.*, 61. pl; X, 1841.

West Sumatran Banded Leaf-monkey.

Distribution. West coast of Sumatra opposite the territories of *catemana* and *percura*, including Mt. Ophir, which is the type locality.

Remarks. With the next form this agrees in having the pale buffy areas restricted to the post-thoracic region of the ventral surface. They thus differ from the other Sumatran and Malay Peninsular forms, and approximate to the Bornean races of *femoralis*. Treated by Pocock as a race of *melalophus*.

(*j*) *P.f. batuana* Miller, *Smiths. Misc Coll.* XLV, 65, 1903.

Batu Island Banded Leaf-monkey.

Distribution. Batu Islands, west coast of Sumatra.

Remarks. Agrees with *rhionis*, *catemana* and *siamensis* in having the buffy areas uninterruptedly continuous from chin to pubes, but it is darker in the upper parts and the upper arm is nearly as dark as the hand.

(*l*) *P.f. chrysomelas* (Muller). *Tijds. Natuur. Geschied.*, V, 138, 1938.

West Bornean Banded Leaf-monkey.

Distribution. Dutch West Borneo.

Remarks. The buff parts are restricted to the post-thoracic region and strictly confined to the ventral surface, the chest being blackish with some white frosting. The pale thigh stripe occupies less than one-third the circumference of the limb, but is prolonged as far as the ankle.

(*m*) *P.f. arwasca* Miller, *J.Mammal.*, XV, 126, 1934.

Sarawak Banded Leaf-monkey.

Distribution. Sarawak, N. Borneo.

Remarks. Similar to *chrysomelas*, but the neck and chest are paler and conspicuously washed with pale brown. The thigh stripe occupies more than one-third of the circumference of the limb.

2. **Presbytis melalophus** (Raffles) *Tr.Linn.Soc.* XIII, 244, 1822.

Black-crested Leaf-monkey or Simpai.

Distribution. Central and south-eastern Sumatra.

Remarks. Differs from *P. femoralis* in the absence of whorls on the vertex, the hairs of which form an upstanding, transversely-disposed crest. There is no forwardly directed brow-fringe. The forms known as *percura* Lyon, *batuana* Miller, and *sumatrana* Müller et Schlegel are, following Miller, here listed under *femoralis* but are regarded by Pocock as representatives of *melalophus.*

There appear to be no true geographical races or subspecies of *melalophus*, but it is particularly liable to curious colour mutations, most of which have received names. These are as follows.

(*a*) Typical *melalophus* is a reddish form, the back being red, tinged with brown; the cheeks are white and the ventral surface and limbs reddish yellow.

(*b*) *P.m. flavimanus* Geoffroy, 1830, is also a reddish mutant. The cheeks and ventral surfaces, however are white, and the tail dark above and white below.

(*c*) *P.m. nobilis* Gray, 1842, is the most erythristic type of all, lacking all but the slightest infuscation on the back. The form labelled *ferrugineus* by Schlegel appears to be identical with *nobilis.*

(*d*) *P.m. fuscomurina* Elliot, 1906, is a whitish mutant. It possesses no blackish or red colour on the back or limbs, and the outer side of the thighs is white. Pocock has distinguished a still more extreme whitish mutation from Palembang, without naming it.

(*e*) *Blackish mutants.* These verge in the opposite direction, red being absent and replaced by black on the dorsal surface, the belly, etc., being white. Pocock has included them under *sumatrana*, *percura*, and *batuana*, with the status of subspecies. This is correct if they prove to be without frontal whorls, but if they do not, then they should be included under *femoralis.* The blackish mutants examined by me in the flesh have no frontal whorls and have all the other general features of *melalophus.*

3. **Presbytis thomasi** (Collett) *P. Z. S.* 613, 1892.

Thomas's Leaf-monkey

Distribution. N. E. Sumatra.

Remarks. Apparently replaces *melalophus*, which it closely resembles, in the northern districts of Sumatra. It differs in the arrangement of the hairs in the preauricular region. In colouration it approaches closely to the Bornean species *P. hosei*, but is contrasted therewith by virtue of its bicoloured tail.

4. **Presbytis aygula** (Linn.) *Syst. Nat.* I, 27, 1758.

Mitred Leaf-monkey or Sureli

(Syn. *mitratus*, Esch., 1821; *comatus*, Desm., 1822; *fulvogriseus* Desmoulins, 1825.)

Distribution. Java.

Remarks. Has a single frontal whorl, and the hairs behind it rise to form a crest, which extends on to the occiput like a mat. Brow-fringe short. General colour dark ashy-grey to iron-grey darkening on the loins. Head, cheeks and proximal parts of limbs black, but distal parts white, which colour also prevails on the ventral areas from chin to tail tip.

(*a*) *P. a aygula* (Linn. 1758).

Western Mitred Leaf-monkey

Distribution. Western Java.

Remarks. Description as for the species.

(*b*) *P. a. fredericae* Sody, *De Trop. Natuur*, XIX, 68, 1930.

Sody's Mitred Leaf-monkey

Distribution. Central Java.

Remarks. Upper parts black, except for a little white on the limbs. Ventral surface black, grey and white from before backwards. White thigh stripe present and joined above to the white of the abdomen.

5. **Presbytis hosei** (Thomas) *P. Z. S.*, 159, 1889.

Hose's Leaf-monkey

Distribution. Borneo. North and central parts of the island up to 4,000 feet.

Remarks. In the absence of a frontal whorl, this form agrees with *melalophus* and *thomasi*. It has the same arrangement of the pre-auricular hairs as in *melalophus*. It is distinguished from both the forms mentioned by its colour pattern. The form described originally by Thomas (1892) as a separate species under the name *everetti* has been said to be the female of *hosei*. Pocock accepts this, and so did Chasen and Kloss (1931), but Gyldenstolpe (1920) and Miller (1934) do not. Miller (*loc. cit.*) further describes another form, *canicrus* as distinct, but resembling *everetti*. Pocock accepts it as a subspecies of *hosei*. It lacks the white spot on the forehead present in *hosei* and *everetti*, besides other differences in pigmentation and hair pattern.

6. **Presbytis sabana** (Thomas) *Ann. Mag. Nat. Hist.* (6) XII, 230, 1893.

Paitan Leaf-monkey

Distribution. Borneo; lowlands of north-east coast from Paitan Bay to Sandakan Bay.

Remarks. A very distinct form with two frontal whorls close to the brow and a high pointed crest rising between them, and not extending on to the occiput. In colour much like *P. hosei* but with no white on the head.

7. **Presbytis cruciger** (Thomas) *Ann. Mag. Nat. Hist.* (6) X, 475, 1892.

Cross-bearing Leaf-monkey

Distribution. Borneo.

Remarks. There is considerable doubt about the validity of this species. Banks (1930) regarded it as a hybrid between the blackish *P. chrysomelas* of the lowlands and the erythristic *P. rubicundus* of the mountains, chiefly on distributional grounds. Chasen and Kloss (1931) and Pocock (1938) regard it as a red and black mutant of *chrysomelas*. It is reddish in general colour with a cross shaped dark mark on the shoulders.

8. **Presbytis rubicunda** (Müller) *Tijdsch. Nat. Geschied.* V, 137, 1841.

Maroon Leaf-monkey

Distribution. Borneo, typically the south-eastern part of the island.

Remarks. An invariably erythristic form, the general colour being a deep maroon or chestnut. The newborn is said to be white, without the "*cruciger*" pattern. The hair arrangement on the head resembles that of *P. aygula*.

Races. Whether or not this species is represented in various parts of Borneo by geographical races is rather uncertain. Besides the typical form, which hails from the south-eastern part of the island, at least three others have been described on rather precarious grounds. These are (*a*) *P. r. carimatae* Miller, 1906, from Carimata Island, S. W. Borneo, (*b*) *P. r. ignita* Dollman, 1909, from Mt. Mulu in Sarawak, and (*c*) *P. r. rubida* Lyon, 1911, from S. W. Borneo.

Chasen and Kloss (1931) only admit the typical form and Dollman's *ignita*, which differs in having paler hands and feet, instead of the black of the typical form. Pocock (1935) leaves the matter in doubt, which seems to be the reasonable course until we know more about this species.

9. **Presbytis frontata** (Müller) *Tijdschr. Nat. Geschied.*, V, 136, 1838.
White-fronted Leaf-monkey

Distribution. Borneo. Exact limits uncertain, but at least from N. W. to S. E. across the island.

Remarks. A well defined species distinguished by the naked area on the forehead and complete absence of brow fringe. There are two whorls on the hairy part of the scalp, with an upstanding crest between them.

Races. Elliot (1909) gave the name *nudifrons* to a form from Sarawak. This may prove to be racially distinct, but present evidence is uncertain.

Genus **Pygathrix** Geoffroy, 1812

Doucs

Type. P. nemaeus (Linn.) 1771.

Distribution. Indo-China.

Generic characters. Apparently nearest to *Trachypithecus* but differs in cranial characters and in colour pattern The new-born young is said to be intermediate between that of *Trachypithecus* and *Presbytis.*

1. **P. nemaeus** (Linnaeus) *Mantissa Plant.*, 571, 1771
Douc or Cochin-China Monkey

Distribution. Cochin-China.

Remarks. Distinguished by flesh coloured face, white forearms and brown crural region.

2. **P. nigripes** Milne Edwards, *Nouv. Arch. Mus.*, VI, 7, 1871
Black-footed Douc

Distribution. Cochin-China and Annam.

Remarks. Probably only a subspecies of the last. It is more melanistic, having blackish face, forearms grey and crural region, with feet, black.

A third race described as *P. nigripes moi* by Kloss (1926) from Annam is of doubtful validity.

Genus **Presbytiscus** Pocock, 1924

Tonkin Snub-nosed Monkeys

Type. *P. avunculus* (Dollman)

Distribution. Tonkin.

Generic Characters. This is the first of a group of genera distinguished by the up-turned external nose. It differs from the others in the form of the extremities, the palm and sole being short, but the digits long.

1. **Presbytiscus avunculus** (Dollman) *Abstr. P. Z. S.*, 18, 1912

Dollman's Snub-nosed Monkey

Distribution. Tonkin.

Remarks. The only species of the genus.

Genus **Rhinopithecus** Milne-Edwards, 1872.

Snub-nosed Monkeys

Type. *R. roxellanae* (Milne-Edwards)

Distribution. China and E. Tibet.

Generic Characters. Nose as in preceding, but hands and feet have long palm and sole, with digits of normal length.

1. **Rhinopithecus roxellanae** (Milne-Edwards) *Comptes Rend.*, LXX, 841, 1870.

Orange Snub-nosed Monkey

Distribution. N. W. China to Kokonoor and Kansu-Kinsu, N. W. Sze-chuen at high altitudes. E. Thibet.

Remarks. Dorsal surface greyish black, with some silver spangling. Cheeks, forehead and ventral surface deep orange.

2. **R. bieti** Milne-Edwards, *Arch. Mus. Hist. Nat.* X, 121, 1896

Yunnan Snub-nosed Monkey

Distribution. Yunnan Province, China.

Remarks. Less brilliantly coloured than *R. roxellarae*, main colours being black, brown and white.

3. **R. brelichi** Thomas, *P. Z. S.*, 224, 1903.

Brelich's Snub-nosed Monkey

Distribution. Van Gin Shan Mountains, Central China.

Remarks. A very large species with an oval white patch between the shoulders.

Genus **Simias** Miller, 1903

Short-tailed Snub-nosed Monkeys

Type. *S. concolor* Miller, 1903.

Distribution. Mentawey Islands, W. Sumatra.

Generic Characters. Nose as in *Rhinopithecus*, but extremities similar to *Presbytiscus*. Differs from all other Leaf-monkeys in having a short, slender tail, which is almost naked, except at the tip.

1. **S. concolor** Miller, *Smiths, Misc. Coll.*, 671, 1903.

Distribution. Mentawey Islands.

Remarks. The only species of the genus. It exists on several of the islands of the Mentawey group and has been separated into two races by Chasen and Kloss (1927).

(*a*) *S. c. concolor* Miller, 1903.

Pagi Island Snub-nosed Monkey

Distribution. South Pagi Island and Sipora.

Remarks. Head and upper parts clove brown. Limbs similar, but becoming black on hands and feet. Underparts pale.

(*b*) *S. c. siberu* Chasen and Kloss *P. Z. S.*, 1927.

Siberut Island Snub-nosed Monkey

Distribution. Siberut Islands.

Remarks. Like the typical form, but darker, especially on the rump. Limbs concolorous with the black hands and feet. Underparts fuscous-black.

Genus **Nasalis** E. Geoffroy, 1812

Proboscis Monkeys

Type. *N. larvatus* (Wurmb).

Distribution. Borneo.

Generic Characters. Adults of both sexes distinguished by long, pendulous nasal organ, overhanging the upper lip. Young have a nose similar to *Rhinopithecus.*

1. **Nasalis larvatus** (Wurmb) *Verhandl. Batav. Genootsch.*, III, 145. 1781.

Proboscis Monkey, Long-nosed Monkey

Distribution. Borneo.

Remarks. The only species of the genus.

REFERENCES TO LITERATURE

BANKS, E., 1930—*P. Z. S.*, pp. 693-695 (Bornean Leaf-monkeys)

CHASEN, F. N. and KLOSS, C. B., 1927—*P. Z. S.*, pp. 139-141 (Leaf-monkeys of Mentawey Islands)

1931—*Bull. Raffles Mus.*, Singapore, No. 6, pp. 5, 6 (*cruciger*)

ELLIOTT, D. G., 1909—*Ann. Mag. Nat. Hist.* (8), IV, p. 266 (*nudifrons*)

1913—*Review of the Primates*, II, pp. 19-114

FORBES, H. O., 1896—*Handbook to the Primates*, II, pp. 100-148

GYLDENSTOLPE, N., 1920—*K. Sv. Vetensk. Akad. Handl.*, LX, p. 9

HILL, W. C. O., 1934—*Ceylon J. of Sc.*, B, XIX, pp. 23-88 (Purple-faced Monkeys)

1936a—*Ceylon J. of Sc.*, B, XX, pp. 115-133 (Purple-faced Monkeys)

1936b—*Ceylon J. of Sc.*, B, XX, pp. 211-251 (Pre-natal development of *Semnopithecus*)

1937—*P. Z. S.*, B, pp. 205-216 (Primates of Travancore)

JERDON, T. C., 1874—*Mammals of India*, pp. 3-9

KLOSS, C. B., 1926—*Ann. Mag. Nat. Hist.* (9), XVIII, p. 314 (*Pygathrix moi*)

MILLER, G. S. junr., 1934—*J. Mammalogy*, XV, pp. 124-137 (*Presbytis femoralis* group)

POCOCK, R. I., 1928—*J. Bombay Nat. Hist. Soc.* XXXII, pp. 472-504, 660-677 (Leaf-monkeys of British India)

1931a—*J. Bombay Nat. Hist. Soc.* XXXV, pp. 51-59 (*anchises*)

1931b—*J. Bombay Nat. Hist. Soc.*, XXXV, pp. 276-288, 297-311, 530-551 (Macaques)

1935—*P. Z. S.*, pp. 895-961 (Leaf-monkeys east of Bay of Bengal)

SCHWARZ, E., 1928a—*Zeitsch. für Säugetierkunde*, III, 88. 92-97 (*Colobus*)

1928b—*Ann. Mag. Nat. Hist.* (10) I, pp. 649-663 (*Cercopithecus*)

SODY, H. J. V., 1930—*De Trop. Natuur*, XIX, p. 68 (*Presbytis aygula fredericae*)

1931—*Natuurk. Tijdschr. Ned. Ind.*, pp. 258-261 (*T. p. kohlbruggei*)

1937—*P. Z. S.*, B, p. 257

THOMAS, OLDFIELD, 1892—*P. Z. S.*, p. 582, pl. XLI (*P. everetti*)

EXPLANATION OF PLATES

PLATE XXXIV

Semnopithecus entellus, subadult ♂ from Bengal

PLATE XXXV

Semnopithecus priam, adult ♂ from Ceylon

PLATE XXXVI

Kasi johnii, adult ♀ from Peermade, Travancore

PLATE XXXVII

Trachypitheous obscurus flavicauda, adult ♂ from Sritamarat, Peninsular Siam

PLATE XXXVIII

Presbytis melalophus, adult ♀ from Palembang, S. Sumatra

[Received for publication, July 27, 1938]

Semnopithecus entellus ♂

Semnopithecus priam ♂

Kasi johi

Trachypithec u l unu

Presbytis melalophus ♀

PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1936-1937 SESSIONS

Twenty-fourth Annual General Meeting

Minutes of the 24th Annual General Meeting, held 18-11-1936, at 5.30 P.M., in the Lecture Hall of the Colombo Museum. The President occupied the chair and there was an attendance of 45 members and visitors. After the minutes of the previous meeting were read and confirmed, Mr. D. Y. Padmaperuma, was elected an Ordinary Member of the Society.

The following Office-bearers were elected for the session 1936-37 :—

Patron.—H. E. Sir R. E. Stubbs, G.C.M.G.

Vice-Patrons.—Sir Solomon Dias Bandaranaike, K.C.M.G., Hon. Mr. D. S. Senanayake, the Minister of Agriculture and Lands.

President.—Prof. F. O'B. Ellison.

Vice-Presidents.—Mr. D. R. R. Burt, Dr. A. Nell, Prof. W. C. O. Hill, Prof. N. G. Ball, and Mr. A. H. Malpas.

Honorary Secretary.—Mr. D. C. Gunawardena.

Honorary Treasurer.—Mr. P. Kirtisinghe.

Council.—Messrs. E. C. T. Holsinger, P. E. P. Deraniyagala, G. M. Henry, L. G. O. Woodhouse, Dr. P. C. Sarbadhikari and Dr. S. E. Fernando. No student Member was elected.

Prof. F. O'B. Ellison and Mr. E. C. T. Holsinger were nominated for the office of President. A ballot resulted in Prof. Ellison being elected by 10 votes to 7. The new President thanked the Society for the honour they had done him and proposed a hearty vote of thanks to the retiring Office-bearers.

After the adoption of the reports of the Honorary Secretary and the Honorary Treasurer, Prof. W. C. O. Hill exhibited a preserved specimen of a double-headed calf, and a live specimen of a Lion Marmoset (*Leontocebus leoninus*).

Mr. A. H. Malpas then delivered his Presidential Address on " The Ceylon Pearl Oyster." The lecture was well illustrated. After explaining the general structure and life history of the Pearl Oyster, the lecturer referred to the cyst pearls which were most important commercially. The origin of pearls was still a matter of doubt. Pearls were not a natural product of the oyster, but an accidental one due to the stimulation of the mother of pearl cells by some foreign body. Reference was made to the commercial enterprise of Mr. Michimoto of Japan, who was well known for the culture of pearls.

In conclusion Mr. Malpas recommended research into the formation of pearls. Questions were asked by Prof. W. C. O. Hill, Messrs. P. Kirtisinghe, D. R. R. Burt and the President. The lecturer replied suitably.

Proceedings were brought to a close with a hearty vote of thanks proposed by the President to Mr. Malpas for his very interesting lecture.

One Hundred and Thirty-eighth General Meeting

Minutes of the 138th General Meeting, held 24-III-1936, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 35 members and visitors. After the minutes of the previous meeting had been read and confirmed, Mr. A. L. John Pulle was elected to represent the Student Members in the Council of the Society.

Prof. W. C. O. Hill exhibited a series of specimens showing the development of the Grey Leaf-monkey (*Semnopithecus priam*) before birth. As compared with the human embryo, that of the Grey Leaf-monkey showed very little difference at about nine mm. Various differences, however, appeared as time went on. The crest on the head was important as it distinguished the Grey Leaf-monkey from the Black Leaf-monkey and separated the Madras and Ceylon animals from those of Northern India which had no crest at all.

Mr. D. R. R. Burt described the New Zealand Tuatara (*Sphenodon*) which was rapidly becoming extinct. A skeleton of this ' living fossil ' was passed round. The skull showed an aperture in the centre of the forehead for a third eye found in primitive types, but this was covered with skin as in the case of the water monitor.

The President gave an account of methods of Colour Photography and showed a number of slides illustrating this process. Professors N. G. Ball and W. C. O. Hill showed some slides of colour photography which they had prepared, after which proceedings were brought to a close.

One Hundred and Thirty-ninth General Meeting

Minutes of the 139th General Meeting, held on 14-VII-1936 at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 39 members and visitors. After the minutes of the previous meeting had been read and confirmed Dr. L. Nicholls delivered his lecture on " The Food of the People of Ceylon." Dr. Nicholls had made an intensive study of the diets in use in Ceylon and of the effects on the poorer classes of the poor diets which many of them consumed. The lecture was illustrated with lantern slides and graphical sharts showing the heights and weights of children. From his nutritional survey Dr. Nicholls had arrived at the following conclusions :—

1. A considerable proportion of the skin eruptions and diseases of the teeth of the poorer classes are due to dietary deficiencies.

2. The diet of the vernacular school children was deficient in proteins, too rich in carbohydrates, insufficient in fats and oils and deficient in minerals and vitamin A.

3. The result of a difference in diet showed that the boys of the Royal College—composed mainly of the sons of the rich—were taller and heavier than the boys in the other secondary schools, who in turn were taller and heavier than the vernacular school boys.

4. Strict vegetarianism was bad for growing children and expectant mothers. There never was a vigorous well grown vegetarian race of men. If better races were to appear in Ceylon it was necessary to increase the production of foodstuffs of animal origin.

Mr. D. R. R. Burt, Dr. A. Nell and Prof. W. C. O. Hill and the Secretary offered remarks.

Proceedings were brought to a close by the Chairman who proposed a hearty vote of thanks to Dr. Nicholls for his very interesting and instructive lecture.

One Hundred and Fortieth General Meeting

Minutes of the 140th General Meeting, held on 8-IX-1936, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 92 members and visitors.

After the minutes of the previous meeting had been read and confirmed, Mr. G. M. Henry exhibited two Giant Moths and two species of the Tarantula. The Atlas Moth was one of the largest in the East. It made its cocoon specially on the cinnamon leaf, while the Tusser Moth, from which tussore silk was made, showed a partiality for the leaves of the country almond.

The two species of Tarantula, showed no cannibalistic tendencies nor did they eat birds, in spite of the popular reference to them as bird-eating spiders.

Mr. P. E. P. Deraniyagala, exhibited a live *Dryophis* (snake), popularly known as Henakandaya. Though it was much dreaded by people, it was only mildly poisonous. He next showed some crocodile skins and exhibited a brood of young crocodiles. The mother which belonged to the species *Crocodylus porosus* was shot in the Bolgoda Lake. Its skin, unlike that of other species, had a great commercial value. He proposed to watch the growth of the baby crocodiles and experiment on the possibilities of rearing them on a commercial basis.

Mr. P. Kirtisinghe demonstrated some specimens of fossilized crabs found in Trincomalie and described them briefly.

The President brought the proceedings to a close by displaying under the microscope different types of sand he had gathered from the seabeach at Hambantota. They possessed a remarkable richness of colour and in lustre were akin to precious stones.

One Hundred and Forty-first General Meeting

Minutes of the 141st General Meeting, held on 13-X-1936, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 20 members and visitors.

After the minutes of the previous meeting had been read and confirmed, the President gave a brief account of the formation of igneous rocks and exhibited under the microscope some slides of igneous rocks from the British Isles.

Prof. W. C. O. Hill exhibited a mounted specimen and the bones of a Sumatran Orang-utan and described it fully. It had died in course of shipment in Colombo. It was a rare and almost extinct form of Orang and was much larger than the Bornean type. This was clear by a comparison of the skeletons. But it was not quite certain whether they were two different species.

Mr. G. M. Henry next exhibited a caterpillar of the Tusser Moth and a small Centipede (*Orphnaeus brevilabiatus*). The Velvet Mite (*Trombidium grandissimum*) were parasitic on the grasshopper in the early stages and lived in burrows later. They were common in the dry regions during the rains. The Tarantula lives in crevices and dark places. Its bite is harmless to man.

The Secretary in a note on the Natural History of Mannar showed some photographs and exhibited specimens illustrative of the flora of Mannar. Those adapted to physical drought were the Umbrella Tree, the Cockspur Thorn and the Baobab Tree which was introduced to Ceylon by the Arabs in ancient times; while those adapted to physiological drought were *Salicornia*, *Suaeda* and *Sesuvium*.

Of zoological interest were the Mushroom-like sponge, the *Murex* the source of the ancient purple dye, and the Catfish or Crucifix Fish, the male of which guarded the nest and the young. The observation of Aristotle in the waters of the Acheolus was confirmed only in the 19th century by Agassiz who discovered a similar phenomenon in the American Catfish.

One Hundred and Forty-second General Meeting

Minutes of the 142nd General Meeting, held on 18-IX-1936, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 59 members and visitors.

After the minutes of the previous meeting had been read and confirmed Dr. R. L. Spittel gave a description of the life and habits of the Veddahs, illustrating his remarks by screening two reels depicting Veddah life. At the conclusion of the lecture several questions were asked to which the lecturer replied suitably and the meeting terminated.

One Hundred and Forty-third General Meeting

Minutes of the 143rd General Meeting, held on 8-XII-1936, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 23 members and visitors.

After the minutes of the previous meeting had been read and confirmed, Dr. A. W. R. Joachim delivered his lecture on "The Important Soil Groups of Ceylon and their General Distribution". Before dealing with the subject proper, the lecturer outlined the principle and methods underlying modern soil classification and survey work. He then classified the major soil groups of Ceylon as follows :—

1. The laterite and lateritic, red and yellow loams of the wet and dry zones.

2. Soils derived from limestones (Miocene and crystalline) and Jurassic rocks red loams.

3. Organic deposits overlying red and yellow earth—the patna soils fern-land or kekilla soil and low lying peat soils.

4. Residual and transported deposits—Coconut soils, cinnamon soils and gravelly soils.

5. The recent alluvial and marine deposits—paddy soils and coastal sands.

The lecture was illustrated by several charts and a map and some samples of Ceylon soils were exhibited. After a few questions were asked and suitably replied to, the Chairman expressed the thanks of the Society to Dr. Joachim for his interesting lecture after which proceedings were brought to a close.

One Hundred and Forty-fourth General Meeting

Minutes of the 144th General Meeting held on 12-I-1937, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 30 members and visitors.

After the minutes of the previous meeting were read and confirmed, Mr. P. E. P. Deraniyagala delivered a lecture on " The Big Game Fishes of Ceylon ". A game fish was not merely a large fish but one that fought hard until it was landed. Big game fishes were of interest in that they disclosed distinct migratory tendencies and serve in studying those seasonal changes in the ocean that affected the migrations of the other food fishes.

The best known fresh water game fish was the Mahseer (Lehella) found in the rivers and around Rakwana. Next was the Valleya, a catfish. The Ara (*Ophiocephalus marulius*) frequently leapt at Kingfishers and at times seized snakes basking on branches overhanging the river. The lagoons had two good game fishes: the Modha (*Lates calcarifer*) and the Kalava (*Polydactylus sexifilis*). They were common at Elephant Pass. Strictly marine were the Mackerel-like forms, which are the swiftest and strongest of the hard-boned ocean fishes. The Sier-fishes (Thora) were common especially off Point Pedro.

The Tunnies or blood fishes were the Bonito (Balaya) used in the preparation of Maldive fish and the smaller Atevalla. Dolphin fishes were beautifully coloured, their flesh was dark and resembled meat. The best of the game fishes were the beaked forms. The Broad-billed Sword Fish (Kadu Koppera) was now known to be found in the Indian Ocean. The big game fishes were important for economic purposes and sport. With careful mapping out of the regions and periods of migration, extensive fishing could be begun in the Indian Ocean as is done in the Pacific.

At the conclusion of the lecture several questions were asked to which the lecturer replied. A suggestion was made to the Council of the Society to consider the alteration of the time of the meeting from 5.30 to 6 P.M. After a hearty vote of thanks proposed to the lecturer by the President, the meeting terminated.

Twenty-fifth Annual General Meeting

Minutes of the 25th Annual General Meeting, held on 9-II-1937, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 41 members and visitors.

After the minutes of the previous meeting had been read and confirmed, Mrs. L. M. Steele and Mr. A. C. J. Wirakoon were elected ordinary members of the Society.

The Reports of the Honorary Secretary and Honorary Treasurer were then adopted.

The following Office-bearers were elected for the session 1937-1938:—

Patron.—H. E. Sir R. E. Stubbs, G.C.M.G.

Vice-Patrons.—Sir Solomon Dias Bandaranaike, K.C.M.G., Hon. Mr. D. S. Senanayake, the Minister of Agriculture and Lands.

President.—Prof. W. C. O. Hill.

Vice-Presidents.—Prof. N. G. Ball, Mr. A. H. Malpas, Dr. P. C. Sarbadhikari, Mr. W. W. A. Phillips, Prof. F. O'B. Ellison.

Honorary Secretary.—Mr. D. C. Gunawardena.

Honorary Treasurer.—Mr. P. Kirtisinghe.

Council.—Mr. P. E. P. Deraniyagala, Mr. G. M. Henry, Dr. S. E. Fernando, Mr. D. R. R. Burt, Dr. A. Nell, Mr. R. B. Naish.

Prof. F. O'B. Ellison delivered his Presidential Address on "Living Lights". He said that the property of giving off light is found in plants only among the fungi; some bacteria and some mushrooms alone showing the phenomena of luminosity. The claim has been made for some mosses, e.g., *Schistostega osmundacea* found in caves, and even some flowering plants, but the apparent light from the former is only reflected light, like a cat's eye in the dark or a luminous reflecting road sign, and luminosity in the latter has not been confirmed. Some bacteria and some mushrooms, however, shine brightly. Luminous bacteria are used for testing filters for leaks.

Luminous animals on the other hand are found among the Protozo, Coelenterata, Molluscoide, Annulata, Echinodermata, Arthropoda, Mollusca and the Chordata, but no fresh water forms are known.

The nature of the light: It is due to a chemical reaction. A protein *luciferin* (very stable and may be boiled with acid) is oxydised to *oxyluciferin* by an enzyme *luciferase*, not necessarily in the animal's body but often in the surrounding water into which the mixture is discharged, but oxygen must be present.

The light is remarkable for its economy, practically no heat being produced. Efficiency 96 per cent., electric arc 7 per cent., ½ watt lamp 3 per cent., Spectrum yellow to blue only.

Structure of light organs: light often associated with granules. The structures are glandular or eye-like.

Function of the light production: in bacteria probably accidental, also in fungi and protozoa.

In some it may be a warning sign; in others a lure for its prey. In some worms, a distraction, like the wriggling, severed tail of a lizard. In the deep-sea fishes, undoubtedly for a lantern to find their way about and see their food, as it is pitch dark below 2,000 feet and luminous fishes have good large eyes.

The lecture was fully illustrated and a very interesting discussion followed in which several members took part. The President proposed a hearty vote of thanks to the lecturer for his very illuminating address.

Two decisions of the Council were then announced to the meeting (*a*) that meetings would in future be held at 6 P.M. and not at 5.30 P.M. (*b*) that each lecturer or exhibitor should give the Secretary a summary of his talk for insertion in the minutes and later in the *Ceylon Journal of Science*. This summary should reach the Secretary at least 10 days before the next meeting; otherwise there would be no report of the talk either in the minutes or in the Proceedings which are published in the *Ceylon Journal of Science*.

One Hundred and Forty-sixth General Meeting

Minutes of the 146th General Meeting, held on 9-III-1937, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 31 members and visitors.

After the minutes of the previous meeting were read and confirmed, Dr. A. Nell read a paper on the Proposed Fauna and Flora Ordinance.

The Honorary Secretary exhibited nests of the Weaver bird, *Ploceus philippinus*, from Katuwana in the Southern Province, and Tamarisk plants from the mouth of the Aruvi Aru. There were many theories of the so called ' male nest ' and the truth could be arrived at only by field observations. Mr. G. M. Henry referred to the field observations of Mr. S. Ali in an issue of the *Journal of the Bombay Natural History Society*, which disproved the old theories. The Tamarisk, *Tamarix indica*, a variety of which is referred to as the manna in the Bible, flourished on the sand-banks of the Aruvi Aru. The *Mahavamsa* showed that the Tamarisk was once cultivated as an ornamental tree in the Royal Park at Anuradhapura. The shrub is beautiful in foliage as well as in flower, and its cultivation in Colombo gardens was worth considering.

The President showed a coloured cinematograph film (on a projector kindly lent by Dr. R. L. Spittel), which he had taken during December, 1936, when the Pelicans and the Painted Storks at the Museum Zoo, were engaged in nest building and incubating eggs. The Pelican was shown sitting on her nest made of sticks on top of one of the large aviaries. The male bird was shown on guard at the top of one of the high trees. On one side of the Pelican's nest, was shown a nest also of sticks, &c., built by the Painted Storks. The second half of the film showed the waterfowl being fed with fish at the pond. Besides the species already mentioned, examples of Spoonbill, Ibis, Grey Heron and Parson Stork, were presented on the film.

It was decided to celebrate the 25th Anniversary of the Society by a Natural History Exhibition. The Secretary was requested to make the necessary arrangements and invite the co-operation of the members and of kindred Societies. The meeting then terminated.

Twenty-fifth Anniversary Celebrations

The 25th Anniversary Celebrations was held on 27-VII-1937 at 5 P.M., in the Lecture Hall of the Colombo Museum.

The exhibits and demonstrations were as follows :—

Prof. W. C. O. Hill.— The Evolution of Primates. / The Evolution of the Primate Brain.

Dr. A. Nell.—Prehistoric Stone Implements.

Prof. F. O'B. Ellison.—Radiation Pressure of Light.

Miss A. K. Joshua.— Vertebrate Embryology. / Plant Nutrition.

Dr. P. C. Sarbadhikari.—Some living and ancient Plants.

D. C. Gunawardana, Esqr.— Male Nests of the Weaver Bird. / Branched Areca Palm.

W. Richard de Silva, Esqr.—Fungi, Thorny Plants, &c.

Lantern Slides.

Rev. Fr. M. J. Le Goc, O.M.I.— Cycas. / Double Orchids.

Prof. F. O'B. Ellison.—Ceylon Sunsets in Colour.

Prof. W. C. O. Hill.—Photographs of Living Primates.

A large number of visitors were present. Explanatory talks on their exhibits were given by the President, Prof. F. O'B. Ellison, Dr. A. Nell, and Miss A. K. Joshua and Fr. M. J. Le Goc.

Tea was served at 5.30 P.M.

The President brought the meeting to a close by thanking all the members and visitors for their kind presence and encouragement. The Secretary wishes to express his sincere thanks to those members who co-operated with him to make the exhibition a success by their exhibits and demonstrations.

One Hundred and Forty-eighth General Meeting

Minutes of the 148th General Meeting held on 14-IX-1937, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 29 members and visitors.

After the minutes of the previous two meetings were read and confirmed, Prof. E. K. Wolff delivered his lecture "On the Principles of Prevention of Tuberculosis in Ceylon". The lecture was well illustrated. (See *C. J. of Sci. D.* Vol. IV, pp. 165-178 for full account.)

Proceedings were brought to a close by the Chairman who proposed a hearty vote of thanks to the lecturer.

One Hundred and Forty-ninth General Meeting

Minutes of the 149th General Meeting held on 19-X-1937, in the Lecture Hall of the Colombo Museum.

The President occupied the chair and there was an attendance of 24 members and visitors.

After the minutes of the previous meeting were read and confirmed, Prof. E. K. Wolff, M.D.; Mr. J. R. de la H. Marett, B.Sc., and Mr. P. I. Roberts, B.A., were elected ordinary members and Messrs. T. Samuel, T. de Kretser, and K. C. A. Silva were elected student members.

Mr. G. M. Henry exhibited three grasshoppers (*Tettigoniidae*) and briefly explained their habits.

Mr. J. R. de la H. Marett then delivered his lecture on the "Genetical Theory of Natural Selection". After a brief outline of the mechanism of heredity as understood to-day, the lecturer set out first of all to describe the effect on the Darwinian hypothesis produced by the discoveries of Mendel and of the many facts of genetical science that have since been established. Modern genetics sprang from the work of Morgan who showed that what Bateson had recognized as unit hereditary characters or Mendelian factors must be the result of so-called genes lineally arranged on the chromosomes that were visible within the cell nuclei. Following the development of a technique of fruit-fly breeding, whereby genes could be mapped and their progress traced through succeeding generations, Müller and others were able artificially to transform these gene-effects thus bringing about the mutations first recognized by de Vries and since his day regarded as the most probable source of that novelty on which the constant variability called for by the theory of Evolution through Natural Selection must depend.

None the less, closer acquaintance with the facts of modern genetics revealed almost as many shortcomings in the so-called genetical theory of Natural Selection as it provides supports. Thus the lecture resolved itself into a brief recapitulation of some difficulties that are fairly well recognized followed by an attempt to offer some constructive and in some cases original suggestions as to how, despite the apparently unsatisfactory device of random mutation, certain accelerating and regulatory devices might together be believed to have used it as a foundation and so, in combination with it, contributed towards the adaptational perfection that we observe in Nature. The devices in question which were dealt with serially, were inbreeding, sexual selection, racial mixture, and a fourth so-called Neo-Lamarckian process based on a presumed variability in the inherited capacity for self modification through effort and experience.

An interesting discussion followed, after which a vote of thanks was passed to Mr. Marett for his interesting lecture.

One Hundred and Fiftieth General Meeting

Minutes of an Extraordinary General Meeting held on 6-XII-1937, at 9 P.M. in the Lecture Hall of the Colombo Museum.

His Excellency the Governor presided and there was a large attendance of members and visitors. Prof. W. C. O. Hill demonstrated two preserved specimens of the primitive South American Monkey *Aotes*.

Mr. L. G. O. Woodhouse then delivered his lecture on "Ceylon Butterflies" The lecture was well illustrated. The meeting terminated with a vote of thanks proposed by the Chairman to Mr. Woodhouse for his interesting lecture.

All blocks illustrating this Part by courtesy of the Survey Department, Ceylon.

PRINTED AT THE CEYLON GOVERNMENT PRESS, COLOMBO.

22——J. N. 81289 (1/39)

INDEX.

A

B

D

M

N

U

V

PRINTED AT THE CEYLON GOVERNMENT PRESS, COLOMBO.