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EDITORIAL NOTICE.

In consequence of the departure of Dr. A. Willey from Ceylon the editorship of this journal has been taken over for the time being, in accordance with Government approval, by the Government Entomologist.

E. ERNEST GREEN,
Government Entomologist,
Royal Botanic Gardens, Peradeniya.

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BY

ALDO CASTELLANI, M.D. (Florence),

Director of the Clinique for Tropical Diseases, Ceylon ; Professor of Tropical Medicine and Lecturer on Dermatology, Ceylon Medical College ; Member of the Royal Society's Commission on Sleeping Sickness in Uganda (1902–1903).

AND

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SPOLIA ZEYLANICA.

"MIMICRY" IN CEYLON BUTTERFLIES, WITH A SUGGESTION AS TO THE NATURE OF POLYMORPHISM.

By R. C. Punnett, M.A.,

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(With two coloured Plates.)

BEING interested in the striking resemblances in colour and pattern which are to be found between butterflies belonging to different genera and families, I took advantage of a visit to Ceylon during the past summer (1909) to observe as many as possible of these cases in the living state. Though my stay on the Island was a short one—two months only—it was mainly devoted to the study of these phenomena, and as I have arrived at definite conclusions on some points, I have thought it worth while to place on record my observations, together with the few experiments that I was able to undertake.

Before, however, proceeding to my subject-matter, I wish to make certain acknowledgments. To my friends, Dr. Willey and Mr. R. H. Lock, I am grateful for unwearying kindness and for generously giving me all the assistance that was in their power. I owe also a debt of gratitude to Mr. E. E. Green for placing freely at my service his encyclopædic knowledge of the insects of Ceylon, and for a consignment of butterflies which arrived shortly after my return. To Col. Manders and to the Hon. Mr. F. Mackwood I am indebted for information; to the latter also for several specimens. Lastly, I wish to acknowledge the kindness of Prof. Poulton, who was good enough before my departure to give me some duplicate specimens illustrating the most conspicuous cases of mimicry in Ceylon butterflies, thereby materially lightening my task of becoming familiar with a strange fauna.

The Principal Cases of Mimicry in Ceylon Butterflies.

Though the Rhopaloceran fauna of Ceylon is not a rich one in comparison with that of most tropical countries, several cases have nevertheless made their way into the literature of mimicry. These cases I have put together in the following list :—

Mimic.	Model.*
Hypolimnas bolina, ♀ ..	... *Euplœa* (several species)
,, *misippus*, ♀ ..	.. *Danais chrysippus*
Elymnias fraterna, ♀ ..	.. ,, *plexippus*
Argynnis hyperbius, ♀ ..	.. ,, —
Pareronia ceylonica, ♀ ..	.. ,, *vulgaris* (and allies)
Prioneris sita, ♂ and ♀ ..	.. *Delias eucharis*, ♂ and ♀
Papilio clytia, ♂ and ♀ ..	.. *Euplœa* (several species)
,, (var. *dissimilis*) ♂ and ♀ ..	.. *Danais vulgaris* (and allies)
Papilio polytes, ♀ ..	.. *Papilio aristolochiæ*
,, (var. *romulus*) ♀	.. ,, *hector*

With the exception of *Argynnis hyperbius* and *Prioneris sita* I have had frequent opportunities of observing all these cases, and in every one it has appeared to me that the resemblance is far less striking when the insects are seen alive than when they are exhibited pinned out in the orthodox way on cork. I have found that with very little experience the eye comes to distinguish the "mimic" from the model without hesitation. As a rule, it is in mode of flight that they differ from one another. By this character the *dissimilis* variety of *P. clytia* can at once be distinguished from *Danais vulgaris* and its allies, and by it the normal form of *P. clytia* or the female of *Hypolimnas bolina* (Pl. II., fig. 6) can be readily differentiated from any of the *Euplœas*. Or again, it may be a difference in the pattern of the under surface of the wings which leads to dissimilarity in the general appearance of the living insects. The female of *Pareronia ceylonica* (Pl. II., fig. 1 B) with outspread wings is exceedingly like *Danais vulgaris* and the other closely allied species of this genus. But as soon as it flies off the difference of under surface at once becomes apparent (*cf*. Pl. II., figs. 1 C and 2 B), and in this particular instance there is also a marked difference in the manner of flight, so that these forms, although so extraordinarily similar when viewed from the upper surface and at rest, could certainly not be confused when flying. And when at rest, of course with the wings closed, they could not possibly be mistaken for one another.

One of the best known of the Ceylon models is *Danais chrysippus*, together with its ally *D. plexippus* (Pl. II., figs. 9 A and 9 B), and the three principal mimics of these two forms are the females of *Hypolimnas misippus*, *Argynnis hyperbius*, and the Satyrid, *Elymnias fraterna*. Of these three, the last-named was the one I had most opportunity of observing. It was common in Colombo during July,

* I have also seen it suggested that *Elymnias singhala* mimics *Euplœa core*, and that *Ergolis* serves as a model for the female of *Apatura parisatis*. In neither case does the resemblance seem to me sufficiently close to require further notice.

flying in places where both the models were also abundant. The colour pattern of *E. fraterna* (Pl. II., fig. 8 B) is less sharply cut than in either of the models, and this feature, combined with a somewhat different mode of flight and an entirely different scheme of colouration on the under surface (Pl. II., figs. 8 C and 9 B) is, for any but a quite unpractised eye, sufficient to identify this species at a distance of 20 feet or more away.

The case of *Hypolimnas misippus* female and *Danais chrysippus* is now so well known that it is unnecessary to dwell upon the extraordinary resemblance between these two insects as regards the upper surface of their wings. *H. misippus* I only met with occasionally, and never flying with the ubiquitous *D. chrysippus.* Its mode of flight is quite distinct, and had I seen them flying together my impression is that I should not have had much difficulty in picking it out from among the Danaids.

The relation of *Argynnis hyperbius* female to *Danais plexippus* is an interesting one. As the plate shows (Pl. II., figs. 9 A and 10 B), the two insects are quite distinct in appearance when set out in the ordinary way. But when flying, I am told by Col. Manders that they are extraordinarily alike. Now, *A. hyperbius* is a typical up-country insect, and is very rare below 4,000 feet. *D. plexippus*, on the other hand, is very rarely to be met with above 4,000 feet. The two forms only come into contact over a narrow zone on the confines of their respective territories, and for the most part their distribution is entirely separate. Under these circumstances it is difficult to believe that the presence of a distasteful species in another part of the Island, which looks like the Fritillary only during flight, can in any way benefit the latter by serving as a model.

Papilio clytia is a tailless form, dimorphic in both sexes. The brown form with orange-yellow spots on the margin of the hind wings (Pl. II., fig. 3 B) bears some resemblance to a *Euplœa* (Pl. II., fig. 11), while the other form [var. *dissimilis* (Pl. II., fig. 3 A)] is striped somewhat after the fashion of *Danais septentrionis* (Pl. II., fig. 2 A) and *D. vulgaris.* The ground-colour of the Papilio however is yellowish, while that of the Danaids is blue with a slight greenish tinge. The brown form I only met with once at close quarters, in the jungle just outside Trincomalee. *Euplœas* were very abundant at the time, but as the Papilio approached me I at once recognized that it was something different, and when caught it turned out to be *P. clytia.* Subsequently I saw several specimens in the open at Dambulla, and although I was unable to catch them there was no question of comparing them with *Euplœa*, owing to their general appearance and their stronger and bolder mode of flight. *P. clytia* var. *dissimilis* I saw first in the jungle near Sigiriya, and had no difficulty in recognizing it, though I could not get near enough to catch it among the trees. Later on I took it at Dambulla, where it was not unplentiful on the top of the rock. Danaids were also flying there, but there was no question of confusing the Papilio with them.

Putting aside for a moment the case of *Papilio polytes*, to which I shall refer later, my impression of all these so-called cases of mimicry, which I have been able to see, is that the resemblances are certainly not sufficiently close to deceive the eye of a civilized man with little experience of them. For that reason I am inclined to doubt whether they would systematically deceive an enemy brought up among them, whose means of earning a livelihood depended largely upon the readiness with which he could distinguish between mimic and model. I do not wish to deny that in some cases, and upon occasion, the resemblance may be of service. It is quite conceivable that an insectivorous animal with a distaste for Danaids would, when confronted with a choice between *Pareronia ceylonica* and a non-mimetic species, choose the latter so long as it only saw the upper surface of the former. And when the mimetic resemblance is already established, I see no difficulty in the supposition that the form which exhibits it is placed at an advantage with respect to natural selection compared with the non-mimetic form, provided that such resemblance to a distasteful model is a close one. But I feel that there are insuperable difficulties in the way of conceiving such resemblance to have *arisen* through the operation of natural selection. To this subject, however, I shall have occasion to refer later.

The Case of Papilio polytes.

Since 1865, when Wallace's well known memoir on "The Papilionidæ of the Malayan Region" appeared, this striking case has been regarded as one of the classic instances of mimicry. Excellent coloured representations of this species were given by that author, and more recently by Moore in his "Lepidoptera of Ceylon." It is also figured by Distant in his "Indo-Malayan Rhopalocera," but as these memoirs are not always readily accessible I have had prepared the coloured plate which will be found at the end of this paper. It has been made directly from the actual specimens (which were all fresh and perfect) by the four-colour process, and gives on the whole an excellent representation of the different forms shown.

P. polytes is a fly which is abundant throughout India and Ceylon, occurring both on the plains and on the hills wherever are to be found the citronaceous plants on which the larva (Pl. I., fig. 7) feeds. Throughout this region the male (Pl. I., fig. 1) is accompanied by three forms of female (Pl. I., figs. 4–6), of which two are so different from him as to have each been regarded at some former time as a distinct species, and it was not until Wallace studied them that the polymorphic nature of these females was understood. From

Wallace came also an interpretation of this peculiar case in terms of the theory of mimicry then just suggested by Bates. Briefly, that interpretation is as follows :—

P. polytes is a palatable insect. The larva feeds on citronaceous shrubs and trees and, in its later stages, is inconspicuous upon its food plant (*cf.* Pl. I., fig. 7). The chrysalis may be regarded as protectively coloured (Pl. I., figs. 8, 9).* Yet in this presumably palatable insect there exist two additional forms of female, which are characterized not only by marked divergence from the normal type, but by the conspicuous form which that divergence takes.† So far as can be seen there is no suggestion of ordinary protective colouration here. Now, living side by side with this species are two other species of Papilionid butterflies, *Papilio aristolochiæ* (Pl. I., fig. 5) and *Papilio hector* (Pl. I., fig. 6), each of which bears a strong resemblance to one of the two aberrant forms of female of *P. polytes*.‡ Both of these forms have conspicuously coloured red and black larvæ, which both feed upon the poisonous *Aristolochia* plants. Both are common species, and both consequently fulfil the conditions of abundance and distastefulness which the theory of mimicry exacts from qualified models. By their resemblance to these two unpalatable species the "mimicking" forms of *P. polytes* have been enabled to cheat their enemies and to preserve their species. And the case is the more striking in that while *P. hector* and the hector form of *P. polytes* are confined to India and Ceylon, both *P. aristolochiæ* and the aristolochiæ form of *P. polytes* have a wider range eastward.

For the upholders of the mimicry interpretation the resemblance between the model and its mimic would appear to have been brought about by the piling up of minute variations in the required direction through a process of survival of those most like the model. Upon the adequacy of this conception I do not wish to dwell, until I have offered some criticisms derived from personal experience with reference to the resemblance obtaining between the "mimics" and their "models."

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* The colour is very variable, though whether this is in relation to the surfaces on which it pupates is at present unknown. The two specimens figured here were bred by me under conditions which in so far as could be seen were exactly similar, though the one became clear green and the other a darkish brown.

† In the account which follows I have used the terms "male form," "aristolochiæ form," and "hector form," respectively, for these three females, terms which indicate sufficiently which form is meant for the reader who is not familiar with this species. Technically these three forms are respectively the *pammon*, *polytes*, and *romulus* forms of the species *P. polytes* (*cf.* "Fauna of British India, Butterflies," vol. II., pp. 61, 62).

‡ Though placed in the same genus as *P. polytes* these two species differ from it in many structural points, and will doubtless eventually find their way into another genus when the classification of the family has been placed on a more satisfactory basis. They are closely allied to each other and come into Haase's group of Pharmacophagus or "Poison-eaters."—("Bibliotheca Zoologica," 1891.)

First, as regards the likeness between model and mimic in either case. As seen pinned out in a cabinet the resemblance between *P. aristolochiæ* and the aristolochiæ form of *P. polytes* is, as far as general wing pattern goes, remarkably close, especially for the fore wings. Yet one cannot help feeling that one has to do with a different insect, and I think this is because of the difference in quality of the white patch on the hind wing. This patch is rather smoky in *P. aristolochiæ*, whereas in the *polytes* mimic it has a cleaner and brighter look. The other point of marked difference lies in the colour of the body, which, except for a dark stripe dorsally, is of a bright vermilion colour in *P. aristolochiæ*. This feature is not so well shown as it might be on the plate, owing to the fact that the body of the specimen had been laterally compressed in the paper to which it was transferred when caught. In the living insect, with its wings spread out at rest, the scarlet body is a most noticeable feature and at once arrests attention. In the aristolochiæ form of *P. polytes*, as the plate shows, the body is uniformly black, and this gives the resting insect quite a different appearance when its wings are expanded. In the absence of the bright vermilion colour, it lacks for the human observer the dangerous look of *P. aristolochiæ*.

The resemblance between *P. hector* and the hector form of *P. polytes* is not so striking as in the preceding case. The markings on the fore wings are remarkably similar, but the general ground colour, except in worn specimens, has a somewhat different appearance in the two species. In *P. hector* it is deeper in shade and has a distinct steely sheen, which is entirely wanting in *P. polytes*. In the hind wings there is a very distinct difference in the quality of the red. In *P. hector* it is a bright rich scarlet, while in *P. polytes* the red is much pinker, and its effect is further softened by a sparse powdering of blue scales. Perhaps the impressions which these two insects convey may be expressed by saying that the red of *P. hector* looks as if it had been got by an aniline dye, while that of *P. polytes* appears to have been put on with a more delicate water-colour. But in this case again, as in the preceding, it is the brilliant scarlet head and body of *P. hector* which at once makes it apparent that one has to do with a different insect. This feature immediately strikes the observer and, when the insects are at rest, makes it impossible to mistake *P. hector* even at a distance of several yards.

The insects, however, may be at rest with closed wings, and I have therefore represented in figs. 1 A–6 A the under surfaces of the hind wings of the same specimens used in figs. 1–6. A comparison of fig. 3 A with fig. 5 A at once brings out the great difference in the quality of the red in the two cases. The suggestion of aniline dye in *P. aristolochiæ* is very marked, and the striking difference in quality in model and mimic is even more marked in the actual insect than it appears to be on the plate. In *P. hector* (fig. 6 A) and the hector form of *P. polytes* (fig. 4 A) the under surface of the hind wing is very like the upper one, and what was written of the difference there applies here equally.

But it may be objected that though model and mimic may be readily distinguished at rest, whether with wings expanded or closed, yet the resemblance between them may be sufficient to deceive such enemies as attack them when flying. Such, however, is certainly not the case. The mode of flight of *P. polytes* is similar for all three forms, and is totally distinct from that of *P. hector* and *P. aristolochiæ.* In these two last species the flight is very peculiar. The insect steers a very even course for a butterfly, and looks as if it were flying mainly by means of its fore wings, which vibrate very rapidly. In *P. polytes*, on the other hand, the flight is of the somewhat lumbering up and down type, which is characteristic of many of the Papilionidæ. Though not easy to express in words, the difference is exceedingly marked, and the practised eye has no difficulty in distinguishing between *P. polytes* and *P. hector* or *P. aristolochiæ* at a distance of 40 to 50 yards.

During the time I was in Ceylon I spent many hours catching and watching these three species, where and whenever the opportunity presented itself, and I have come to be strongly of opinion that in the natural state the differences between these so-called models and mimics, whether resting or flying, are so distinct that they are little likely to be confounded by an enemy with any appreciation of colour or form.

And here I would draw attention to certain points in connection with the distribution of these species in Ceylon. During my stay on the Island I managed, with some assistance, to catch nearly 50 specimens of females of *P. polytes*, and I subsequently received 10 more specimens from Mr. E. E. Green, of which 4 (1 male form, 1 aristolochiæ form, and 2 hector form) were from Kandy or Peradeniya, and 6 (2 aristolochiæ form and 4 hector form) were from higher up-country, either at Pundaluoya or Hakgala. I have included these specimens in the following table, with the idea of comparing the distribution of these forms with that of the supposed models :—

	Trincomalee.	Colombo.	Anuradhapura.	Haragama.	Kandy and Peradeniya.	Pundaluoya and Hakgala.
Male form	14	5	—	—	1	—
Aristolochiæ form ..	5	2	—	1	1	2
Hector form ..	10	5	1	3	4	4

From this it appears that in the low-country, especially at Trincomalee, the male form is, generally speaking, not less abundant than either of the other two. At Colombo both *P. aristolochiæ* and *P. hector* are common, the former being exceedingly so. Most of the Trincomalee specimens came from close to the shore, between Forts Frederick and Ostenberg. The ground here is moderately open and dotted about with patches of scrub. *P. polytes* was abundant in September, but the female insect is difficult to catch, as it keeps flying rapidly across the open and diving into the heart of one thorny scrub patch after another, doubtless in search of the food plant. I managed to catch but a very small percentage of those I saw. Of the females (which were less numerous than the males), that resembling the male was far the most abundant, and was distinctly more numerous than the other two female forms together. Of these two, I caught more of the hector form than of the aristochiæ form, because the former is more easily distinguished from the male. Wherever there were several flies to chase I gave the preference to the female, and I have no doubt that I sometimes mistook the aristolochiæ form for a male *polytes*, with which it can be easily confused at a short distance away. On the whole, after many hours spent on this collecting ground, I came to the conclusion that, though the hector form may have been slightly more common, these two forms occurred in almost equal numbers. The relative abundance of these forms is of interest in connection with the occurrence of the models *P. hector* and *P. aristolochiæ*. The former is a common insect in this locality, though at the time I was there it was certainly not nearly so common as *P. polytes*. Of *P. aristolochiæ*, I never saw a single specimen during the whole of the time I was in Trincomalee, though I was always on the look out for it.

In Colombo, *P. aristolochiæ* is very abundant, and *P. hector* is not uncommon, though not nearly so abundant as its relative. One may see a dozen or more of the former to one of the latter. My experience of this locality as regards *P. polytes* was that the male form and the hector forms were about equally abundant, and that the *aristolochiæ* form was distinctly scarcer. Col. Manders, to whom I mentioned this, expressed himself of the same opinion.

Higher up, at Kandy and Peradeniya, *P. hector* becomes very scarce, while *P. aristolochiæ* is exceedingly abundant. Nevertheless, the hector form of *P. polytes* is certainly more numerous than the aristolochiæ form. During the month I spent in this part of the country I never saw either the aristolochiæ form of *P. polytes* or *P. hector*. Higher up-country, at Hakgala and Pundaluoya, *P. hector* is no longer found. Yet if one may judge by the samples procured from these parts, the hector form is distinctly the commonest form of *polytes* female.

Summing up such evidence as exists in connection with the distribution of our three species, the following statements may be taken as a fair presentation of the facts:—

(1) In the low-country the male form of *polytes* female is at least as numerous as either of the other forms, and may be the most abundant of the three.

(2) In the north-east of the Island, in the "hector" country, the aristolochiæ form of *polytes* is nearly as abundant as the hector form, though its model is at any rate exceedingly scarce.

(3) Higher up-country, where *P. hector* is rare or absent and *P. aristolochiæ* is common, the hector form of *polytes* is more abundant than the aristolochiæ form.

It is obvious that these statements are not in harmony with the ideas of those who look to the theory of mimicry for an explanation of the polymorphism that exists among the females of *P. polytes.* For if the hector form derives an advantage where *P. polytes* is found associated with *P. hector* (*e.g.*, at Trincomalee), why is it not far more numerous than the other two forms in such places? And if the co-existence of *P. aristolochiæ* in any locality confers a benefit of selection value upon the aristolochiæ form of *P. polytes*, how are we to reconcile this with the fact that where *P. aristolochiæ* is exceedingly abundant (*e.g.*, Kandy and Peradeniya) its supposed mimic is the scarcest of the three *polytes* females? And, again, if the selection has been so stringent as to give rise to two new forms of female in *P. polytes*, how comes it that the male form is in some places still the commonest of the three? It certainly cannot be due to "the atavistic influence of the male," for, as is well known, there are localities in which all the females are of the aristolochiæ form, while the male is of the normal type.

Whatever the true explanation may be, the facts connected with the distribution of these species in the Island of Ceylon are far from lending support to the view that the polymorphic females of *P. polytes* have owed their origin to natural selection in the way that the upholders of the theory of mimicry would lead us to suppose.

Some further criticism of the theory as applied to *P. polytes* will be offered in connection with the enemies of butterflies in Ceylon.

The Enemies of Butterflies in Ceylon.

Those who maintain that the resemblances which occur between butterflies of distinct species have arisen gradually through the operation of natural selection on minute variations have several difficulties to encounter. Apart from the question whether a minute variation can in many cases be conceived as having any sensible selection value, there is the further question of the nature of the enemies which give it this presumed value. In other words, what are the chief enemies of butterflies in the imago stage, and what evidence is there that they exercise discrimination in their Rhopaloceran diet? Information of this sort is notoriously difficult to obtain, and I have therefore not hesitated to put on record the following observations, meagre though they be, which appear to bear upon the point.

(*A*) *Birds.*—To what extent butterflies are preyed upon by birds is a question which has excited much controversy in recent years, and such information as exists upon the subject has lately been brought together by Marshall.* Many birds will undoubtedly devour butterflies upon occasion, though it seems unlikely, except in a few cases such as those of *Merops* and *Microhierax*, that they make a regular practice of it. From a nutritive point of view, there is a good deal of waste material in a butterfly. At the same time it is rather a cumbrous mouthful, and it is not unnatural to suppose that with insect life of other kinds abounding the bird would devote its attention to more succulent species. But a hungry bird will probably take what it can get, without inquiring very closely whether the insect belongs to what are termed unpalatable groups or not. Marshall, for instance, quotes observations of Doflein to show that *P. hector* may be captured by *Merops* in Ceylon.

During my ten weeks' stay in Ceylon and S. India, I endeavoured to keep my eyes open as far as possible to any evidence of butterflies being attacked by birds. Only on one occasion did I observe a bird directly attacking a butterfly. In Peradeniya, one day, at the edge of some jungle, I was cautiously stalking a specimen of *Papilio agamemnon*. When within about 6 feet of it, and in hopes of transferring a desirable specimen to my pocket, a magpie robin suddenly swooped down upon it. It completely missed the butterfly, which, however, to my regret, was scared away. Upon another occasion I noticed near Trincomalee a butterfly fluttering in the middle of the road. On examination it turned out to be a specimen of *P. agamemnon*, with the wings of the right side clean shorn away near the base. The specimen was otherwise uninjured. Though there is no direct evidence, it seems not unlikely that in this case a bird may have been responsible for the damage. This was all the evidence in favour of birds attacking butterflies that I was able to collect from personal observation, but my friend Mr. MacBride, of the Public Works Department at Trincomalee, told me that he had once seen crows catching butterflies as they swarmed round a flowering tree. Unfortunately he was unable to say for certain what the butterfly was, but from his description I am inclined to think that it was a species of *Euplœa* (probably *E. core*).

On the other hand, I have frequently watched birds hawking insects on some flowering tree where butterflies abounded, but have never seen them even offer to attack. Close to the verandah of a

* Trans. Ent. Soc., Lond., 1909.

bungalow in which I stayed near Tanjore was a tree with a little greenish flower which was very attractive to insects. It was not more than 30 yards from where I sat, and I was able with a pair of glasses to see very clearly what was going on. During the earlier part of the day the tree swarmed with butterflies, among which *Telchinia violæ*, *Delias eucharis*, *Papilio demoleus*, and several species of *Ixias*, *Terias*, and *Teracolus* were most noticeable. On it several minahs were generally hawking insects, and though butterflies were all round them, and sometimes even settled within a few inches of them, they never once offered to attack them while I was watching, but confined their attentions to flies and other insects. Though it may be granted that some of these species, notably *Telchinia* and *Delias*, are distasteful to birds, yet this can hardly be maintained of *P. demoleus*, which is a fairly close ally of the presumedly palatable *P. polytes*, the larva feeding on the same food plants and being in appearance practically indistinguishable from that of the latter species.

The general impression that I got from collecting in this part of the world is, that as serious enemies of butterflies in the imago state birds may be left out of account. When driven by stress of hunger they will no doubt attack them, but in such cases it is exceedingly improbable that they would exercise that discrimination between the so-called palatable and unpalatable species which is postulated by the supporters of the theory of mimicry.

So far as one can judge by observation the chief enemies of butterflies in Ceylon are lizards and Asilid flies, and it will be convenient to consider them apart.

(*B*) *Lizards*.—Two of the commonest species of Ceylon lizards are the "blood suckers," *Calotes versicolor* and *C. ophiomachus*. Both species have considerable power of changing their colour, which may range from a dull sooty brown to a bright green that is particularly brilliant in the latter species. Apparently they derive their popular name from the fact that the head and neck may assume a bright red hue, and it is conceivable that this may serve as a lure for insects. Both species commonly attain a length of 15–18 inches, inclusive of the long tail, though larger specimens are not infrequent. Both are bold, active animals, fond of the sun, and not easily frightened by man. The staple food of both species is insects of all sorts, and an examination of the contents of a number of stomachs shows that they will devour ants, cockroaches, earwigs, beetles, caterpillars, &c. In several cases I have been able to find the remains of butterflies, the characteristic heads of which resist the digestive juices of the reptile as well as the subsequent boiling in potash. Though I have never personally seen *Calotes* catch a butterfly under natural conditions, Mr. McBride and his wife assured me that they have not infrequently seen them doing so, and other observers have told me the same. I think there can be little doubt that *Calotes*, owing to its great abundance and arboreal habits, is one of the chief enemies of butterflies in Ceylon. And in support of this view may be cited the numerous instances in which one catches butterflies damaged in such a way that it is impossible to resist the deduction that something with a wide mouth has taken a bite out of the wings when they were closely apposed at rest. In such cases the shape of the injuries as well as their clean cut nature (*cf.* Pl. II., fig. 7) both point to their being the work of lizards rather than of birds.

Accepting then the lizard as being responsible for an appreciable share in the mortality of butterflies, the question arises as to whether he shows any preference for or dislike to this or that species. In order to obtain evidence on this point I kept a couple of lizards in large cages and introduced various butterflies at intervals. Owing to the wetness of the season while I was at Peradeniya, and the consequent difficulty of procuring butterflies of some of the species which I wanted during the time at my disposal, the experiments are not nearly so full as I could have wished. Nevertheless they are not without interest, and I give the record of a week's experiments with one of the lizards (" Sambo ").

Aug. 20.—Sambo was given three *P. aristolochiæ* this evening just before dark. One was damaged. and was found dead at the bottom of the cage next morning. The other two had been eaten.

Aug. 22.—Sambo ate another *P. aristolochiæ* which was given to him.

Aug. 23.—Sambo given four *Danais vulgaris* and a large diurnal moth (*Euschema maculata*), which might be regarded as a possible rough mimic of a Danaid. He at once went for the insects and ate two of the Danaids in the first 15 minutes. Eventually he ate all five.

Aug. 24.—Sambo was given a mixed lot, viz., one *Terias sp.*, one *D. vulgaris*, one *Junonia almana*, one *Mycalesis mineus*, and one *Mycalesis patnia*. He started by eating the *Terias* (a brilliant yellow Pierid) and the *Danais* in the first half hour. About 1½ hour later the others had also been devoured.

Aug. 25.—Sambo given a Hesperid, one *D. vulgaris*, and one *Delias eucharis*. He ate all without hesitation and with much apparent relish.

Aug. 26.—Sambo given in the afternoon one *Euplœa core* and one *Junonia iphita* (both are dark brown flies, the former being presumably distasteful). After a few hours he ate the *Euplœa*, while the *iphita* was eaten about 10 A.M. next morning.

From this record it is obvious that Sambo cannot be said to have exercised any discrimination in his choice of food. The presumedly distasteful *Danais* was eaten before the presumedly palatable *Euschema* or *Mycalesis*, and the so-called distasteful *Euplœa* was taken before the supposedly palatable *Junonia iphita* of not very dissimilar colouration. Nor was any hesitation manifested towards *Papilio aristolochiæ* with its postulated evil taste and marked warning colouration.

As *P. aristolochiæ* has been regarded from the nature of its food plant as one of the most unpalatable of all the Ceylon butterflies, I may mention another experiment which was made in connection with its larva. In a cage containing two specimens of the lizard *Lyriocephalus* I placed four full-grown larvæ of *P. aristolochiæ*, an imago each of *Danais chrysippus* and *D. plexippus*, together with some twenty grasshoppers. They were all introduced one evening, and on examining the contents of the cage next morning I found that the lizards had eaten several of the grasshoppers, the specimen of *D. plexippus*, and two of the *P. aristolochiæ* larvæ, and this in spite of the marked black, white, and red warning colouration of the latter. The remaining two larvæ had crawled to the top of the cage out of harm's way.

From such experiments as these one can hardly fail to draw the conclusion that *Calotes* as well as *Lyriocephalus* will readily eat anything in the way of butterflies that they come across. Nor is this surprising, in view of the fact that such noxious creatures as the large red ant (*Œcophylla smargdina*) and hairy caterpillars constitute a considerable proportion of the contents of their stomachs. They certainly do not appear to exercise that nice discrimination with regard to butterflies, which is necessary for the establishment of mimicking forms on the theory of natural selection. And here I may call attention to the series of experiments by Finn, as the result of which that author was led to a similar conclusion. The experiments were made both with lizards in captivity and with lizards at liberty, and the author sums up his impressions in the following sentence: "The behaviour of these reptiles certainly does not appear to afford support to the belief that the *butterflies*, at any rate, usually considered nauseous, are distasteful to them.*

(*C*) *Diptera.*—The large predaceous flies of the family Asilidæ are among the chief enemies of butterflies in Ceylon, and in places where they are numerous it is a common sight to see one of them carrying some butterfly whose juices it is busily engaged in sucking. To my friend Mr. C. C. Dobell I owe the first instance with which I met of one of these flies attacking a butterfly. At Anuradhapura

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* Finn, F.—Contributions to the Theory of Warning Colours and Mimicry, No. II. Experiments with a lizard (*Calotes versicolor*).—Journ. Roy. Asiat. Soc., Bengal, vol. LXV., 1897.

In a paper published in the Biological Bulletin, 1903, Miss A. H. Pritchett gives an account of some experiments with the lizard *Sceloporus floridanus*. This species took the so-called distasteful models *Anosia plexippus* and *Papilio philenor* "with evident relish," and other brightly coloured forms were also eaten readily. As the result of her experiments Miss Pritchett concludes that lizards show no preference, but eat Lepidoptera indiscriminately.

one day, while standing a few yards away from me, he netted a male specimen of *Appias paulina*. Just as he caught it a large fly darted upon it, and on examining his capture he found an Asilid astride of the butterfly, with its piercing mouth parts buried in the thorax. The butterfly was apparently killed immediately, and it seems possible that these flies inject some poisonous fluid into their prey, which at once renders them inert. Subsequently at Trincomalee I captured, within a few days, Asilids* carrying and devouring the following species, all of which were abundant at that time—*Appias paulina*, *Catopsilia pyranthe*, *Junonia lemonias*, *Terias sp.*,† *Nacaduba sp.* Generally the butterfly was carried with its wings apposed, while the Asilid sucked its juices from the side of the thorax. From the following evidence I am inclined to believe that even the larger and more powerful species are not exempt upon occasion from the attacks of these ferocious flies. One afternoon, on the road between Trincomalee and Tamblegam, I picked up a fresh specimen of *Papilio crino*, a species of larger size than *P. polytes*. All the juices had been drained out of its body, and this had evidently been done quite recently, for it had not had time to get stiff when I found it. Moreover, the scales of the fore wing were rubbed symmetrically in a little patch on either side, just where the feet of the Asilid would have come had it captured the Papilio in the position in which Mr. Dobell's *Appias* was captured. The butterfly was picked up just at the time when the males of various species, including *P. crino*, were settling on moist or otherwise attractive patches by the roadside, and in my own mind I have no doubt but that this specimen had been suddenly killed by an Asilid as it settled on such a patch, and that, after being sucked dry, it had been dropped on the road where I found it.

Whether Asilids exercise any discrimination with regard to the butterflies that they attack is a question which is not easy to answer with the little knowledge at present at our disposal. Such evidence as exists has recently been brought together by Poulton,‡ and even among the few cases hitherto recorded there are two in which the Asilid preyed upon distasteful species.

After having repeatedly watched these flies hawking along roads and jungle paths near Trincomalee and elsewhere, I am inclined to believe that they swoop at the first butterfly that comes near enough to give them a chance of catching it. As they sit watching, as a rule on or close to the ground in a sunny place, it is obvious that such butterflies as habitually fly high or keep for the most part in the jungle are unlikely to be attacked. Since the females of most of

* The commonest species was *Scleropogon piceus* (Pl. II., fig. 16). For this identification I am indebted to my friend Mr. C. Lamb.

† I took only one Asilid carrying a Lycænid, and this belonged to a smaller species than that usually met with.

‡ Trans. Ent. Soc., Lond., 1906.

the so-called mimics, which were flying when I was at Trincomalee, were jungle lovers and generally avoided open spaces, *e.g.*, *Papilio polytes*, *Hypolimnas bolina*, *Pareronia ceylonica*, &c., I cannot think it probable that, even if Asilids were discriminating in their attacks upon these butterflies, they would be afforded much opportunity of exercising that discrimination.

In these three forms, viz., birds, lizards, and Asilids, I am inclined to think that we have the most serious enemies of butterflies in Ceylon. But my friend Professor E. A. Minchin, from observations that he made in Africa, has suggested to me that monkeys may also be a factor in the establishing of mimetic likeness. As to the possibility of this I can say nothing, for I had no opportunities of making any observations myself, neither do I know of any records which bear upon the point. In the case of *P. polytes*, however, I feel doubts as to their exerting much influence, for in the northern part of the Island, where these animals occur in plenty, the male form of *P. polytes* female is the most abundant, whereas the "mimetic" forms are more common higher up, where monkeys are very much scarcer. But I would call attention to the suggestion here, in case others may have better opportunities of making observations.

Formation of Polymorphic Forms.

Those who regard natural selection as an adequate explanation of the formation of polymorphic forms hold that they have gradually arisen by the accumulation of small variations over a long series of generations; and from this standpoint we may consider how the different female forms of *P. polytes* may conceivably have arisen. And in doing so, we shall assume that the form of the male is the ancestral one, and that the hector and the aristolochiæ forms have arisen from this. In other words, we shall assume that at some former epoch the species *polytes* existed only in what we now term the male form. And for our present purpose we may confine our attention to the evolution of the aristolochiæ form. Now, on the hypothesis we are considering, this may have come about in either one of two ways, according as we admit that *P. aristolochiæ* at that time existed as the form we now know, or was different. If *P. aristolochiæ* was then as it is to-day, we must suppose that the aristolochiæ form of *polytes* ♀ arose by gradual limitation of the white area on the hind wing, by gradual extension of the red lunules, and by gradual thinning of the scales between the nervures of the fore wing. The great stumbling-block to this view is the difficulty of attributing any selection value to the initial stages of variation.

On the alternative view we may suppose the *P. aristolochiæ* bore a strong resemblance to *P. polytes* to start with, and that it gradually evolved into its present state because it was of advantage to it that the nauseous properties with which it was originally endowed should be advertised as conspicuously as possible. Meanwhile a parallel process of variation occurred in a portion of the species *polytes*, and those variations which kept pace with *P. aristolochiæ* survived and eventually formed the "aristolochiæ form" of female in *polytes*. Considerable powers of discrimination being granted to the hypothetical enemies of the species, this view minimises the difficulty of the selection value of the initial small variations. On the other hand, it has serious drawbacks. In the first place, it does not explain, any more than does the other view, the continued existence of the unchanged *polytes* living under the same conditions. And secondly, it involves the proposition that the ancestral form of the model is similar to that of the unaltered male of the mimic—a proposition which the consideration of cases where the same species serves as a model for more than one mimic at once shows to be untenable. For it is obvious that the male of *Argynnis hyperbius* (Pl. II., fig. 10 A) as well as that of *Elymnias fraterna* (Pl. II., fig. 8 A) cannot both be made to serve as the ancestral form of *Danais plexippus* (Pl. II., fig. 9 A).

We are therefore forced back upon the former view that model and mimic were in the beginning widely different, with its attendant difficulty of attributing selection value to minute variations. For this they are bound to do who desire to regard natural selection as a factor in the *formation* of these mimetic forms.

And here we may draw attention to certain other difficulties which this view involves. If the mimic has arisen by a series of transitional forms, why do these forms never occur in nature? In *P. polytes*, for example, we have a species in which some of the females remain unchanged, and we should naturally expect to find transitional forms numerous on this view of the formation of the mimetic forms. Yet they have never been known to occur, and their absence cannot but cast a doubt upon the adequacy of this view as an explanation of the facts.

The difficulty of males so seldom becoming mimetic has already been alluded to. There is yet another difficulty with regard to polymorphism among females. There are species where the females are markedly polymorphic, but cannot be regarded by any stretch of imagination as mimicking distasteful forms. No one, I think, would venture to match all the different forms of *Papilio ormenus* or *P. memnon* with appropriate models. And I doubt whether any one could find a model for the *helice* variety of *Colias edusa*, or the *valesina* form of *Argynnis paphia*. Yet a scheme which offers an explanation of the occurrence of polymorphism among the females of Lepidoptera should cover such cases, as well as those in which the polymorphic forms bear a resemblance to some distasteful species.

Apart then from the questions whether the resemblances in many cases of mimicry are sufficiently close to be of effective service to the mimic, and whether the action of natural selection can be regarded as sufficiently stringent to have brought these resemblances into being, there are still the following difficulties in the way of the acceptance of the hypothesis of those who look to natural selection as an explanation of polymorphic forms in Lepidoptera :—

(1) The attribution of selection value to minute variation.
(2) The absence of transitional forms.
(3) The frequent absence of mimicry in the male sex.
(4) The inability to offer an explanation of polymorphism, where the polymorphic forms cannot be regarded as mimics of a distasteful species.

Moreover, the hypothesis assumes that minute variations of all sorts can be inherited, a position which at present is lacking in experimental proof.

There is, however, another point of view, which not only avoids these difficulties, but is at the same time more in harmony with the facts of variation and heredity as we are coming to know them. On this view natural selection plays no part in the *formation* of these polymorphic forms, but they are regarded as having arisen by sudden mutation, and series of transitional forms do not exist because such series are not biologically possible. Polymorphic forms may arise and may persist, provided that they are not harmful to the species, and it is possible to look upon their existence as due to the absence of natural selection rather than to the operation of this factor. Nevertheless, natural selection, though unconcerned with their formation, may play a part in their *conservation*. To take a definite example in illustration. The "aristolochiæ form" of female must be supposed to have arisen from the type form as a sudden mutation, entirely independently of natural selection. But it is not unlikely that the action of natural selection may have aided it in becoming established, whether from its resemblance to *P. aristolochiæ*, or for some other reason. For once in being it is conceivable that even a very slight advantage over the normal form might enable it to hold its own with, and even replace, the latter (*cf.* p. 19, note). But whether this is so or not must for the present, in the absence of decisive evidence, remain doubtful. Though natural selection may operate in the *conservation* of the polymorphic form, it cannot on this view be supposed to play any part in its *formation*.

A Suggestion as to the Nature of Polymorphism.

That polymorphism in a species should so frequently be confined to the female sex has long been remarked upon by those who study these matters, and the explanation most favoured is that the female, burdened as she is with the next generation, is more exposed to the action of natural selection and in greater need of some protective adaptation. The weak point of such a view is that it does not explain why the male is not similarly protected. In connection with this problem recent Mendelian research on sex-limited inheritance is highly suggestive. It has been shown that certain types of inheritance receive their simplest explanation on the assumption that the female is heterozygous for a sex factor not contained in the male, and that this sex factor may, on segregation of the gametes, repel the factor for some other character for which the female is also heterozygous. From the beautiful experiments of Doncaster and Rayner* it has been inferred that inheritance of this type occurs in the common currant moth (*Abraxas grossulariata*), where a distinct colour variety, var. *lacticolor*, occurs. The factor for the *grossulariata* pattern appears to segregate against the female sex factor, with the consequence that in only one type of mating, and that a necessarily rare one, is the *lacticolor* pattern transmitted to the male sex.† It is not difficult to conceive of an extension of these principles to cover cases of polymorphism among the females of a species, and the next few paragraphs are devoted to the consideration of an imaginary scheme of this nature. In the absence of experimental evidence such a scheme can of course have only a suggestive value, and I have ventured upon these speculations, after some hesitation, with the idea that they may attract the attention of some who have opportunities for breeding from species with polymorphic females. If any such are led to regard the problem from a rather different standpoint to that which has hitherto been customary, these speculations will not have failed of their purpose.

Let us then suppose our imaginary case to be a species in which there are three distinct forms of female, α, β, and γ, of which the first (♀ α) is like the male. Let us suppose also that the forms β and γ have arisen from the original form α by the elimination of factors through some mutational process, and that β and γ are each heterozygous for a factor (A) for which ♀ α and the male are homozygous. Further, let it be assumed that the factor A segregates against the factor for femaleness in the way that the *grossulariata* factor behaves in the female of the currant moth (*Abraxas*). Lastly, let it be supposed that the difference between ♀ β and ♀ γ depends upon the presence or absence of the factor B, which is not affected by the sex factor in segregation. Then we may represent the various individuals of our imaginary species as having one or other of the following zygotic constitutions :—

♂	♀ α	♀ β	♀ γ
♂♂ AA BB	♂♀ AA BB	♂♀ A*a* BB	♂♀ A*a* *bb*
or	or	or	
♂♂ AA B*b*	♂♀ AA B*b*	♂♀ A*a* B*b*	
or	or		
♂♂ AA *bb*	♂♀ AA *bb*		

* Proc. Zool. Soc., 1906.

† In addition to the above instance this peculiar sex-limited form of inheritance has now been worked out in canaries and fowls. Inheritance of this form is certainly to be found in man also, while analogous phenomena have been met with in sweet peas. For a general account the reader may be referred to Bateson's work on "Mendels' Principles of Heredity," Cambridge, 1909, chap. X.

We are now in a position to work out the results of the various possible matings between these different individuals.

(1) ♂ × ♀ α.—Since both the male and ♀ α are in every case homozygous for the factor A such matings can only give ♂♂ and ♀♀ of the male type.

(2) ♂ × ♀ β.—Since there are three possible kinds of male differing in constitution, though not necessarily in appearance, and since ♀ β may also be either homozygous or heterozygous for B, it follows that there are six possible types of mating between these two forms, viz. :—

(i.) ♂♂ AA BB × ♀♂ A*a* BB
(ii.) ♂♂ AA B*b* × ♀♂ A*a* BB
(iii.) ♂♂ AA *bb* × ♀♂ A*a* BB
(iv.) ♂♂ AA BB × ♀♂ A*a* B*b*
} giving ♂♂ and ♀♀ β only.
(v.) ♂♂ AA B*b* × ♀♂ A*a* B*b*, giving ♂♂, ♀♀ β (75 per cent.). and ♀♀ γ (25 per cent.).
(vi.) ♂♂ AA *bb* × ♀♂ A*a* B*b*, giving ♂♂, ♀♀ β (50 per cent.) and ♀♀ γ (50 per cent.).

(3) ♂ × ♀ γ.—Since ♀ γ is on our hypothesis always of the same constitution, it follows that the only three possible matings here are :—

(i.) ♂♂ AA BB × ♀♂ A*a* *bb*, giving ♂♂ and ♀♀ β only.
(ii.) ♂♂ AA B*b* × ♀♂ A*a* *bb*, giving ♂♂, ♀♀ β (50 per cent.), and ♀♀ γ (50 per cent.).
(iii.) ♂♂ AA *bb* × ♀♂ A*a* *bb*, giving ♂♂ and ♀♀ γ only.

The experimental test of the correctness of such a scheme would lie in substantiating the following propositions :—

(1) The form of female which is like the male in pattern breeds true, and does not throw either of the other two forms of female.

(2) Neither of the other two forms of female can give the female of the male pattern.*

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* Should this be confirmed by experimental evidence, it would offer a simple explanation of the complete disappearance of the "male form" of female which seems to have taken place in most polymorphic species. Thus the Malayan *Papilio theseus* and *P. ambrax*, near allies of *P. polytes*, have only the "aristolochiæ form" of female, a condition which could rapidly come about on the above scheme if the "aristolochiæ form" were already in existence and received some slight advantage over the normal form through the operation of natural selection. For if neither female could throw the other, even a small advantage possessed by the one would lead rapidly to the other's elimination. On this view cases of sexual dimorphism in the colour patterns of Lepidoptera are cases of advanced polymorphism in which one form of female, viz., that like the male, has been eliminated, either in the history of the species itself or of its precursors.

(3) Either of the two forms of female which are unlike the male may give both forms, or may breed true.

(4) Of the two forms of female which are unlike the male, one may give females which are all of the same form and unlike herself, while the other must always throw some females like herself. (Thus, ♀ γ mated with an appropriate male can give only ♀♀ β, but ♀ β must always give some at any rate of her own type of ♀).

It is assumed here that any given female is fertilized by a single male. Where a female can be fertilized by more than one male the working out of such a case would become more difficult. Complications of this nature would however not affect (1) and (2), where the expectation would remain the same whatever male or series of males was introduced.

So far as I am aware the only breeding experiments with polymorphic females which have been recorded are with *Papilio dardanus** and *Colias edusa*,† and in either case the records are very scanty. In the *dardanus* experiments six families were raised, two from each of the three ♀ forms *cenea*, *trophonius*, and *hippocoon*, and the results, though of course too few for definite opinion, appear to me not discordant with an explanation on the lines suggested above. Of especial interest are the two families from *hippocoon* ♀♀. In one of these there were 14 ♀♀, viz., 8 *cenea*, 3 *trophonius*, and 3 *hippocoon*, while in the other all the 13 ♀♀ produced were of the *hippocoon* form. Such a result seems to point to a difference of constitution of the parents of one sex certainly, and possibly of both. Each of these eventualities is allowed for in such a scheme as that outlined above, while in harmony also with it is the fact that none of these polymorphic females appears to be capable of producing a female of the male type. The case is of course more complicated by reason of the greater number of polymorphic forms, and it is to be hoped that further experiments will be made on the breeding of this interesting species.

The single family in the case of *Colias edusa* mentioned above was bred from the pale *helice* variety which, as is well known, is confined to the ♀ sex. The eggs laid by this specimen gave 79 ♂♂, 19 *edusa* ♀♀, and 52 *helice* ♀♀. The fact that *edusa* ♀♀ can come from *helice* appears to be inconsistent with the scheme suggested above, and it is not unlikely that this particular scheme may here break down. Nevertheless it should be pointed out that in *edusa*, as in many other species, the common type of ♀ is not of the male pattern, and we may be dealing here with two forms of female of the β and γ types, the α type in this species being unknown. And

* Poulton, E. B., Trans. Ent. Soc., Lond., 1909.
† Main. H., and Harrison, A., Trans. Ent. Soc., Lond., 1905, p. vi.

here the matter may be left until more experimental evidence is forthcoming.*

It has been suggested above that the males of a species with polymorphic females may be of different constitution with regard to the factors they contain, and with this in mind I have examined the series of males of *P. polytes* which I collected. There is considerable variation in the amount of the red marking and of the lunules of the hind wing. Two distinct forms can be readily picked out, viz., that in which the red is entirely absent and the lunules are much reduced (Pl. I., figs. 11 and 11 A) and that in which the lunules are relatively large and the red markings very distinct (Pl. I., figs. 10 and 10 A). Between these two extremes are found intermediate forms which cannot be sorted with the same certainty. Generally speaking, however, the intermediates fall into two groups: (*a*) those in which the lunules are large and in the hindermost at any rate furnished with some red scales, and (*b*) those in which the lunules are small and the red is confined to the spot by the tail. These I have called respectively Int. I. and Int. II. In the appended table I have, with the help of my friend Mr. J. C. F. Fryer, classified the available males according to their markings and the locality from which they came :—

TABLE II.

	Trincomalee.	Kandy and Peradeniya.	Colombo.	Haragama.	Anuradhapura.	(Up-country) Uragala, Gonagama, Pundaluoya.
Red ..	—	9	1	2	—	1
Int. I. ..	17	7	6	2	1	4
Int. II. ..	15	—	—	2	—	6
No red ..	32	1	1	1	—	3

Several points of interest may be made out from this table. Very noticeable is the absence of really "red" ♂♂ at Trincomalee, as well as the great preponderance here of ♂♂ which show no red. While the hotter and drier climate of these parts may possibly lead to a general diminution of the red scales, this cannot be the

* Since the above was written Mr. E. E. Green has succeeded in raising a brood of *P. polytes* from the "male form" of female. All the females of this brood, 37 in number, were of the "male form," a fact which is in harmony with the scheme suggested above. And here attention may be called to an important paper by J. C. H. de Meijere on *Papilio memnon*, which has recently been the subject of breeding experiments in Java. It is suggested that the data from the three forms of female are consistent with a Mendelian interpretation of this case. (Zeitschrift fur induktive Abstammungs und Vererbungslehre, 3 Heft. 1910.) It should be mentioned that all the three forms of female here are different to the male.

sole cause of the non-red ♂♂ being so greatly in excess. For such males may occur, though in a smaller proportion, in the higher parts of the Island, *e.g.*, Kandy and Pundaluoya. I am inclined to consider that there exists a connection within certain limits between the amount of red and the constitution of the male, and to regard the " red " males (and probably those of Group Int. I. also) as being more intimately connected with the hector form of female, in which the lunules are larger than in the other forms. But whether this is really so can only be determined by breeding experiments, and breeding experiments we must have before we can hope to understand more of the nature of the various forms of *Papilio polytes*.

APPENDIX.

In addition to the instances already given of resemblance more or less marked between different species of Lepidoptera, I met with the following cases which seem of sufficient interest to place on record :—

While at Trincomalee in September I was struck with the scarcity of Hesperids. *Parata butleri* was abundant and *Badhamia exclamationis* was found occasionally, but outside these two species neither my boy nor myself took a single Hesperid. Accordingly, when I one day saw in sparse jungle an insect which looked like a Hesperid other than the above two species, I devoted my attention to capturing it. After some minutes of stalking I succeeded, and found, rather to my surprise, that the putative Hesperid was a moth (*Ophiusa mezentia*). In size and general appearance it is not unlike *Tagiades atticus* (Pl. II., figs. 4 and 5). I prefer to leave to others the decision as to which in this case is the mimic and which the model.

On Pl. II., fig. 13, is figured an insect which I took one day in Kandy, at the bottom of Lady Horton's Drive. I netted it as it flew across the road, inwardly congratulating myself upon the acquisition of a hitherto uncaptured Lycænid. On extracting it from the net my first impression was that the antennæ were missing. But on looking more closely I discovered that it was not a butterfly at all, but a bug belonging to the species *Hansenia glauca*. Here again I will leave it to those who are more expert than I to pronounce upon which is mimic and which is model.

While hunting *P. polytes* one day at the edge of the jungle at Trincomalee I caught a small dragon fly (*Rhyothemis variegata*), which I took to be a butterfly until I had actually got it within my net. In this small species (Pl. II., fig. 17) the proximal parts of both fore and hind wings are black, the distal part of either being transparent. Between the transparent and the dark part is a narrow opaque white area. During its fluttering flight the outer transparent portion of the wings is invisible, and even at close quarters this little dragon fly looks very like a butterfly. I subsequently met the insect again at Pannipitiya near Colombo, and my friends Dr. Willey and Mr. Dobell, who happened to be with me at the time, were both struck by its Lepidopteran appearance. I am doubtful whether to invoke Pseudaposematism or Pseudepisematism for the interpretation of this case.

Another dragon fly which is interesting in this connection is *Neurothemis tullia* (Pl. II., fig. 15). The general yellow-brown and black colouration of this insect, coupled with its peculiar sharp and jerky yet soft flight, so unlike that of most of its relatives, results in a distinct resemblance to the butterfly *Rahinda hordonia* (Pl. II., fig. 14) when on the wing. There may perhaps be some who would be tempted to argue that the dragon fly has developed its peculiar colour and flight in adaptation for deceiving and preying upon the butterfly. For their sake it may be pointed out that the dragon fly hawks insects in the bright sun, and I never met it in the shady localities frequented by *R. hordonia*. Whenever I saw it, moreover, it was in company with many dragon flies of larger and more powerful species, among whom it could hardly be regarded as judicious to masquerade in Lepidopteran guise. At the same time I may add that, though I frequently watched these groups of dragon flies, and though butterflies of the genera *Catopsilia*, *Appias*, and *Junonia* abounded here, I never saw a dragon fly attack any of them.

Lastly, I would draw attention to a small Chalcosid moth, *Chalcosia venosa* (Pl. II., fig. 12), which was abundant along Lady Horton's Drive during August. It has a remarkably Pierid-like appearance.* There is, however, no Pierid here with which it could possibly be confounded.

Explanation of Plates.

Note.—With the exception of figures 7, 8, and 9 on Plate I. all the figures were made directly from the actual specimens by the four-colour process.

Plate I.

Fig. 1.—Male of *Papilio polytes*.

Fig. 2.—Female (male form) of *P. polytes*.

Fig. 3.—Female (aristolochiæ form) of *P. polytes*.

Fig. 4.—Female (hector form) of *P. polytes*.

Fig. 5.—Male of *Papilio aristolochiæ*. In this species the colouration of the two sexes is similar.

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* The white of the wings of this moth is, however, not due to the presence of uric acid derivatives, as in the Pieridæ. For this fact I am indebted to Dr. F. G. Hopkins, who very kindly made the requisite test (*cf.* Hopkins, Phil. Trans., 1895, p. 663).

Fig. 6.—Male of *Papilio hector*. The female of this species is very similar to the male, though the red has a more orange shade.

Figs. 1 A–6 A.—Under surface of left hind wings of the above. The wing was taken from the same specimens as those figured in figs. 1–5. For fig. 6 A a separate specimen was used, since the left hind wing of that figured as fig. 6 was damaged. There is practically no difference in these two, except that 6 A has a rather shorter tail.

Fig. 7.—Caterpillar of *P. polytes*, full-fed.

Fig. 8. } Chrysalis of *P. polytes*.
Fig. 9. }

Note.—For these three figures I am indebted to Mr. Green, who had them prepared for me by Mr. A. D. Alwis, the artist at the Royal Botanic Gardens, Peradeniya.

Fig. 10, 10 A.—Under surface of hind wings of males of *P. polytes*, showing variation in colour pattern.

Fig. 11, 11 A.—Upper surface of hind wings of males of *P. polytes*, showing variation in colour pattern.

PLATE II.

All specimens × about $\frac{4}{5}$.

Figs. 1 A–C.—*Pareronia ceylonica* (Pieridæ); 1 A, male; 1 B, upper surface of female; 1 C, under surface of female.

Figs. 2 A–B.—*Danais septentrionis* (Danaidæ); 2 A, upper surface; 2 B, under surface.

Figs. 3 A–B.—*Papilio clytia* (Papilionidæ); 3 A, var. *dissimilis.*

Fig. 4.—*Ophiusa mezentia*, Cram. (Heterocera).

Fig. 5.—*Tagiades atticus* (Hesperidæ).

Fig. 6.—*Hypolimnas bolina* (Nymphalidæ), female.

Fig. 7.—*Elymnias fraterna* (Satyridæ). Specimen of female with wings bitten, probably by a lizard.

Figs. 8 A–C.—*Elymnias fraterna* (Satyridæ). 8 A, male; 8 B, upper surface of female; 8 C, under surface of female.

Figs. 9 A–B.—*Danais plexippus* (Danaidæ). 9 A, upper surface; 9 B, under surface.

Figs. 10 A–B.—*Argynnis hyperbius* (Nymphalidæ). 10 A, male; 10 B, female.

Fig. 11.—*Euplœa core* (Danaidæ).

Fig. 12.—*Chalcosia venosa* (Heterocera)

Fig. 13.—*Hansenia glauca* (Rhynchota).

Fig. 14.—*Rahinda hordonia* (Nymphalidæ).

Fig. 15.—*Neurothemis tullia*, Dru. In the actual specimen the brown near the basis of the wings is brighter and more conspicuous.

Fig. 16.—*Scleropogon piceus* (Asilidæ), female.

Fig. 17.—*Rhyothemis variegata*, Joh.


P. polytes, ♂
1
2
P. polytes, ♀
(" male form ")
P. aristolochiae, ♂
5
3
P. polytes, ♀
(" aristolochiae form ")
P. hector, ♂
6
4
P. polytes, ♀
(" hector form ")
1 A
2 A
5 A
3 A
6 A
4 A
8
9
10
10 A
7
11
11 A


1 C
2 B
8 C
9 B
1 B
2 A
8 B
9 A
1 A
3 A
8 A
10 B
4
11
10 A
5
3 B
15
12
16
7
13
14
6
17

ON SOME SYNGNATHIDS ("PIPE FISH") FROM CEYLON.

By GEORGE DUNCKER (Hamburg).

(With one Plate.)

SYNGNATHIDS or pipe fishes are known to inhabit the fresh waters of East Africa as well as of continental India, but, strange to say, not as yet from Ceylon. Last summer (1909) I determined to investigate some Ceylon rivers with reference to the occurrence of Syngnathids, with the result of finding four species, viz., *Microphis brachyurus*, Bleeker, *Doryichthys cunculus*, Ham.-Buch., *Doryichthys ocellatus*, n. sp., and *Syngnathus spicifer*, Rüpp., var. *djarong*, Bleeker.

A review of all Syngnathids hitherto observed in Ceylon may be combined with the description of the species mentioned above; further investigation certainly will lead to the discovery of many more, especially marine species.

Gastrotokeus, Kp.

Brood organ of male abdominal, not covered by cutaneous folds. Eggs isolated in open cutaneous cells. Upper as well as lower lateral edges of trunk and tail continuous; middle lateral edges of trunk nearly or entirely reaching upper ones of tail behind the dorsal fin. Interstitial scutella and lateral line absent. Dorsal, anal, and pectoral fins (referred to as D, A, and P) present, caudal fin (C) absent; tail prehensile. Trunk much depressed, its ventral surface bordered by middle lateral edges.

1. *Gastrotokeus biaculeatus*, Bl.

Kaup, 1856, p. 19; Duméril, 1870, p. 528; Günther, 1870, p. 194; Day, 1878, p. 681, Pl. 174, fig. 5; Day, 1889, p. 467, fig. 167.

Syngnathus blochii, Bleeker, 1853, p. 24.

Truncal annuli (abdominal plus caudal) 15–18 plus 40–55. Annuli below dorsal fin (annuli subdorsales) 0–2 plus 8–10. Dorsal rays (D) 37–47. Anal rays (A) 4–5. Pectoral rays (P) 19–23. Frequently with numerous short immovable cutaneous appendages, similar to algæ. Chin with two simple or little ramified short movable tentacles of reddish-brown colour. Anus papilliferous. Eggs rather large, ovoid, generally in 8 longitudinal and 23–28 transverse rows. Total length up to 25·7 cm. Mature males 16·4 to 25·7 cm.

Colour during life grayish to sea-green; edges of body with indistinct reddish blotches. Small round dark blue dots, becoming brown in spirit, ventrally along the middle lateral edges of trunk.

Living between the weeds of a Zostera, sp., the leaves of which equal in breadth that of the animal, attached to their stems by means of the prehensile tail, the head erect, and therefore not easily visible. The decaying leaves of the Zostera are covered with small mucous gray algæ, which are strikingly similar to the cutaneous appendages of the fish. Slowly and clumsily swimming.

Distribution.—From East Africa to Polynesia. In the Colombo Museum there are several specimens, without details of locality.

Sinhalese name.—Moralla (Colombo).

Microphis, mihi.

Brood organ of male abdominal, not covered by cutaneous folds, laterally protected by plates which correspond to the lower lateral edges of trunk and are ventrally divergent. Eggs small, numerous, isolated in open cutaneous cells. Upper as well as lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail; keels of the several rings terminating in a free spine posteriorly. Scutella and lateral line present; D, A, C, and P present; A situated behind middle of total length.

2. *Microphis brachyurus*, Bleeker. Duméril, 1870, p. 595.

Syngnathus brachyurus, Bleeker, 1853, p. 16.
Doryichthys brachyurus, Günther, 1870, p. 184.
Doryichthys Hasselti, Kaup, 1856, p. 57.
Doryichthys auronitens, Kaup, 1856, p. 59; Günther, 1870, p. 182.
Microphis auronitens, Duméril, 1870, p. 597.
Doryichthys millepunctatus, Kaup, 1856, p. 60; Günther, 1870, p. 183.
Microphis Bleekeri (Day), Duméril, 1870, p. 599.
Doryichthys Bleekeri, Günther, 1870, p. 182; Day, 1878, p. 680, Pl. 174, fig. 3; Day, 1889, p. 465.
Microphis douanii, Duméril, 1870, p. 592.

Ann. 20–22 plus 21–23; ann. subdors. 1–2 plus 6–8; D 37–43, A 3–5, C 9, P 18–23. Operculum longitudinally keeled, with 1–8 radiating elevated ridges below the keel. Middle ray of C enlarged and somewhat elongate. Eggs small, in 4–13 longitudinal and 60–110 transverse rows. Total length up to 18·2 cm.; mature males 12·2–16·7 cm.

Ground colour dark, with numerous fine white dots. Operculum sometimes with black spots. Orange coloured and black spots at the corners of the mouth. Lower side of rostrum with light dark-edged transverse fasciæ. Caudal fin orange coloured at dorsal and ventral margin. Male with a blood-red vertical stripe on the opercle near its hind edge ; a longitudinal stripe of the same colour immediately beneath the anterior half of the middle lateral edge, both these stripes disappearing in spirit. Iris brown, with golden lustre.

In fresh and brackish waters ; numerous amongst grassy weeds ; quickly and skilfully swimming.

Distribution.—From East Africa to Polynesia. Several specimens in the Colombo Museum, from the Panadure river at Horetuduwa, near Moratuwa, 4 miles upstream. In the Hamburg Museum (No. 11,557) 10 males, 34 females and young from the Gin-ganga and Opata-ela at Wakwella (Duncker), (No. 11,558) 3 males and 8 females from the Mahaweli-ganga, below Thalavai estate, near Trincomalee (Duncker).

Sinhalese.—Loku ela theliya (Wakwella) ; vetakeyiya moralla (Panadure) ; mudha aspaya (Negombo).

Doryichthys, mihi.

Brood organ of male abdominal, entirely covered, when filled with eggs, by broad, not coalescent, lateral protective plates, which sometimes have a narrow cutaneous fold along their free margin. Eggs large, isolated in cutaneous cells. Upper lateral edges of trunk and tail discontinuous, lower either continuous or discontinuous; in the latter case middle lateral edges of trunk continuous with lower ones of tail. All the body edges smooth in the adult. Scutella and lateral line present. D, A, C, and P present ; A situated anterior to middle of total legth. Fresh and brackish water fishes.

3. *Doryichthys cunculus*, H.B. Günther, 1870, p. 181 ; Day, 1878, p. 679, Pl. 174, fig. 4 ; Day, 1889, p. 465, fig. 166.

Microphis cunculus, Kaup, 1856, p. 64 ; Duméril, 1870, p. 591.

Ann. 17–18 plus 25–28 ; ann. subdors. 3 plus 7–8 ; D 50–53, A 3, C 9, P 18–20. Lower lateral edges of trunk and tail continuous ; middle lateral edges of trunk subcontinuous with lower ones of tail. Anal fin just in front of middle of total length. Protective plates of brood organ well developed ; no cutaneous folds found (pouch empty). Eggs rather large, according to the remnants of cells in 3–4 longitudinal and about 50–55 transverse rows. Opercle with a single longitudinal keel. Total length 13·9 cm.

Colouration grayish-brown ; several indistinct narrow dark longitudinal stripes on the side of the trunk. Diffuse dark spots on the upper lateral edges of trunk, most distinct on the ring borders. A dark stripe on each side from tip of snout through the eye over opercle, above its keel, to base of P ; ventral half of opercle silvery. Iris reddish-brown.

Distribution.—India (Malabar, mouth of Ganges, Bengal, Orissa), Ceylon.

Colombo Museum: one male from Panadure river at Horetuduwa.
Sinhalese.—Vetakeyiya moralla.

4. *Doryichthys ocellatus*, n. sp. Plate, fig. A.

Ann. 15–16 plus 31–32; ann. subdors. 1–2 plus 7–8; D 37–40, A 4, C 9, small, P 17–19. Lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Opercle with a straight keel; beneath and parallel to the latter one, rarely two weaker ones, more distinctly visible in posterior half of opercle. Abdominal edge very prominent in females. Anal fin in front of middle of total length. Rings of adults smooth, of young ones spiny behind, as in Microphis. Caudal fin of young individuals comparatively large. Brood organ from second body ring to first caudal ring, with large, completely closing, but not coalescent protective plates; no cutaneous folds. Protecting plates much deeper than dorsal wings of inferior lateral scutes. Eggs large, in 4 longitudinal and about 30 transverse rows. Total length up to 13 cm.; mature males 9·5 to 13 cm.

On the middle lateral edges of the trunk, on each border of its rings, one black white-bordered ocellated spot, the white contour of which disappears in spirit. Back light reddish-brown, sides yellow-gray; protective plates of brood pouch darker. A dark longitudinal stripe on each side from tip of snout through the eye to the opercle, behind which, more or less distinct, it passes on to the trunk between upper and middle lateral edge. Caudal with yellow dorsal and ventral margins. Iris yellowish-red.

The only two females of our material happen to be regenerated specimens; in the one of 10·1 cm. length there are 24 caudal rings and 7 caudal fin rays (fin enlarged); in the other one of 9·5 cm. length there are 25 caudal rings and 8 caudal rays (fin enlarged). Evidently they have accidentally lost 6–8 caudal rings and yet been able to regenerate a caudal fin.

Distribution.—Ceylon.

Col. Mus.: one male from Kalu-ganga, near Galatura tea estate, 32 miles up river (H. Drummond Hay).

Hbg. Mus. 11,559: one female, five young, from Mahaweli-ganga, below Thalavai estate, near Trincomalee (Duncker).

Hbg. Mus. 11,560: five males, one female, four young, from Gin-ganga, at Wakwella (Duncker).

Nearly related to Doryichthys caudatus, Peters.

Sinhalese.—Punchi-ela theliya (Wakwella), mudha aspaya (Negombo).

Corythroichthys, Duncker.

Brood organ of male subcaudal, not covered, without lateral protective plates, bordered by narrow longitudinal posteriorly divergent cutaneous folds. Eggs small, numerous, incompletely isolated in very shallow cutaneous cells, cake-like, sticking to each other. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail continuous; middle lateral edges of trunk subcontinuous with upper ones of tail. Scutella and lateral line present. D, A, C, and P present.

5. *Corythroichthys conspicillatus.*

Syngnathus conspicillatus, Duméril, 1870, p. 544; Günther, 1870, p. 174; Day, 1888, p. 808; Day, 1889, p. 463.
Syngnathus hæmalopterus, Bleeker, 1853, p. 20.
Corythroichthys fasciatus, Gray; Kaup, 1856, p. 25.
Syngnathus fasciatus, Duméril, 1870, p. 543.

Ann. 16–18 plus 33–38; ann. subdors. 0–1 plus 5–7; D 25–32, A 3–4, C 9–10, P 14–18, annuli or rings in the region of the brood pouch (referred to as B R) 10–16. Middle lateral edges of trunk and upper ones of tail terminating near to each other, as a rule on the border between last ring of trunk and first of tail. Opercle with a straight keel in its entire length. Forehead and eyes prominent. Eggs small, numerous, in 6–11 longitudinal and 28–37 transverse rows. Total length up to 17·3 cm.; mature males 9·7–17·3 cm.

Ventral surface of head and opercles with dark longitudinal, of rostrum with dark transverse, fasciæ. A black transverse fascia ventrally on each of the first three body rings, frequently resolved into spots. All the rings with fine black reticulated lines.

During life the three black bands on the throat as well as the posterior margin of the anal opening seamed by orange colour. In the males light bluish-silvery stripes between the dark bands at the throat, missing or little developed in the females. Ground colour of ventral surface of head brassy-yellow to coral-red. Rostrum, upper edges of trunk, and subdorsal region wine-red, the latter with coral-red blotches. When not disturbed this fish moves snake-like on the bottom, but swims rapidly if disturbed. Frequent on coral sands.

Distribution.—From East Africa to Polynesia.

Col. Mus.: males and females, from Jaffna (Day-Haly, 1888).

Hbg. Mus. 11,563: two males, three females, from Trincomalee harbour (Duncker).

Tamil.—Kudira.

Trachyrrhamphus, Kp.

Brood organ of male subcaudal, without lateral protective plates, not covered, bordered by narrow longitudinal cutaneous folds, diverging posteriorly. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Scutella and lateral line present. D, A, C, and P present; C small; base of D elevated.

6. *Trachyrrhamphus serratus*, Schleg.

Kaup, 1856, p. 23; Duméril, 1870, p. 538.
Syngnathus serratus, Schlegel; Günther, 1870, p. 167; Day, 1878, p. 677, Pl. 173, fig. 4; Day, 1889, p. 461, fig. 164.
Trachyrrhamphus cultrirostris, Peters, 1870, p. 710; Duméril, 1870, p. 539.
Trachyrrhamphus intermedius, Kaup, 1856, p. 24; Duméril, 1870, p. 538.
Syngnathus intermedius, Günther, 1870, p. 168; Day, 1878, p. 678, Pl. 173, fig. 6; Day, 1889, p. 462.
Syngnathus ceylonensis, Günther, 1870, p. 168.

Ann. 22–24 plus 44–49; ann. subdors. 2–4 plus 2–3; D 25–29, A 4, C 9–10, rudimentary, P 14–19, B R 20–22. Generally with short cutaneous appendages, similar to algæ, on the surface of the body, especially on the dorsal surface. Opercle with a very short basal keel and fine radiating striæ. Dorsal median line of rostrum with a serrated crest. Forehead and eyes prominent. Eggs very small and numerous, in 8–10 longitudinal series. Total length up to 26·8 cm. Uniformly brown coloured.

Distribution.—From Zanzibar to Japan.

Col. Mus.: 1 ♂, Ceylon.

Urocampus, Günth.

Brood organ of male subcaudal, with or without weak lateral protective plates, with broad longitudinal cutaneous folds, converging posteriorly and coalescent during the breeding period. Upper lateral edges of trunk and tail continuous; lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Scutella and lateral line present. D, C, and P present, A (always ?) absent; D commencing for more than its own length behind anal ring.

7. *Urocampus southwelli*, n. sp. Plate, figs. B (♂) and C (♀).

Ann. 8 plus 49–50; ann. subdors. 7 plus 12; D 14, A 0, C 10, well developed, P 8–10, B R 8, without protective plates. Opercle keeled in anterior two-thirds of its length. Body-edges very indistinct. Subdorsal tail-rings somewhat elevated. No cutaneous appendages. Rostrum longer than postorbital region of head. Eggs comparatively very large, biserial, 8–10, longitudinally arranged in seven anterior rings of B R—♂ 45 mm., ♀ 40 mm. Uniformly yellowish-brown.

From *U. guntheri*, mihi (W. Australia), with similar numbers of rings, distinct through the absence of cutaneous appendages, the greater length of D, and the shorter opercular keel.

Distribution.—Ceylon.

Col. Mus.: 1 ♂, 1 ♀, from Marichchukkaddi bay, in $2\frac{1}{4}$ fathoms, in tow-net. (T. Southwell.)

Syngnathus, L.

Brood organ of male subcaudal, generally with lateral protective plates, always with broad longitudinal cutaneous folds, converging and coalescent during the breeding period. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail continuous; middle lateral edges of trunk subcontinuous with upper or with lower edges of tail.

8. *Syngnathus spicifer*, Rüpp.; var. *djarong*, Bleek.

Distribution.—Madagascar, India, Ceylon, Borneo, Java, Philippines, New Guinea.

Hbg. Mus. 11,561: 3 ♂♂ from Opatha-ela, near Wakwella (Duncker).

Hbg. Mus. 11,562: 11 ♂♂, 16 ♀♀, 21 juv. from Mahaweli-ganga, below Thalanai estate, near Trincomalee (Duncker).

Sinhalese.—Eta theliya (Wakwella).

Among the forms united by Günther under the name of *Syngnathus spicifer* there are at least three to be distinguished, two of which may be considered salt and fresh water varieties of the same species, while the third one represents a separate species. They are:—

(*a*) Syngnathus spicifer, Rüpp.; var. gastrotænia, Bleek.
Syngnathus spicifer, Rüpp.—Kaup, 1856, p. 36 partim; Duméril, 1870, p. 546 part; Günther, 1870, p. 172 part; Day, 1878, p. 662 part, and Pl. 174, fig. 1; Day, 1889, p. 462 part; Peters, 1869, p. 276.
Syngnathus gastrotaenia, Bleeker, 1853, p. 22.
Syngnathus Kummii, Bleeker; Duméril, 1870, p. 548; Günther, 1870, p. 172.

Salt and brackish water.

(*b*) Syngnathus spicifer, Rüpp.; var. djarong, Bleek.
Syngnathus spicifer, Rüpp. Synonyms see above, except Day, 1879, Pl. 174, fig. 1.
Syngnathus djarong, Bleeker, 1853, p. 22; Duméril, 1870, p. 545.
? Syngnathus Helfrichii, Bleeker; Duméril, 1870, p. 547.
Syngnathus spicifer, Rüpp.; var. rivalis, Peters, 1869, p. 276.

Brackish and fresh water.

(c) Syngnathus argyrostictus, Kuhl et Van Hasselt ; Kaup, 1856, p. 33 ; Duméril, 1870, p. 545.
Syngnathus spicifer, Günther, 1870, p. 172 part.
? Syngnathus biserialis, Gray ; Kaup, 1856, p. 33.

Diagnoses of the two Species.

Syngnathus spicifer, Rüpp.

Ann. 14–16 plus 38–43 ; ann. subdors. ÷ 2–0 plus 6–9 ; D 23–30, A 2–3, C 10, P 13–18, B R 14–21. Middle lateral edges of trunk subcontinuous with lower ones of tail. Opercle keeled in its entire length. Sides of trunk without ocellated spots. Total length up to 15·4 cm.

Distribution,—From East Africa to Polynesia.

Syngnathus argyrostictus, Kuhl et Van Hasselt.

Ann. 15–16 plus 33–41 ; ann. subdors. ÷ 1–0 plus 6–8 ; D 25–29, A 3, C 10, P 15–17, B R 16–19. Middle lateral edges of trunk subcontinuous with upper ones of tail. Opercle keeled in its entire length. Length of rostrum equal to distance of præorbital margin from base of P. Sides of trunk with numerous small white black-bordered ocellated spots in 3–7 longitudinal series. Total length up to 13·6 cm.

Distribution.—Malay Peninsula, China, Japan.

Diagnoses of the Varieties of Syngnathus spicifer, Rüpp.

(*a*) Var. *gastrotœnia*, Bleek.

Rostrum longer than the remaining part of the head. Trunk rather deep, but without a particularly prominent abdominal edge. Abdomen with about 14 dark cross bars. Total length up to 15·4 cm. Mature males 10·0–15·4 cm.

(*b*) Var. *djarong*, Bleek.

Rostrum about as long as the postorbital length of the head. Trunk deep ; abdominal edge very prominent. Abdomen unicoloured, lighter than the bluish-black abdominal edge. Total length up to 14·1 cm. ; mature males 8·3–12·6 cm.

The formulæ of numbers of rings, &c., taken from 44 specimens of the first and 29 of the second variety are :—

(*a*) Ann. 14–15 plus 38–42 ; ann. subdors. ÷ 2 ÷ 1 plus 7–9 ; D 25–30, P 14–18, B R 15–21.

(*b*) Ann. 14–16 plus 39–43 ; ann. subdors. ÷ 2–0 plus 6–7 ; D 23–29, P 13–16, B R 14–17.

More distinctly these differences will come out from the corresponding average values :—

(*a*) Ann. 14–73 plus 39–81 ; ann. subdors. ÷ 1–32 plus 7–41 ; D 27–61, P 16–37, B R 18–26.

(b) Ann. 14–79 plus 40–63; ann. subdors. ÷ 0–53 plus 6–31; D 26–28, P 14–76, B R 15–06.

The dorsal fin of var. *djarong* therefore stands somewhat more forward and is shorter than that of var. *gastrotœnia*, which latter has more pectoral rays and a larger brood pouch than the former. In both varieties the protective plates of the brood organ are very small, scarcely developed. Eggs of var. *djarong* small, in 4 longitudinal and about 60 transverse series.

Colouration of var. *djarong* during life:—Abdomen of male purplish-red, of female grayish-green, with blue-black abdominal edge. Ventral surface of rostrum and opercles silvery or brass-coloured, with blackish spots and stripes more or less irregularly arranged. C brown, with lighter dorsal and ventral margins. D with dark spots. Some specimens from the Mahaweli-ganga had the lip of the rostrum orange-coloured. Iris brass-coloured.

In New Guinea and the Bismarck Archipelago I collected var. *gastrotœnia* at ten, and var. *djarong* at four localities, but once only found the two varieties together at the mouth of a draining ditch of a coconut plantation at the seashore; everywhere else the var. *gastrotœnia* preferred the water more saline than the var. *djarong*.

Hippocampus, L.

Brood organ of male subcaudal, without protective plates; its two cutaneous folds entirely united, forming a bag-like brood pouch, which has a small muscular orifice anteriorly, immediately behind the anal ring. Upper lateral edges of trunk and tail discontinuous; lower lateral edges of trunk and tail discontinuous; middle lateral edges of trunk continuous with lower ones of tail. Trunk compressed, generally deep. Head in an angular position to the longitudinal axis of trunk. No scutella; lateral line present. Scutes of body rings with narrow elongated wings and shortened keel. D, A, and P present, C absent; tail prehensile. Base of D elevated.

Of Hippocampus I have seen only three specimens from Ceylon, which seem to belong to two different species. It is impossible, however, at the present state of our knowledge to safely distinguish between the South Asiatic species of Hippocampus, with the single exception of *H. kuda*, Bleek. Characters traditionally applied, such as shape of the corona, of the spines of the body, colour, size of cutaneous appendages, are useless for the distinction of species; they vary considerably according to age and individuality, as I have convinced myself on larger series of the two European forms, *H. guttatus*, Cuv., and *H. brevirostris*, Cuv.

Description of the three specimens :—

Col. Mus. : ♂, ann. 11 plus 40; ann. subdors. 2 plus 1; D 18, A ?, P 19–18, B R 8. Rings subequal. Head and trunk with numerous fine white dots arranged in reticulated lines. Ceylon.

Col. Mus. : ♀, ann. 11 plus 38; ann. subdors. 2 plus 1; D 17, A 5, P 16. Rings subequal. Uniformly dark brown. Ceylon.

Hbg. Mus. : ♀, ann. 11 plus 37; ann. subdors. 2 plus 1; D 18, A 4, P 16. Rings subequal. Head and body with numerous fine white dots arranged in reticulated lines. Gulf of Mannar.

According to the number of caudal rings and of pectoral fin rays, which are systematically important, the two latter specimens may belong to the same, the former one to a different species; they certainly are not *Hippocampus kuda*, Bleeker. *Hippocampus guttatus*, Cuv. (*cf.* Günther, 1870, p. 202; Day, 1878, p. 682), is exclusively a European species, which is found from the Mediterranean to the North Sea. The synonym in the places cited above therefore is erroneous.

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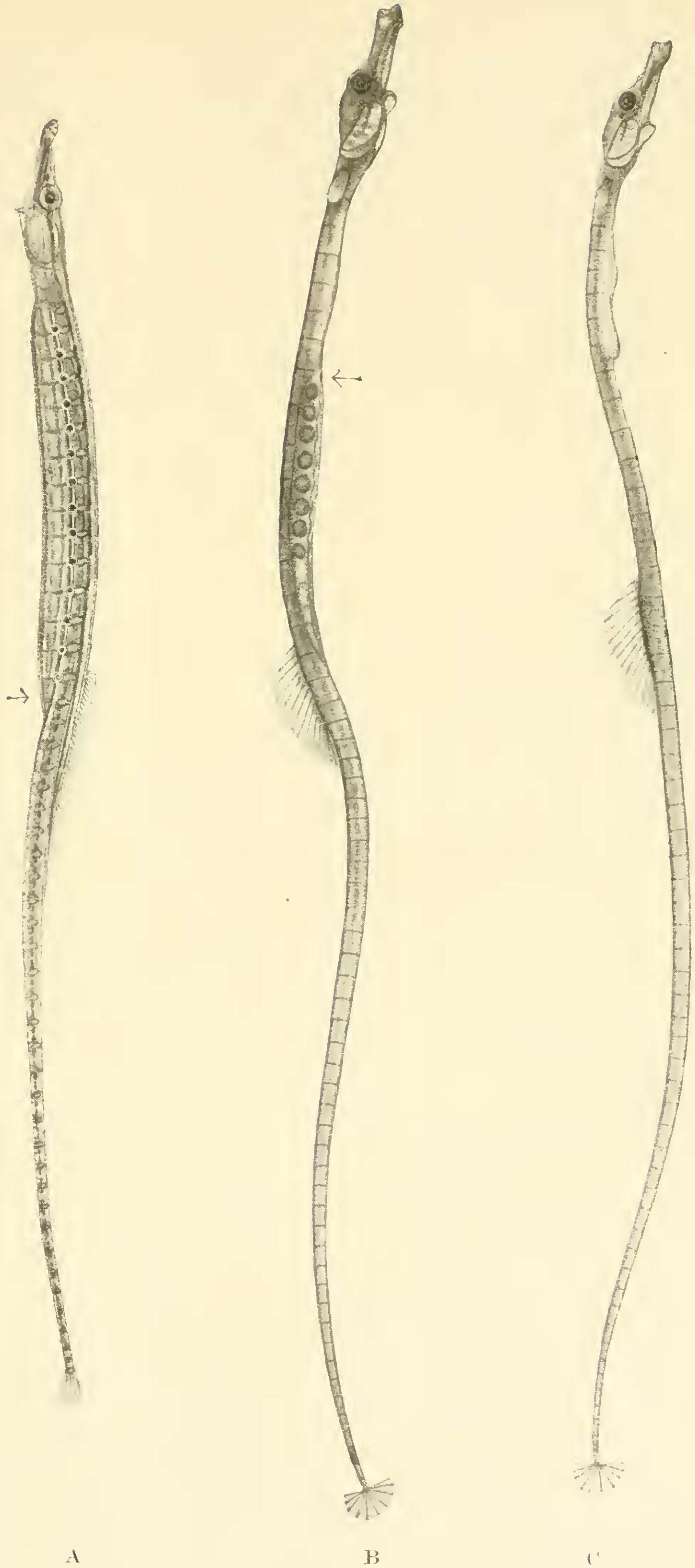
Explanation of Plate.

A.—*Doryichthys ocellatus.*

B.—*Urocampus southwelli*, ♂.

C.—*Urocampus southwelli*, ♀.



Syngnathids of Ceylon.

REMARKS ON SOME RECENTLY ACQUIRED CEYLON SNAKES.

By Major F. Wall, I.M.S.

TO Dr. Willey I am indebted for a specimen of the Ceylon water-snake *Tropidonotus asperrimus*, and to Mr. E. E. Green for six other snakes, all of which are worthy of special remarks.

Tropidonotus asperrimus, Boulenger.

The specimen sent convinces me that this snake is not entitled to rank as a species, but is better considered as merely an insular colour variety of *T. piscator*, Schneider, comparable to the Andaman variety *tytleri* of the same species. Its markings accord well with the figure in Mr. Boulenger's Catalogue (Vol. I., Plate XV., fig. 2), but the last two costal rows are quite smooth, so that it is evident that some specimens perfectly agree with typical forms of *piscator* in the only character, excepting colour, upon which it is separated from that species. Mr. Boulenger claims that only the last row is without keels.

I prepared the skull, and this and the dentition perfectly accord with those of typical forms of *piscator* from India. The teeth are as follows: maxillary, 21 left, 22 right; palatine, 11 left, 12 right; pterygoid, 22 left, 24 right; mandibular, 22 left, ? right (broken). The dentition of four other skulls of Indian *piscator* in my collections is: maxillary, 21 to 25; palatine, 11 to 15; pterygoid, 24 to 27; mandibular, 23 to 27.

Dendrelophis tristis, Daudin.

Two specimens were received, one head and neck only, the other a gravid ♀, measuring 3 ft. 11½ in., killed at Peradeniya at the end of December, 1909, and containing 7 nearly mature eggs.

The Ceylon form of this snake appears to be an insular variety, at least I cannot remember ever having seen it in any part of India. It differs from the Indian form in (1) the absence of a light round spot on the back of the head in the interparietal suture; (2) the light vertebral stripe is very conspicuous, being bright yellow, and limited to a small extent of the forepart of the spine; (3) there is no black line between the dark brown dorsal colouration and the buff flank stripe; (4) all the scales, including the vertebral, are heavily bordered with black basally and apically. The variety is very nicely shown in Plate XII. of the Bombay Natural History Journal, Vol. XIX., Part 4, which accompanies my article on this snake, and which should be called *Dendrelophis tristis*, not *Dendrophis pictus*. I have little doubt now that the British Museum artist painted this from a Ceylon specimen. This variety, which may be called *taprobanensis*, agrees with the Indian form in the following ways : (1) the narrow vertebral row of scales, which, though enlarged, are considerably longer than broad ; (2) having only two supralabials, the fifth and sixth normally touching the eye ; (3) narrow black posterior borders to the second, third, and fourth supralabials (and first, too, sometimes) ; (4) a narrow, short, and rather obscure postocular black stripe.

I have prepared and examined the skull of one of these specimens, and find the nasal bones, the ridges on the parietal bones for muscular attachment, and the maxillary dentition—in that the posterior teeth are shorter than the anterior—all agree with the Indian form, figures of which appear in the diagram accompanying my article in the Bombay Journal (*A*, *a* to *g*). The only difference is in the number of the maxillary and pterygoid teeth, which exceed those in the usual Indian form.

The dentition of this is herewith given with that of all my Indian skulls for comparison :—

No. of Specimen.	Side of Head.	Teeth. Maxillary.	Palatine.	Pterygoid.	Mandibulars.	Habitat.
1	Left	?	?	19	20	Eastern Himalayas (Parhok)
	Right	18	13	19	21	
2	Left	17	11	20	22	do.
	Right	18	12	20	?	
3	Left	19	12?	20	20?	do.
	Right	18	11	21?	21	
4	Left	18	11	24	22	do.
	Right	17	11	22	?	
5	Left	19	11	19	23	Eastern Himalayas (Parhok or Tindharia)
	Right	18	11	22	21?	
6	Left	21	12	22	21?	?
	Right	21	12	23	21?	
7	Left	21	13	?	22	Madras
	Right	19	11	21	21	
8	Left	20?	12	24	?	South India (Madras ?)
	Right	22	13	25	24	
9	Left	20	13?	26	21?	Western Ghats (Matheran)
	Right	22	13	24	22	
10	Left	21	14	28?	26	Nilgiri Hills (Kotagiri)
	Right	22	14	29	24	
11	Left	21	13	29	25	Ceylon (Peradeniya)
	Right	21	13	30	24	

It will be seen that the dentition agrees with that of a specimen from the Nilgiri Hills, collected many years ago, in which I omitted to note the distinctions in colour and markings given above, so that it is possible that the Ceylon form may, as in many other cases, be found also in the South Indian Hills.

Oligodon sublineatus, Dum et Bib.

A single ♂ specimen of this snake from Matale, measuring 8½ in., was specially interesting, in that the scale rows were aberrant, numbering 13 instead of 15. Studying this specimen, it was observed that the sixth and seventh rows above the ventrals coalesced, reducing the normal 15 to 13 rows, and in several places the row so formed divided to bring the number to the normal 15 and then fused again. I have seen a similar aberration arising in the same manner in other species of *Oligodon* and its nearly allied genus *Simotes*. The ventrals numbered 140, and the subcaudals 32. The general appearance of this snake is remarkably like that of its poisonous relative, *Callophis trimaculatus*. There are the same black spots in a single costal series down each side of the back, and the same head marks, but the dark collar is broken in the median line, unlike *trimaculatus*. The median row of ventral spots was absent in this specimen.

An examination of the skull I prepared from this specimen is interesting. There is an edentulous interval that would take at least two teeth in the front of the maxillary and mandibular bones, the palatine bone is edentulous, and a long edentulous interval is seen in the front of the pterygoid bone, so that the few teeth in this are situated in the middle. It is to be noted that Boulenger (Cat., Vol. II., p. 233) states that the pterygoid teeth are wanting in this genus, but I find them present in all the species of which I have skulls, viz., *venustus*, *dorsalis*, *subgriseus*, *erythrogaster*, as well as this species.

The maxillary teeth in this specimen number 7, the pterygoid 5 or 6, and the mandibular 10.

Bungarus ceylonicus, Günther.

Two well-grown specimens of the "Karawella" killed at Peradeniya were sent to me, a ♂ measuring 2 ft. 2½ in., with 233 ventrals and 32 subcaudals, and a ♂ ? measuring 2 ft. 5¼ in., with 223 ventrals and 37 subcaudals.

I prepared both skulls, and find the dentition as follows: the maxillæ are provided with 3 small grooved teeth behind the paired fangs. There are from 11 to 12 palatine, 8 to 10 pterygoid, and 15 to 17 mandibular teeth.

Callophis trimaculatus, Daudin.

One specimen of this very rare snake was sent to me, killed at Matale, an adult measuring 1 ft. 3¼ in. The species has only twice before been recorded from Ceylon, once by Haly (First Report, Snakes, Colombo Museum, 1886, p. 16), from Tissamaharama, 20 miles north-east of Hambantota, and once by Dr. Willey (Spol. Zeylan., Vol. V., Part XX., p. 186), from Niroddumunai, near Trincomalee.

The ventrals in the Matale specimen are 228 and subcaudals 28.

I have prepared the skull, and find the dentition as follows: maxillary, 2 to 3 small grooved teeth behind the paired fangs; palatine, 6 to 7; pterygoid, 6; mandibular, 8 to 9.

Reference to Boulenger's Catalogue (Vol. III., p. 396) shows that the genus *Callophis* has no maxillary teeth behind the fangs. It is obvious from this that the characters made use of by this authority to differentiate this genus must be altered, or this species removed therefrom; and in this connection I may mention that in a specimen of the species *Maculiceps* lately received from Tenasserim (Kawkariek, Amherst District) I find three grooved teeth in the maxilla behind the paired fangs.

NOTES ON KANDYAN ART.

By Ananda K. Coomaraswamy, D.Sc.

(With two Plates.)

Chank in the Museum at Kandy.

THE Kandy Museum has lately acquired a very beautiful chank, mounted in damascened brass, and comparable with the fine specimen which is figured in "Mediæval Sinhalese Art," Pl. XLI., I. As in that case, the termination is in the form of a *serapendiya* head, and a continuation of the metal work runs round the mouth of the chank. The foliar scrolls proceeding from the animal's mouth are partly broken. The chank itself is plain, and not inlaid as in the other example. Like the other, it comes from Uda Nuwara ; in this case, from the Dewale at Lankatilaka. The other example was given by Narendra Sinha to a Dewale at Eldeniya (or Aludeniya ?), and it may be assumed that this specimen also is at least as old as the earlier part of the eighteenth century. It measures $10\frac{2}{5}$ inches in full length.

Carved Powder Horn.

Mr. A. B. Casse Lebbe possesses a very fine carved Kandyan powder horn. The material is buffalo horn, and the delicate carving a fine example of *liya pata* work.

Weight of a Stock-drill.

When last in Ceylon I obtained a beautifully carved stock-drill (*torapanaya*) weight, elaborately carved in serpentine. This material is probably derived from the exposure near Ragalla, which was examined by Mr. Parsons, and is described in the Administration Report of the Mineralogical Survey for 1906. It is interesting to note that the carved weight shows signs of local abrasion, where it has evidently been rubbed down in recent times for medicinal purposes, as described in the report referred to.

Seen from above, the weight has a pentagonal section ; there is a ring of *pala peti* ornament round the bore, and below this are the five angular ornaments of *naga bandha* form ; below this again is a simpler form of *pala peti*, followed by several delicate mouldings. The total height of the weight is $3\frac{1}{8}$ in., the diameter of the bore is $\frac{3}{4}$ in. above and $\frac{7}{8}$ in. below. Other illustrations of stock-drill weights from Ceylon will be found in "Mediæval Sinhalese Art," fig. 91, and in Mr. Parker's "Ancient Ceylon," figs. 240, 241.

The present specimen is said to have belonged to Devendra Mulacariya, and was obtained from one of his descendants.

Photograph of a Kandyan Kendiya.

The accompanying photograph of a *kendiya* was taken some years ago by Messrs. Skeen & Co., and lately given to me by Mr. F. Skeen; the present whereabouts of the original is unknown. It represents a fine specimen, probably made in silver, and no doubt formerly the property of a Buddhist temple. It is scarcely distinguished in form from an ordinary *kotalaya*, except by the presence of a lid.

Filigree and other Beads.

The great variety of beautiful gold beads found in Kandyan jewellery, whether of local or Tamil origin, is very remarkable, and I illustrate here a selection, which should not, however, be regarded as exhausting all the varieties obtainable. All the principal types are known by name. Any filigree bead is *wayiramuni;* one with stars (No. 1) is called *taruka wayiramuni*, "star filigree bead"; one with dots (No. 16) is called *arimbu wayiramuni*, "dot filigree bead"; one chased like No. 4 *arimbu surulu wayiramuni* (but this appears to be an error, as this is not actually a filigree bead, but belongs to the other class).

Beads other than filigree are called *bubul.* Ribbed varieties (Nos. 14, 19, and 21) are called *reli bubul*, "waved beads," or "undulated"; those with a sharp angle, diamond-shaped in section, are called *dippatan*, "two-facetted"; those chased (Nos. 3 and 7) are called *ketayan bubul*, "chased beads," or "cut beads"; those covered with dots, *arimbu bubul*, "dotted beads" (No. 5). All these are made in two halves, and soldered along the median line. They are, of course, hollow, and very light and delicate.

Another small Kandyan bead, not shown here, is the *gotamuni*, resembling a grain of rice in size and shape; these are made, not in two halves, but by rolling round a piece of thin gold of the requisite size upon itself.

The following are some names of gold necklaces, additional to those given in my "Mediæval Sinhalese Art." I should have been glad to illustrate some, but could not obtain permission to take the photographs of the jewellery at the Dalada Maligawa, from a list of which the names are taken. The names are: *muna-mal malaya*, *pusu-vandaṅ malaya*, *hunu-vel malaya*, *dan-vel malaya*, *arimbu surul malaya*, *mohana malaya*, *sakra malaya*, *torapat sangili malaya*, *sinamuni malaya*. The previously recorded names, *peti malaya*,

KENDIYA.

POWDER HORN.

KANDYAN ART (A. K. COOMARASWAMY).

Bemrose, Collo., Derby.

polmal malaya, and *gedi malaya*, also occur in the list.* It would be exceedingly interesting, and to local and European art students a very valuable thing, if the Ceylon Government would arrange to publish an adequately illustrated account of the Maligawa treasure, in co-operation with the temple authorities ; it is a work which could hardly be accomplished in any other way.

I am indebted to Mr. T. B. Keppitipola for some of the above information ; he is one of the few Kandyan chiefs who, at the present time, take an interest in the arts and legends of the Kandyans.

Bo-leaf as a Decorative Motif.

The well-known Sinhalese bo-leaf ornament, considered as a Buddhist symbol or decorative motif, is certainly of considerable antiquity in India and Ceylon. It appears probable, however, that the form belongs to that large class of ornamental motifs which, like the classical "acanthus," owe their name and later significance to an accidental resemblance in a form of quite different origin. General Beylié writes as follows on the bo-leaf of India :—

"Lanceolate ornament, or, more exactly, conventional leaf ornament, has had its own special history in each country, but particularly in Egypt, where we constantly meet with it on the tombs of Antinoe. It formed later the foundation of the decorative system of Musulman art (13th century) and by reaction of the figured work of Louis XIII. It is not impossible that the lanceolate ornament of the Musulman style, although of Assyrian and Egyptian origin, was only adopted in its ordinary form after having undergone a final transformation in the Indies. The leaf of *Ficus religiosa* appears as a nimbus in many statues of Buddha in memory of the sacred bo-tree under which he attained wisdom. We may anyhow regard it as certain that the temples of Cambodia (9th–12th centuries) and the palace of Angkor-Vat ...... have never felt any other than Hindu and Chinese influence.

"We may add that the principal of the lanceolate or conventional leaf is not Indian, but Oriental, while the multi-lobed ornament, evidently of a leafy character, which appears to originate in Musulman art in the 13th century, on the belly of the vases of Mossul, is very probably of Hindu origin."

In other words, the bo-leaf *form* is of Assyrian or Egyptian origin—like the majority of motifs in decorative art, traced to their ultimate source—and was adopted as a Buddhist symbol in India,

* Another well-known form is the *siri-bo-malaya*, erroneously described as *Sri-bo-malaya* in the index to my "Mediæval Sinhalese Art," where it is illustrated (Plate XLIX., 5). This form comes mainly from the Galle District, and does not appear to be Kandyan.

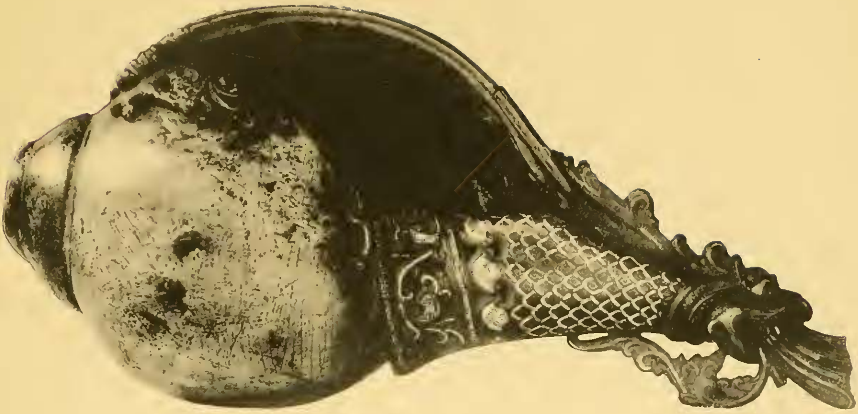
Other necklace names which I have heard are *kalamediri malaya* and *patteya malaya*. Another kind of bead is called *karawila eta*. It would be very advantageous if examples of all these named varieties could be exhibited in the Colombo Museum.

and then more deliberately based on the actual bo-leaf outline ; and this Indian type again influenced Musulman, and through Musulman, European types of ornaments.

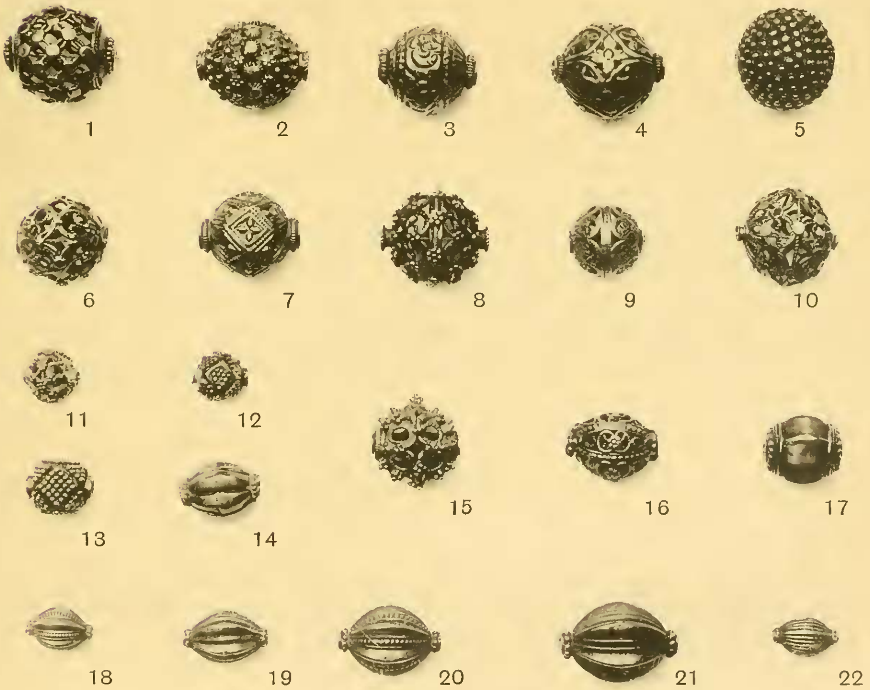
Since writing the above, Mr. Keppitipola has kindly sent me a full list of the names of the beads illustrated. The names are as follows :—

1, *Arimbupeti wayiramuni ;* 2, *Arimbu wayiramuni ;* 3, 4, 7, *Ketayan bubul ;* 5, *Arimbu bubul ;* 6, *Silamuni ;* 8, *Murukasa wayiramuni ;* 9, *Surulu silamuni ;* 10, 15, *Murukasa arimbu wayiramuni ;* 11, *Wayiramuni ;* 12, 13, *Pattan arimbu bubul ;* 14, 18, 20, *Arimbu palakka ;* 16, *Surulu palakka ;* 17, *Dipattan bubul ;* 19, 21, 22, *Reli palakka.*

It will be seen that *wayiramuni* is the term applied to a filigree bead, *bubul* to a bead not of pierced or trellis work ; an ovoid or elongated bead is called *palakka*. The term *pattan* is used, as in gemming phraseology, to signify " facetted." *Arimbu* signifies a grain or dot.



BRASS MOUNTED CHANK.



GOLD BEADS.

1 2 3 4 5

(Inch scale for beads only.)

KANDYAN ART (A. K. COOMARASWAMY).

Bemrose, Collo, Derby.

PEDIPALPI OF CEYLON.

By F. H. Gravely.

(With three Text Figures.)

THE Pedipalpi are a group of Arachnids, or spider-like creatures, which have as yet been very imperfectly studied, as specimens are scarce in the museums of Europe. They include the whip-scorpions (*Thelyphonidæ*) and scorpion-spiders (*Phrynichidæ*), of which the latter at least must be familiar to many residents in Ceylon, as one species (*Phrynichus lunatus*) is not uncommonly met with in bungalows. It is somewhat like a large and very

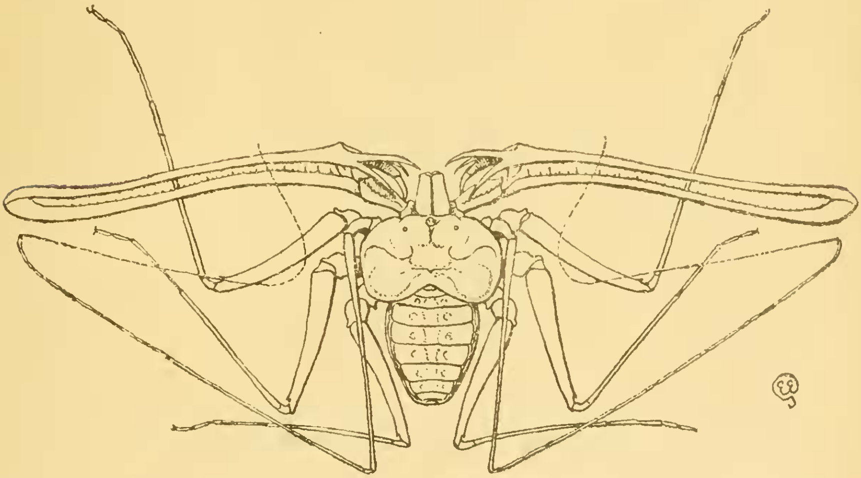


Fig. A.—" Scorpion Spider" (*Phrynichus lunatus*), ♂, natural size.

much flattened spider, having an almost disc-shaped body and long legs, which spread out from it close against the wall on which it rests and over which it darts, usually sideways like a crab, with quite startling rapidity when disturbed. But instead of the four pairs of walking legs found in the spider there are only three pairs, as the first is enormously lengthened and many-jointed, resembling both in form and in function the antennæ of an insect; for with these the creature feels its way about. And in front there is a pair of long arms, corresponding to the claws of a scorpion, terminated by a small claw and some stout curved spines; as a rule, these arms project straight outwards as far as the elbow, where they bend straight inwards again, the forearm being in contact (or almost in contact) with the upper arm throughout its entire length, as shown in the accompanying figure ; but when in a hungry state the creature sees a juicy cockroach or cricket near by, these arms are extended forwards, thus enabling it to catch its prey without approaching it too closely. The arms vary considerably in length and are usually shorter, often much shorter than in the specimen figured, the abdomen, moreover, being frequently larger. The female carries her eggs about with her in a capsule attached to the lower surface of the abdomen.

Another and somewhat smaller and more moisture-loving species of scorpion-spider (*Phrynichus pusillus*) is fairly abundant under stones in the jungles of the Kandy District, and is known to extend to a considerably higher elevation than this ; but further information as to the distribution of this, and indeed of all the

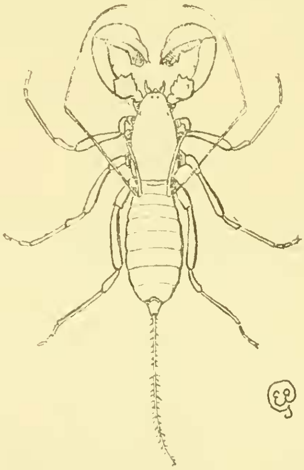


FIG. B.—" Whip Scorpion" (*Labochirus proboscideus*), ♂, natural size.

Pedipalpi in the Island, is very much to be desired, and specimens from any part would be much appreciated both by Mr. Green (Peradeniya Gardens) and myself (Indian Museum, Calcutta) for the elucidation of this matter. It is possible that there may be two distinct species of the small form found in the jungle : one with very long arms and commonest, like the larger species, in the low-country (up to 1,000 feet) ; and another with shorter arms, which is the commonest at higher levels. But this, too, is a matter which cannot be settled until more material is available.

Whip-scorpions, as the name implies, resemble scorpions rather than spiders ; indeed, at first sight the only noticeable difference between whip-scorpions and scorpions lies in the slender whip-like " tail " of the former, which, moreover, lacks the much-dreaded sting of the latter. But in these creatures, as in the scorpion-spiders, the appendages corresponding to the first pair of walking legs of other Arachnids are modified so as to form feelers, though not such extraordinarily long and slender ones.

In the Kandy District I have only met with one species of whip-scorpion (*Labochirus proboscideus*), a creature of about the size of the small brown scorpions often seen about the verandahs of bungalows, but black and of a stouter build ; a much larger species (*Thelyphonus sepiaris*) is, however, recorded from the low-country. The small species is to be found under stones and logs of decaying wood in the neighbourhood of water-courses—but not on marshy ground—and in other parts of the jungle when the ground is thoroughly moistened by the rains. This species digs a burrow

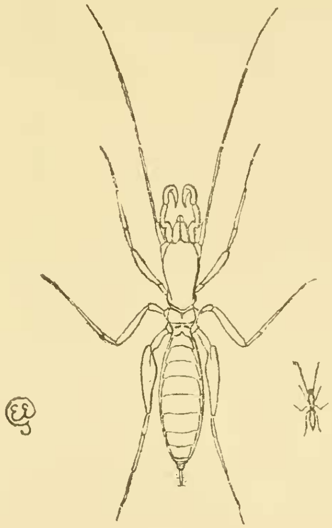


FIG. C.—"Tartarid" (*Schizomus crassicaudatus*), ♀. Magnified 6 diameters, and small figure natural size.

for itself beneath the stones under which it lives; and when its surroundings become dry, it appears to retire underground and remain there ; but on this point also further evidence is wanted. Moreover, males (with long arms) appear to be three or four times as common as females (with shorter arms), a condition which again needs explaining.* Mr. Green tells me that the larger low-country

* Further observations have proved this statement to be erroneous, or at least that it only holds good at a definite season of the year. My first specimens (all males) were obtained on May 5, before the break of the monsoon. The first female was obtained on July 20, a day or two after the commencement of the second period of wet weather this season. From that date to the present time—August 3—females have been much more and males much less frequently found. As the total number of specimens found, however, is little more than a dozen, and as my observations have been confined to a visit of three months, it is impossible to state with certainty that this apparent seasonal appearance of the sexes separately is an actual fact without further evidence; but if so, it is a very remarkable one.

species is probably much less dependent on moisture than the small species ; and like the large species of scorpion-spider it sometimes gets into bungalows. On one occasion, indeed, a friend of his found a fine specimen occupying his bed in a resthouse on the Trincomalee road.

But, beside these large and conspicuous kinds of Pedipalpi, there is yet another family, the *Tartarides*, which contains only very small and inconspicuous forms, characterized by the presence of a very short tail (flattened into a plate in the only species of male definitely known), and a form otherwise resembling that of the whip-scorpions. This family is confined, so far as has been ascertained, to Ceylon and Burma, and scarcely anything is known about it, as specimens are very rarely seen. This is not due to their being scarce, however, for they are quite abundant in the thick deposit of dead leaves in certain parts of the shrubberies of Peradeniya Gardens, and not at all uncommon under stones among grass sheltered by trees or bushes, both at Peradeniya and above Lady Blake's Drive between there and Kandy. Mr. Green tells me that he obtained a specimen at an altitude of about 4,000 ft., and no doubt they are in reality very widely distributed in the Island. But they require very careful looking for in suitable places, and when found they bear such a close superficial resemblance to a largish ant—the sensory legs being directed forwards so as to assume very much the appearance and position of the antennæ of an ant—that their true nature may easily be overlooked. The body of these creatures, however, is somewhat more cylindrical than that of most ants, the " waist " being less distinct ; their jaws work vertically side by side as in spiders, instead of horizontally as in ants, and so are quite inconspicuous ; and their spasmodic darting movements as they search for a hiding-place are also very characteristic ; once a specimen has been seen and recognized there will be no difficulty in recognizing others.

Two species are recorded from Ceylon : the common pale brownish or olivaceous one, $\frac{5}{32}$–$\frac{1}{4}$ in. in length, exclusive of the appendages, when (apparently) mature (*Schizomus crassicaudatus*) ; and a scarcer and more inconspicuous one of a dark olive-green colour, never more than $\frac{5}{32}$ in. in length (*S. suboculatus*). Pocock, in the Arachnid " Fauna of British India," places this species in the Burmese genus *Trithyreus ;* but an examination of living specimens shows that it really belongs to the purely Ceylonese genus *Schizomus*. Only in the former is the male known ; it is much scarcer than the female, and easily recognizable by the flattened and expanded tail. A curious fact about this species, which I am quite unable to explain, is that males and females of a fairly definite and approximately equal size ($\frac{5}{32}$ in.) are found under stones, whilst apparently only females, and these of a larger size, occur among dead leaves.

Apparently none of the Pedipalpi are poisonous. If a whip-scorpion be molested with a finger bearing a cut or raw scratch, this cut or scratch will probably begin to smart violently with the acetic acid ejected by the whip-scorpion from near the base of the tail ; but this is the worst they can do.

Specimens of all these forms of Pedipalpi may be readily kept in captivity and great interest derived from the study of their habits. The larger species of scorpion-spider and whip-scorpion will live comfortably in a bare insect breeding cage, feeding on insects, &c., cockroaches and crickets (not *too* large) being much appreciated. The smaller species of both forms require a layer of light soil—which must never be allowed to get very dry—on the floor of the cage, and will feed on similar insects. Even the largest species like to have water sprinkled in occasionally, so that they may suck up the drops ; and they all prefer to have some shelter—a piece of stone or rotten wood or bark of a tree—under which they may hide by day, their wanderings in search of food being entirely nocturnal.

The common Tartarid *Schizomus crassicaudatus* will live in quite a small glass collecting tube. I have kept one now for several weeks with a little soil and a few of the tiny white insects (Podurids) often found among decaying leaves or under old coconut husks. I presume that it eats these insects, for it has had no other food, and is still perfectly healthy ; but I am by no means sure, as its small size makes its habits in captivity much less easy to study than are those of the scorpion-spiders and whip-scorpions. Probably all the Pedipalpi will turn cannibal in an emergency.

The large scorpion-spider when seen upon a flat wall is most easily captured by lowering a broad glass tumbler over it and then slipping a piece of stout paper or thin card in beneath. The smaller form when met with in the jungle is easily managed by holding him down by the tip of a finger placed on the body, whilst the thumb secures him from beneath. Whip-scorpions I usually seize suddenly in the middle of the body with a pair of forceps. Tartarids are too small to pick up in this way, and too shiny to be easily secured with a camel hair brush. I usually scoop them and some of the surrounding soil with the blade of a penknife into a glass tube, emptying each specimen out into a second tube as I secure it, thus always leaving the first free for another catch. But the extraordinary facility with which they completely conceal themselves in the soil when once they have hit upon a suitable place makes it practically impossible to secure every specimen found.

I have to thank Mr. Green for the very useful figures (all of which have been drawn from life) accompanying this note. These are probably the first published figures drawn direct from the living animals, and they present them in one of their most characteristic attitudes.

NOTES.

1. *Bee-eaters as Fish-eaters.*—The following correspondence appeared in the columns of the "Ceylon Observer" between May 4 and May 11, 1910:—

I shall be glad to hear if any of your readers have noticed bee-eaters fishing. There are a pair of chestnut-headed bee-eaters, which nest pretty regularly in a steep bank on a road below my bungalow, and about 150 yards distant from my pond. Almost any bright afternoon, between 2 and 3 P.M., they may be seen fishing in the pond. They come down from a dead tree, which stands on a knoll some 50 yards away; sometimes hovering for a moment over the water to locate their prey, but more commonly marking it in their swoop, and dashing headlong into the water like a kingfisher, and very rarely missing their fish. I have seen the pair account for a dozen fish in as many minutes; all quite small fry.

When there is a flight of white butterflies on, these birds devote most of their attention to them throughout the day, but on warm bright days nearly always have a go at fishing in the afternoon.

I have heard one or two Tamils call these birds *Min kottu kuruvi*, but this was after I had pointed out the birds dipping the water; it is *possible* they mistook them for kingfishers, though *not* likely, as most of the Tamils here seem to have a very fair knowledge of birds.

I have always hitherto associated bee-eaters with the one diet of insects; and I could not quite trust the accuracy of my eyesight until I brought a strong pair of field glasses to bear on the actors at the short range of 15 to 20 yards. I think it probable that many so-called insectivorous birds change their diet when some chance has put them up to the taste of a new article which happens to suit them.

E. GORDON REEVES.

Wiltshire, Matale, May 2, 1910.

With reference to the interesting observation recorded by Colonel Gordon Reeves, as to the occasional fish-eating or rather fry-eating habits of the chestnut-headed bee-eater, I may point out that it very rarely happens that an opportunity for making such an observation presents itself under ordinary circumstances. There is no reason whatever to doubt the accuracy of the observation. Other cases of birds varying their diet are known, although the change from an insectivorous to a piscivorous diet is perhaps rather abrupter than usual. The opposite change from fish-eating to insect-eating habits is to be noted in the kingfisher family, to which the bee-eaters are somewhat distantly related. I remember being much surprised, many years ago, to find a kingfisher's stomach full of insect remains.

The different kinds of food consumed by omnivorous birds, such as the crow, do not, of course, afford such striking examples of discontinuous dietary as do those of more eclectic birds.

In *Spolia Zeylanica* for March, 1909, Mr. John Still states that he saw a paradise flycatcher plunge from its station on a tree and capture something in the water, just like a kingfisher. I have seen the same species catching butterflies on the wing. So that here we have an exact parallel to Colonel Reeves's observation.

Flycatchers are not related to kingfishers, but they are distantly related to the shrikes or butcher-birds. One might put it that bee-eaters are to kingfishers what flycatchers are to shrikes. All these birds have the habit of sitting on a perch, swooping down from it to their prey, and afterwards returning to it. The late Grant Allen stated positively that among the animals which he had seen in butcher-birds' larders were mice, shrews, lizards, robins, tomtits, and sparrows; but he added that, in spite of its occasional carnivorous tastes, the shrike is at heart an insect-eater. In this variation of diet, on the part of the shrike, we may perceive another parallel to the cases mentioned above.

A. WILLEY.

Colombo, May 4, 1910.

Colonel Gordon Reeves's observation is a most interesting one. I have never noticed these birds fishing, but as they are known to take insects from the surface of water there is no reason why they should not learn to pick up small fry in the same manner.

The "bee-eaters" (*Meropidæ*) are closely allied to the "kingfishers." The two families come next each other in Legge's "Classification of the Birds of Ceylon." Speaking of the habits of the "blue-tailed bee-eater" (*M. Philippinus*), Legge remarks :—"I have seen it dash on to the surface of ponds and rivers and seize insects which were passing over the water. Mr. Holdsworth has observed it hunting close to the surface of the sea, at a distance of a quarter of a mile from the shore."

Again, under *Merops viridis* (the green bee-eater) is a note to the effect that "Blyth has seen them assembled round a small tank seizing objects from the surface of the water, after the manner of a kingfisher." But in his description of the habits of the "chestnut-headed bee-eater" (*M. Swinhoii*), no such custom is noted, though he remarks upon its habit of frequenting "the topmost or most outstretching branches of high trees overhanging water."

E. ERNEST GREEN.

Royal Botanic Gardens, Peradeniya, May 5, 1910.

I must thank Dr. Willey and Mr. E. E. Green for their interesting replies to my query *re* the fish-eating bee-eater. Since the pair, which I convicted of fishing, hatched out their young, they have abandoned their fishing expedition, and may be seen sitting on the tree facing their burrows catching insects (chiefly white butterflies) to feed their nestlings.

By the end of the month they will have departed north. Thrush species have been abnormally common here this year, and migratory Raptores, such as harriers, equally scarce. Not long ago I noticed an India swiftlet with a large white " yoke " or collar. It was very conspicuous amongst its " all dark " associates, and remained in the same locality for some weeks.

E. GORDON REEVES.

Wiltshire, Matale, May 7, 1910.

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2. Extracts from " Entomological Notes " by the Government Entomologist, from the " Tropical Agriculturist," Vol. XXXIV., April, 1910 :—

A Blood-sucking Bug.—A correspondent has sent me specimens of an evil-looking bug which had been gorging itself at his expense. It is quite distinct from the notorious " B-flat " (or bed-bug, *Cimex lectularius*), though it has acquired the same objectionable tastes and habits. The examples first received were small and immature, but their bodies were fully distended with blood. My correspondent reports that he was disturbed at night by the bites of these creatures, and found several of them crawling about the bed. The consequent irritation was severe. Subsequently the adult insect (probably the parent of the troublesome brood) was discovered in the same situation. It proves to be a Reduviid bug (*Conorhinus rubrofasciatus*), an insect of quite formidable size, measuring over an inch in length.

Bugs of this family normally prey upon other insects ; but several species of *Conorhinus* have gained an evil reputation as systematic blood suckers. *C. sanguisugus* is a troublesome domestic pest in parts of the United States ; Darwin, in his " Voyage of the Beagle," describes a species of *Conorhinus* that attacks travellers when camping out on the Pampas of South America. As far as I know the present record is the first of the kind from Ceylon. The insects frequent outhouses, hiding amongst the rafters during the day-time and sallying out to feed at night.

The Colombo Lake Fly.—I have at last received the scientific name of the notorious " Lake Fly." It can now be definitely labelled as *Chironomus ceylanicus.* I fear, however, that this knowledge will not appreciably mitigate the inconvenience occasioned by the pest.

E. E. GREEN.

3. *Crows as fishers.*—I lately had an opportunity of watching a flock of crows doing a bit of "fishing" on their own account just after dusk, as they wended their homeward way, along the Bentota coast. Every time the waves receded they swarmed on the shore, picking up whatever was left in the track of the water. As the waves broke again they rose in air, all the time travelling along the shore in the direction of their flight home.

Colombo, May 20, 1910. C. DRIEBERG.

"*Crows as fishers.*"—In the second volume of his entertaining "Curiosities of Natural History" (reprinted in 1903 from the fifth edition: Macmillan, London), Mr. Frank Buckland has the following remarks on crows, which will be of interest *apropos* of Mr. Drieberg's note. The passage occurs in the chapter entitled "The Gamekeeper's Museum" (see p. 95):—

"As the museum was situated near the sea coast, I was therefore not surprised to see in the collection a Royston, or hooded crow. This bird's proper home is the seashore, where his business is to follow the retiring tide, and to eat what is left thereby. Nor does he object to small crabs and those curious sea-anemones which the good folk of Guernsey so aptly call "bloody-fingers." Having capital wings, he often takes a look at the rocks, where the gulls and other sea-birds build their nests and place their eggs. When these fail him, he will take an inland journey, and very naturally mistakes a game bird's egg for a gull's egg. The keeper, in his turn, very naturally seeing what he is after, mistakes him for a carrion crow, shoots and gibbets him—hence his appearance in the museum. The keeper calls him the saddle-back crow; a good name again, for his head, tail, and wings are black, and the rest of his body of a fine ash-gray colour, so that he looks very like a common crow with a saddle on his back. Our French neighbours too, whose shores he also visits, have evidently, with the same idea, christened him *Corneille mantelée*, or crow with a cloak on. These crows are very quick in finding out dead or wounded birds. A great sportsman tells me that he has often gone at daylight to pick up wild fowl which he had shot the previous evening, and found that these saddle-back crows had anticipated him and made a meal of his wild duck and teal."

At Sea, June 14, 1910. A. WILLEY.

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4. *Rambling Notes*:—

(*a*) **Life-history of a common Ceylon Butterfly.**—*Ypthima ceylonica* is—I should say without exception—the commonest of our Ceylon butterflies. It occurs throughout the year, and is a familiar object in every compound, wayside hedge, or grassy field, up to an elevation of about 4,000 feet. And yet, to the best of my belief, no published description of its early stages or transformations has yet appeared. *Y. ceylonica* is now considered to be a local race of the Indian form *huebneri*, Kirby, of which the larva and pupa are known; but our Island race of the insect has not apparently been bred up to the present time.

Having taken a pair of the butterflies *in coitu* on November 23 last, I placed them under a glass shade with some living grass plants in hopes of obtaining ova. The male insect died on the 25th. No eggs had then been deposited, though the female was still active. On the following morning I found two small globular eggs, laid side by side, near the base of a blade of grass; two more eggs were attached to the extreme tip of another blade, and three others on the under-surface of a broad leaf of ribbon-grass. When magnified it is seen that the egg is not truly globular, but has a slightly longer vertical diameter. It is wider towards the base, and very slightly flattened above and below. The surface is closely pitted with irregular polygonal depressions. The longer diameter is approximately 0·75 mm.

The eggs hatched on December 3. The young larvæ are of a very pale pinkish white tint, with a reddish median-longitudinal line and a similar dorso-lateral line on each side. The sides are more or less completely suffused with rosy red. Every segment, including the head, has a transverse series of colourless tubercles, each supporting a longish obtuse white hair. Head large, fully twice the width of the following segments.

December 10.—The young larvæ are undergoing their first moult. At the end of the first stage the pink colour of the newly hatched larva has entirely disappeared, being replaced by whitish green; the body has thickened until it has exceeded the width of the head; the tubercles have become less prominent and conspicuous; the dorsal, subdorsal, and lateral lines are dull green. After the moult the most marked difference is the appearance of a pair of pointed, conical, divergent processes on the terminal segment.

December 18.—The larvæ have moulted for the second time. There is no marked change in their appearance.

December 24.—The larvæ are preparing to moult for the third time. They are now of a uniform whitish green tint above, with a conspicuously paler lateral line, below which the underparts are of a clear grass-green colour. Upper parts with fine longitudinal darker stripes; the derm roughened with minute spicules, some of which carry a fine blackish hair.

Absence from headquarters prevented observation of subsequent moults; but on January 7 the larvæ appeared to be fully grown, and one of them had suspended itself preparatory to pupation.

The full-fed larva is of a uniform grass-green colour. Vertex of head with a very minute conicle tubercle on each side; terminal segment with two longer tapering pointed processes directed backwards. Under a lens the derm is seen to be roughened with numerous minute white or colourless specules, some of which give rise to fine short hairs—those on the dorsum black, the others colourless. The points of the posterior processes are tinged with pink. Spiracles minute, black.

During development the caterpillars fed only at night. They retired towards the roots of the plant at daylight.

January 8.—Two of the larvæ have pupated. The chrysalis is of robust form; the dorsum of the thorax strongly convex; four prominent transverse ridges across dorsum of abdomen. The two pupæ are dissimilar in colour. One is pale grayish-brown, faintly streaked and mottled with darker brown and purplish markings; the abdominal ridges pale ochreous, bordered in front with dark brown; a pale ochreous lateral stripe. The second is of a grass-green colour, mottled with blackish streaks and spots.

January 19.—The butterflies have emerged, the total developmental period having occupied fifty-four days, of which seven were passed in the egg, thirty-six in the larval, and eleven in the pupal stages.

(*b*) **Curious minatory action of a harmless Snake.**—A young example of *Dipsas ceylonensis*, in my vivarium, exhibits a curious action when handled or disturbed. The terminal 2 inches of its tail are vibrated rapidly in short spasms. This is probably a minatory action, and is suggestive of the vibration of the tail of the rattle snake of the Western Hemisphere. The genus *Dipsas* (or *Dipsadomorphus*) contains several species of tree snakes, all of which have a distinctly viperine appearance both in form and colouration, though they are really quite harmless. The fact that they have grooved fangs (though destitute of poison gland) suggests that they may have descended from a venomous ancestor; and the habit of vibrating the tail noticed above rather strengthens this idea.

(*c*) **A living chain of Ants.**—(*January 8.*)—Mr. T. Petch has just drawn my attention to a living chain of "red ants" (*Æcophylla smaragdina*) spanning a gap 3 inches in extent between the leaf of a shrub occupied by the insects and a plant immediately below. When first observed the chain was some 3 insects thick and bifurcated above, being supported at the upper extremity by two ants to each branch of the chain. These supports held on to the leaf by their feet, and each firmly held in its jaws the foot of one of the next links in the chain. These, in their turn, were gripped by the members below, and so on, until the base of the chain or column was held taut by the lowest members on the leaf below. This living chain was being utilized as a bridge, or rather ladder.

and other members of the colony were passing up and down over the bodies of their devoted comrades. Owing to a strong breeze, which swayed the branches of the shrub, the chain was kept under great tension. After about ten minutes it weakened, by the defection of some of its members, until it consisted of a series of six links, each represented by a single ant. These six insects held on pluckily for some minutes in spite of the increasing strength of the breeze. One member was held by the foot of the middle leg on each side; another was gripped by one anterior and one posterior foot; these two insects appeared to be in imminent danger of being torn asunder. The rupture finally occurred by the failure of the lowest members to retain their hold of the supporting leaf; the chain swung up, and the component members scrambled over each other up to the leaf above. This chain must have been let down—link by link—from above, and indicates a remarkable degree of organization amongst the members of the colony, some of whom must have been deliberately told off for the purpose.

(*d*) **A case of Snake-bite.**—Mr. P. C. Briscoe, of Columbia estate, Hewaheta, sends me particulars of a case of snake-bite. The snake, which was sent for identification, proved to be the small viper *Ancistrodon hypnale*, the bite of which has never been known to prove fatal to man.

It appears that the cooly was bitten at 8.30 A.M. on the second finger of the right hand. His comrades tied a ligature above the elbow and sent the man down to the factory, where he was seen by the superintendent ten minutes later. He was very frightened, and was crying and trembling. There were two distinct punctures from which blood was oozing. The hand was bathed in a strong solution of permanganate of potash, the punctures were lanced with a penknife, and crystals of permanganate rubbed into the cuts. The man was then sent to the local dispenser, who again lanced the place and dressed it with boric acid. About three quarters of an hour after the infliction of the bite the cooly was given a wine-glassful of neat brandy. At 4 P.M. the hand and forearm were swollen, but the man was suffering no pain and complained of no other symptoms. By the next day he had apparently recovered completely.

(*e*) **Reproduction of Leaf-insects by Parthenogenesis.**—I have long suspected that our common leaf-insect (*Pulchriphyllium crurifolium*) can on occasion produce fertile eggs asexually. I have now proof of the fact.

The Rev. L. Lacombe, of St. Joseph's College, Trichinopoly, tells me that three years ago he obtained eggs of the leaf-insect from Ceylon and reared them at Trichinopoly. The eggs produced females only, and these females laid fertile eggs, from which a second generation of fertile females was raised. The third generation proved to be sterile. No males appeared at all.

(*f*) **Homoptera infested by Stylops.**—A small Jassid (*Thompsoniella arcuata*), abundant in the short grass outside my laboratory, is very commonly parasitized by a Stylopid insect, probably a species of *Elenchus*. I have been unable to breed out the adult male insect, but have extracted fairly perfect specimens by boiling the dead pupæ in liquor potassæ. I have seen as many as five of the parasites projecting from between the abdominal rings of the living Homopteron. The same parasite occasionally occurs upon other species of Jassidæ in the same locality.

(*g*) **Hare attacked by Crow.**—A curious incident was observed in these Gardens a few weeks ago. A full-grown hare was seen racing across the lawns, closely followed by a crow. The hare repeatedly dodged and doubled, but the crow—flying quite low—kept up with it, making repeated dabs at it with its beak. Eventually the pursued and pursuer disappeared round a corner, and the finish of the hunt was not observed.

(*h*) **An effective Butterfly Trap.**—A large wire netting enclosure—originally designed as an aviary, but now unoccupied—is proving itself a very effective butterfly trap. For a few weeks, during the migrating season, many different kinds of butterflies entered through the open door and seemed incapable of finding their way out again. Each day fresh arrivals appeared, and remained there until captured and liberated. The most constant tenants have been *Euplœa asela*, *Danais aglea*, *Ornithoptera darsius*, *Papilio parinda*, and *P. polites*. Smaller species also enter, but are able to make their way through the wire mesh. The height of the trapping season was at the end of May and early in June. Since the middle of June no further captures have been effected. The door was open towards the south-west, and the opposite side of the enclosure was occupied by a blank whitewashed wall.

(*i*) **Characteristic odour of Leaf-cutting Bees.**—I do not know if the peculiar odour of many species of *Megachile* (leaf-cutting bees) has ever been noticed or recorded in print. It is so distinctive that I could guarantee to recognize a freshly caught *Megachile* though blindfolded. It is a decidedly unpleasant smell, suggestive—more than anything else—of sour bile.

(*j*) **Food of the Reduviid Bug, Physorhynchus linnæi.**—In Vol. III. (p. 159) of this Journal I gave an account of the slaughter of a large millipede by a comparatively small Reduviid bug. I have since had repeated evidence that this bug (*Physorhynchus linnœi*) preys habitually upon millepedes. I have on several occasions seen the Reduviid perched upon the top of its recently vanquished victim, and its body distended with the blood of its prey. On turning over a large stone I found a full-grown *Physorhynchus* surrounded by a perfect charnel-house of the remains of *Polydesmidæ*, upon which it had been feeding. I have now in captivity two nymphs of this species, which attack, without hesitation, the largest sized millepedes that may be placed in their cage. The millipede is very quickly overcome, the poison injected by the bug having a rapidly paralysing action. I have just measured a 5½ in. millipede that had been killed by a bug only three-quarters of an inch long.

(*k*) **The Call of the Green Grasshopper.**—(*June 24.*)—I have just been watching a common green Locustariid emitting its call. The insect had flown into my room, attracted by the lamps, and was perched upon some cut flowers in a vase. I was able to approach quite close without disturbing it. The call note may be written phonetically as "Tic-a-tic-tic-tic-tic-tic-tic-tic-zzeett," the final note drawn out, while the others were produced in a rapid *staccato*. At the commencement of the call the wings and elytra are a little raised and partially separated ; at each sharp note there is a slight downward movement, and the final drawn-out "zzeett" is emitted as the wings are returned to their normal position.

(*l*) **Sudden appearance of an African Snail in Ceylon.**—The East African snail, *Achatina fulica*, seems destined, before long, to be distributed throughout the Oriental region. It has been established for many years in Mauritius ; and the progeny of a single pair known to have been introduced into Calcutta about fifty years ago are now said to have overrun the whole of Northern Bengal. This same snail has recently attracted attention in the neighbourhood of Beruwala, in the Kalutara District. The fact that they are present in millions shows that the introduction must date back for a considerable number of years, and it is extraordinary that a snail with a shell measuring 5 inches in length has not been noticed before. The recent heavy rains have probably excited unusual activity amongst the snails, but they must have been in evidence on many previous occasions.

E. ERNEST GREEN.

3 56

"SAND-FLIES" (PHLEBOTOMUS) FROM PERADENIYA.

By N. Annandale, D.Sc., F.A.S.B.,

Superintendent, Indian Museum.

(With seven Text Figures.)

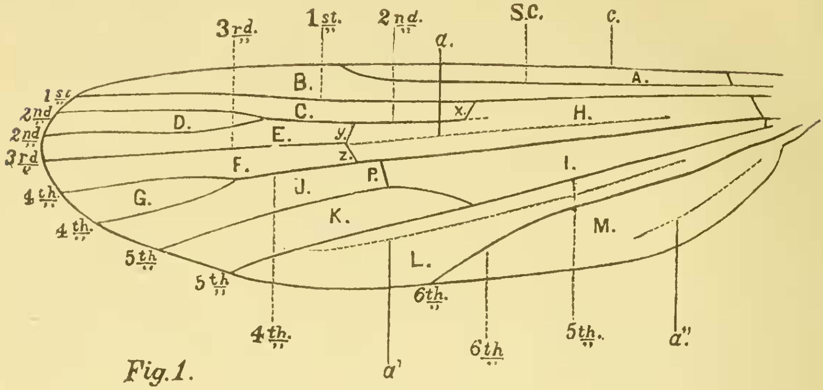
FLIES of at least three families are commonly known in the East as sand-flies, viz., of the Chironomidæ or true midges (*Ceratopogon* and its allies), the Simuliidæ (*Simulium*, known as the "potu" fly in the Himalayas), and the Psychodidæ, which are commonly called moth-flies on account of their relatively large hairy or scaly wings. The only genus of moth-flies that habitually sucks blood has received the appropriate name *Phlebotomus*, and includes the species most frequently called sand-flies, at any rate in the plains of India.

Much evidence has lately been obtained by Grassi* and by the Austrian doctors Doerr, Franz, and Taussig † that fever of a type common in the East,‡ and known by various local names, is transmitted from man to man in the countries round the Mediterranean by *Phlebotomus papatasi*, a species which occurs in northern India, and also probably in Java. It is therefore important, not only from an entomological point of view, that the distribution of flies of the genus should be carefully studied. They may easily be recognized by their narrow, pointed, hairy wings, which are held in a semi-erect position when the animal is at rest, by their silvery sheen, and long slender legs. In general appearance and structure they are not unlike minute mosquitoes. The adults fly to light at night and rest during the day in dark corners in damp places, often in bathrooms. They have the unpleasant habit of biting one's ankles under the dinner table in the evening, and are said to crawl through mosquito nets and under bed clothes for a similar purpose. The larvæ § are peculiar little maggots with four very long bristles at their posterior extremity, and are found on the walls of latrines, among damp moss on stones, in damp earth, and probably in other situations abounding in moisture, but not actually aquatic.

Specimens of the flies are best preserved in small tubes of spirit, but dried specimens packed not too tightly with tissue paper (*not*

* Mem. Soc. Ital. Sci. (iii.), XIV., p. 353 (1907).
† Das Pappatacifieber (Leipzig and Vienna, 1909).
‡ See Wimberley, Ind. Med. Gazette, XLV., No. 8, p. 281 (1910).
§ See Howlett's figure in Maxwell-Lefroy's "Indian Insect Life," p. 559 (fig. 158).

cotton wool) in pill boxes or match boxes are useful. I shall be glad to examine specimens sent to the Indian Museum, Calcutta.



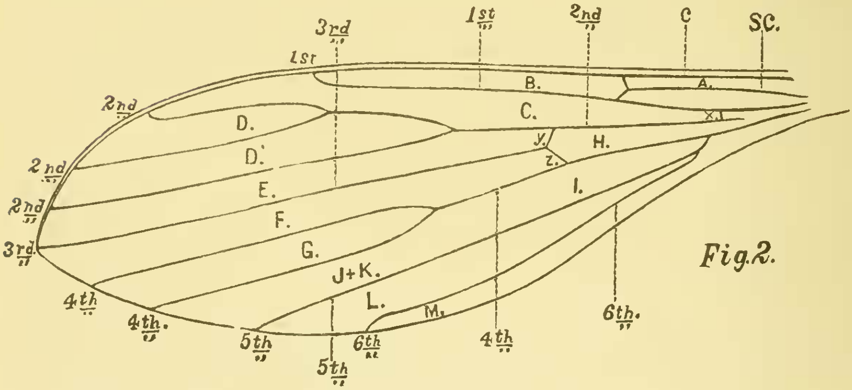


Fig. 1.—Wing of *Culex* (after Theobald). Fig. 2.—Wing of *Phlebotomus argentipes.*

c., costal vein; s.c., sub-costal; 1st to 6th, first to sixth longitudinal veins; a, a′, and a″, incrassations (a′ called by Austen the 6th vein, a″ the 8th); y., supernumerary cross-vein; z., mid cross-vein; P., posterior cross-vein; A., costal cell; B., subcostal cell; C., marginal cell; D., first submarginal cell; E., second submarginal cell; F., first posterior cell; G., second posterior cell; J., third posterior cell; K., anal cell; H., first basal cell; I., second basal cell; L., auxiliary; M., spurious cell.

The most important specific characters reside in the venation of the wings, the structure and proportions of the male genitalia, and the proportions of the various joints of the legs. Diagrams of the wing and of the external male genitalia are here produced by permission of the Trustees of the Indian Museum. Further particulars will be found in the "Records of the Indian Museum," Vol. IV., No. II. (1910).

It has long been known that *Phlebotomus* occurred in Ceylon, but no specimens appear to have been identified specifically. In a small collection made at Peradeniya by Mr. E. E. Green and Mr. F. H. Gravely four species are represented, two of them already known from many localities in India and two new to science. The four species may be distinguished as follows :—

(1) The tip of the first longitudinal vein of the wing but little in advance of the anterior fork of the second longitudinal vein.

(a) Colour silvery brown; the area of the wing paler than the anterior border; the coxæ yellowish; the anterior branch of the second vein about twice as long as the distance between the two forks of the vein .. .. *P. marginatus.*

(2) The tip of the first longitudinal vein far in advance of the anterior fork of the second.

(a) Dorsal surface of the thorax dark brown, the sides yellow. The anterior branch of the second vein slightly longer than the distance between the two forks .. *P. argentipes.*

(b) Thorax brown; coxæ yellowish; the whole of the wings paler than the abdomen. The anterior branch of the second vein about five times as long as the distance between the two forks .. *P. zeylanicus.*

(c) Colour uniform, dull yellowish gray. Wings very narrow; the anterior branch of the second vein shorter than the distance between the two forks .. *P. babu.*

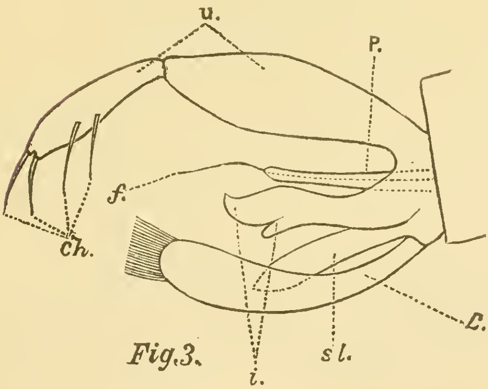


Fig.3.

° Diagram of the external male genitalia of *Phlebotomus:* u., upper or superior appendage; ch., chætæ; f., genital filament; i., intermediate appendage; P., intromittent organ; s.l., subgenital lamella; L., lower or inferior appendage.

Phlebotomus argentipes, Annandale and Brunetti.

Rec. Ind. Mus., IV., p. 44, Pl. IV., fig. 3; Pl. VI., fig. 6.

Several specimens of this common Indian species were taken at Peradeniya in March, June, and July.

Phlebotomus zeylanicus, sp. nov.

♂, ♀. *Size and Proportions.*—Total length of dried specimen about 3 mm. Length of wing 3 mm. Hind leg more than two and a half times as long as the thorax and abdomen; its femur less than three-quarters, but more than half as long as its tibia, slightly longer than the first joint of the tarsus, which is distinctly shorter than the three distal joints together.

FIG. 4.—*Ph. zeylanicus* ♀ (enlarged).

Colour.—Head, thorax, and abdomen brown, paler in the female than in the male; coxæ yellowish; femora, tibiæ, and tarsi silvery gray; wings pale brownish-gray, uniform in colour.

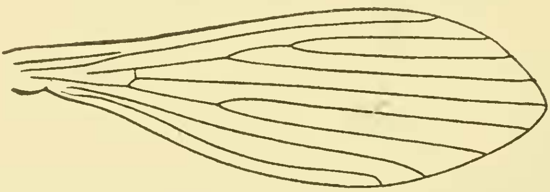


FIG. 5.—Wing of *Ph. zeylanicus* (enlarged).

Wings.—Lanceolate, not very broad, with the two borders not unlike in curvature. The first longitudinal vein extends far forwards, overlapping the anterior branch of the second vein by more than three-quarters of its length. This branch is nearly five times as long as the distance between the two forks, which is much shorter than the distance between the posterior fork and the point at which the vein joins the third vein. The fork of the fourth vein is almost on a level with the posterior fork of the second. The course of the sixth vein, which bends down almost at an angle at the tip, is sinuous.

Male Genitalia.—The distal joint of the superior appendage is slightly shorter, and much more slender than the proximal joint; its outlines are somewhat sinuous, and it bears five long, stout, curved, sharp chætæ, which are arranged as follows:—A pair at the tip of the appendage, a pair on the outer margin at about half the length of the joint, and a single chæta on the inner margin nearer the base. The chætæ are equal or subequal. The intermediate appendage (morphologically the lower branch of the superior one) is slender, pointed, and turned upwards at the tip. It bears a minute, pointed, naked lobe on its ventral surface, and a similar one on its external lateral surface. The inferior appendage is much longer than the proximal joint of the upper one; it is slender as viewed from the side, and of almost uniform width; the tip is narrowly obliquely truncate, and bears a brush of very long and slender hairs; the rest of the appendage is sparsely covered with rather shorter hairs, but there are no spines.

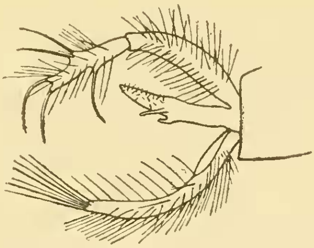


FIG. 6.—Male genitalia of *Ph. zeylanicus* from the right side, × 75.

The genitalia of this species closely resembles those of *P. argentipes*, from which it is distinguished among other characters by the venation of the wing. The venation closely resembles that of *P. malabaricus* (from Travancore) and *P. himalayensis*, but the insect is paler than the former and darker than the latter species. Its genitalia are also very different from those of either.

Several specimens of both sexes were taken at Peradeniya in May, June, July, and August.

Phlebotomus babu, Annandale.

? *Hebotomus minutus*, Rondani, Ann. Soc. Ent., France, 1843 (I.), p. 265, Pl. X., fig. 4.

Phlebotomus, sp., Howlett in Maxwell-Lefroy's "Indian Insect Life," p. 559, fig. 358.

Phlebotomus babu, Annandale, Rec. Ind. Mus., IV., p. 49, Pl. IV., fig. 1; Pl. VI., figs. 3, 3*a* (1910).

This species, which is easily recognized by its small size (length about 1·5 mm.), narrow pointed wings, and pale grayish-yellow colour, is common all over the plains of India; specimens have been taken recently by Major F. Wall, I.M.S., in Chitral in the Hindu Kush mountains. A specimen was obtained at Peradeniya in May.

I have little doubt that my *P. babu* will ultimately prove synonymous with "*Hebotomus*" *minutus*, Rondani, but the original description of the latter is very short and the figure clearly incorrect, and it is impossible, without examining European specimens, to be sure of the identity of the two "species." *P. minutus* was found in Italy on the banks of the river Po.

Phlebotomus marginatus, sp. nov.

o. *Size and Proportions.*—Total length of dried specimen about 2·5 mm. Length of wing 2·5 mm. Hind leg less than two and a half times the length of the thorax and abdomen; its femur about half as long as its tibia, of the same length as the first joint of the tarsus, which is equal in length to the three distal joints together.

Colour.—Rather darker than that of *P. zeylanicus*, the costal border of the wings distinctly darker than their area.

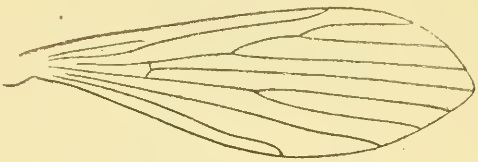


Fig. 7.—Wing of *Ph. marginatus* (enlarged).

Wings.—Resembling those of *P. zeylanicus* in shape, but longer. The first longitudinal vein only reaching forward for a short distance beyond the anterior fork of the second vein. The anterior branch of the latter about twice as long as the distance between the two forks, and approximately equal to the distance between the posterior fork and the point at which the vein joins the third. The fork of the fourth vein distinctly nearer the tip of the vein than the posterior fork of the second.

Unfortunately I have only been able to examine a single female, which was taken at Peradeniya in May, but the venation is so characteristic that the species must be distinct. The wing resembles that of *P. angustipennis*, Meijere,* from Java, which may be a form of *P. papatasi*, but the tip of the first longitudinal vein is nearer that of the anterior branch of the second, and the fly is larger, the latter not a point of much importance. Dr. de Meijere's description is unfortunately very short.

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* Tijd. v. Ent., LII., p. 202., Pl. XII., fig. 14 (1909).

NOTE ON A FRESH-WATER SPONGE AND POLYZOON FROM CEYLON.

By N. Annandale, D.Sc., F.A.S.B.,

Superintendent, Indian Museum.

(With Plate I.)

SHORTLY before leaving Colombo Dr. A. Willey was kind enough to send me a fresh-water polyzoon that he had obtained from a pool on the roadside between Maradankadawala and Galapitagala, in the North-Central Province of Ceylon, on February 18, 1909.

At the base of the polyzoon is a minute sponge which represents a species widely distributed in the East, but only recognized as distinct in 1907, viz., my *Spongilla proliferens.** This sponge was originally described from Bengal, but is now known to occur in most parts of India and Burma, and has been found in Yunnan. The specimens recorded by Prof. Max Weber † from the Malay Archipelago as *Spongilla cinerea*, Carter, also belong to this species. The only fresh-water sponge hitherto recorded from Ceylon is *Spongilla carteri*,‡ from which *S. proliferens* may easily be distinguished by the fact that there are numerous little pointed and spiny spicules free in its substance, and by the structure of the gemmule, which is covered with what appears to be a granular coat instead of the layers of cellular air spaces in which the gemmule of *S. carteri* is enclosed, and is armed with numerous little spined spicules. The sponge is of a brilliant green colour, and always small and very soft. *S. proliferens* may be distinguished from *S. lacustris*, a race of which is common in Madras, by the fact that the aperture of its gemmule is provided with a small chitinous tube.

The polyzoon itself, as Dr. Willey suggests, appears to be identical with the species I recently described as *Pectinatella burmanica*,§ but differs from that species in several features, probably due to environment. The genus *Pectinatella* consists of Phylactolæmatous Polyzoa with horseshoe-shaped tentacular crowns and statoblasts (resting reproductive bodies) of large size, and entirely surrounded by little hooked processes. The individual colonies (zoaria) have a

* Journ. Asiat. Soc., Bengal, 1907, p. 15, fig. 1.
† Zool. Eregeb. Niederl. Ost-Ind., Vol. I., p. 35.
‡ Willey, *Spolia Zeylanica*, Vol. IV., p. 184.
§ Rec. Ind. Mus., Vol. IV., p. 56 (1910).

strongly developed gelatinous investment or synœcium, and are bound together when fully adult in a gelatinous investing membrane. In this way gigantic compound colonies are sometimes formed. In a form allied to *P. burmanica*, namely, the Japanese *P. gelatinosa*, these compound colonies sometimes reach six feet in length, while those of *P. burmanica*, as it grows in the Sur lake in Orissa, are often more than two feet long and several inches thick. The statoblast of this species is nearly round, and its hooked processes are very short, only being visible under a high power of the microscope. Dr. Willey's specimens are peculiar, on account of their small size and of the relatively poor development of the synœcia. The compound colonies consist of only two or three zoaria each, and no zoarium measures more than 10 mm. in greatest diameter; but compound colonies from Orissa often contain hundreds of zoaria, some of which measure over 20 mm. in diameter. The polyps of the Ceylon specimens are correspondingly small, and their zoœcia (the cases in which the individual polyps reside) are much more distinct from one another than they are in Indian examples of the species. Probably these differences are due to differences in nutrition.

The only fresh-water polyzoon hitherto recorded from Ceylon is a *Plumatella* from Colombo, identified by Apstein* as *P. princeps*, Kræpelin (? *P. emarginata*, Allman), a cosmopolitan species or rather group of species common in India.

Explanation of the Plate.

Fig. 1.—Gemmule of *Spongilla carteri*, × 140.

Fig. 2.—Gemmule of *S. proliferens*, × 140.

Fig. 3.—Statoblast of *Pectinatella burmanica*, × 70. 3*a*.—Part of the edge of the same, × 240.

Fig. 4.—Free statoblast of *Plumatella*, sp., × 70.

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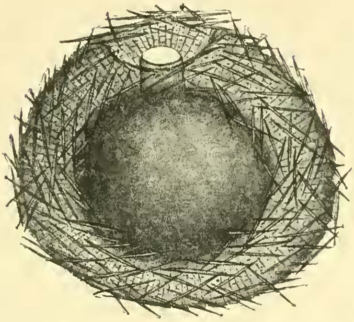
* Zool. Jahrb. (Systematic Part), p. 233, 1907.



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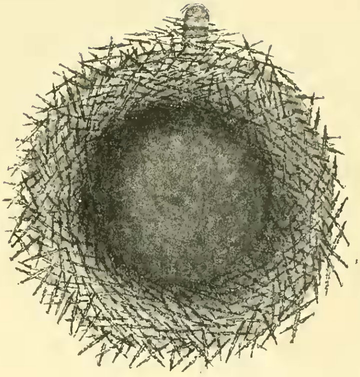

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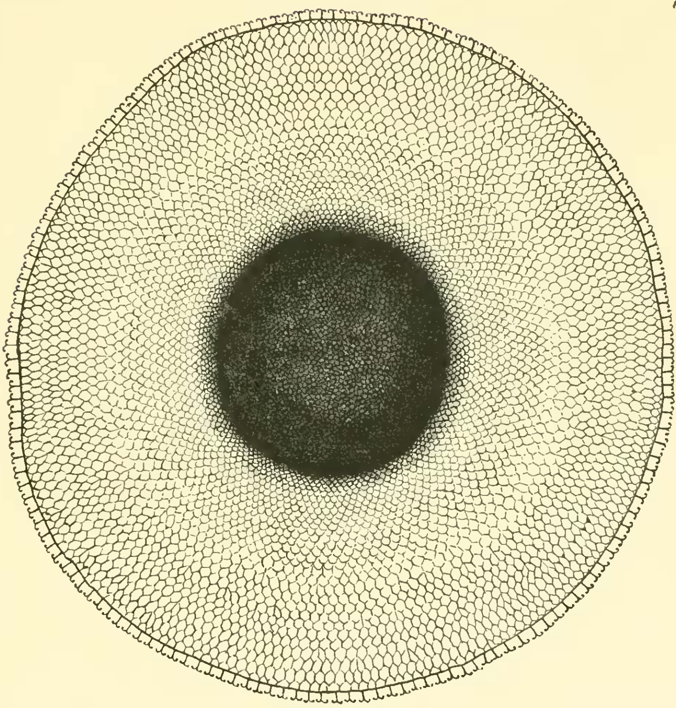

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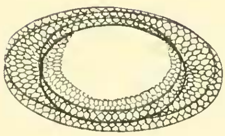

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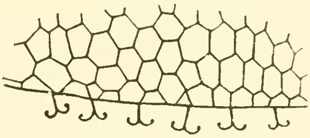

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A. C. Chowdhary, *del.*

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Freshwater Sponges & Polyzoa of Ceylon.

ON SOME PARASITIC PROTOZOA FROM CEYLON.

By C. Clifford Dobell,

Fellow of Trinity College, Cambridge; Lecturer in Protistology and Cytology at the Imperial College of Science and Technology, London, S.W.

(With Plate II.)

CONTENTS.

Introduction.
Record of Animals examined, with Results and Comments.
Descriptions of some new Forms.
Concluding Remarks.
Literature References.
Description of Plate.

INTRODUCTION.

THE following pages are the outcome of a recent visit which I made to Ceylon whilst holding the Balfour Studentship of Cambridge University. During my stay in the Island, which dated from the beginning of July until the end of September, I examined a number of animals from various parts of the country, with a view to discovering parasitic Protozoa. A good deal of my work was attended with entirely negative results, though a certain number of new forms were found, which are here recorded. Both negative and positive results, however, are given in the following pages, in order to assist future workers who may take up the investigation of Ceylon Protozoa.

The work was carried out chiefly in the laboratory attached to the Museum at Colombo, in the laboratory at the Botanic Gardens, Peradeniya, and in the resthouse at Trincomalee.

I wish here to offer my warmest thanks to those who have helped me, in one way or another, in my work—especially to Mr. E. E. Green, Government Entomologist, and to Mr. R. H. Lock, Acting Director of the Botanic Gardens, for their assistance during my stay in Peradeniya; and to Dr. Willey, the late Director of the Colombo Museum, for his unfailing aid and kindness throughout my visit. Though the results of my work here recorded are inconsiderable, they would have been far less but for Dr. Willey's assistance. His extensive knowledge of the fauna of Ceylon, and his untiring zeal in obtaining material for me, proved of incalculable value. Whatever merit attaches to the results here set forth is due in a large

measure to Dr. Willey's enthusiastic collaboration. I am glad to have this opportunity of thanking him once more, and of acknowledging my great indebtedness to him.

This paper was completed, after working through a part of the material which I brought back to England, at the Imperial College of Science and Technology, London, S.W.

I have divided the account of my work into two main parts :—

(1) A record, with notes, of the animals examined ; and

(2) A description of some new forms which I found in the course of examining these animals.

I.—RECORD OF ANIMALS EXAMINED, WITH RESULTS AND COMMENTS.

A.—Record of Animals whose Blood was examined for Protozoa.

FISHES.

With the exception of *Saccobranchus fossilis*, all the seven species of fresh-water fish, whose blood I was able to examine, proved negative.

A.—*Infected.*

1. *Saccobranchus fossilis.*—The record of the examination of the blood of this species is as follows :—

One individual from Colombo lake (part not recorded) (July). Blood negative. Twelve specimens from Colombo lake (Hunupitiya and Kollupitiya) (Sept.). Blood of all negative.

Four specimens from Nugegoda (Sept.). Blood negative.

Two specimens from Fort side of Colombo lake (Sept.). Both infected with trypanosomes. (See comments below.)

B.—*Not infected.*

2. *Anabas scandens.* One individual, Colombo (July).
3. *Clarias magur.*—One individual, Colombo (Sept.).
4. *Etroplus suratensis.*—Two individuals, Colombo lake (Sept.).
5. *Gobius giuris.*—Four specimens, Colombo lake (Sept.).
6. *Ophiocephalus punctatus.*—Two specimens, Colombo (Sept.).
7. *Ophiocephalus striatus.*—A single individual, Colombo (Sept.).

Comments.—The trypanosome found in *Saccobranchus* is that already described by Castellani and Willey (1904) under the name *Trypanosoma saccobranchi.* For the benefit of future workers who may seek this trypanosome, I would call attention to the curious distribution which it seems to have in the fishes of the Colombo lake. My experience indicates that only those fish taken from the *Fort side* of the lake are infected.

Castellani and Willey also failed to find trypanosomes in the blood of *Ophiocephalus striatus*, though they note that Lingard found trypanosomes in this species in India.

The same observers also record a trypanosome as occurring in the blood of *Gobius giuris*, although—as recorded above—the four individuals of this species which I examined proved negative.

Castellani and Willey also record a trypanosome from *Macrones cavasius*, a Silurid.

Amphibians.

The common frog, *Rana tigrina*, is the only amphibian in which I have found blood parasites.

A.—*Infected.*

1. *Rana tigrina*.—My records are as follows :—Two individuals (Colombo, July), both infected with trypanosomes and hæmogregarines. One individual (Colombo, July) infected with hæmogregarines only. Two individuals (Colombo, Aug.), blood negative. One very young specimen (Peradeniya, Aug.), blood negative. Two individuals (Colombo, Sept.), blood of both negative.

B.—*Not infected.*

2. *Bufo melanostictus*. — Three individuals (Colombo, July). One young individual (Peradeniya, Aug.).

3. *Ixalus leucorrhinus*.—A single specimen from Peradeniya (Aug.).

4. *Rhacophorus maculatus*.—One individual from Peradeniya (Aug.) and one from Trincomalee (Sept.).

Comments.—Castellani and Willey examined *R. tigrina*, with negative results. The parasites which I encountered are therefore recorded for the first time from Ceylon frogs. I have little doubt that the hæmogregarine which I found in *R. tigrina* is the same as that described from this species in Bombay by Berestneff (1903), and named *Hæmogregarina berestneffi* by Castellani and Willey (1905).* I encountered intracorpuscular individuals of various forms and sizes, many of them showing the characteristic pink-staining sheath described by Berestneff. In addition to these forms, there were also many free gregariniform individuals in the blood plasma. These were actively motile. I several times observed small forms enter red blood corpuscles. They did this by boring directly into the corpuscle, very much in the way described by Schaudinn (1903) in the case of the sporozoites of *Plasmodium vivax*, but the time taken was very different, as entry was effected in a few minutes. Occasionally, the animal, after reaching the inside of the corpuscle, rested for a few minutes and then wriggled

* Patton (1908) states that he has "had the opportunity of studying no less than five hæmogregarines in *Rana tigrina* and *Rana hexadactyla*, not only in the frogs, but in the leech which transmits them."

its way out again into the blood plasma. The curious method of entry by being engulfed by the corpuscle—recently described in detail by Neresheimer (1909) in *Lankesterella*—I never saw.

Figures of some of the forms of the hæmogregarine encountered are given in Plate II., figs. 3–8.

Berestneff also recorded a trypanosome from the Indian frogs. No name was given to it, and as I believe other observers have also seen this same parasite, which is probably the same as the one I found in Ceylon, I have contented myself with a brief description and figure of the organism, without bestowing a new name upon it. (See p. 74.)

Reptiles.

I had opportunities of examining the blood of a number of different reptiles, including crocodiles, tortoises, lizards, and snakes. The results obtained are as follows :—

Crocodiles.

I was able to examine the blood of two crocodiles, *Crocodilus porosus*. The first, a small specimen from Dadugan-oya, Veyangoda (July), contained a hæmogregarine. (See p. 79.) The second, a very young individual from Ja-ela, near Colombo (Sept.), was negative.

No hæmogregarines have been described from Ceylon crocodiles before, though several other crocodiles from other parts of the world have been found to harbour these parasites. (See p. 79.)

Tortoises.

The three following species of tortoise were examined :—

1. *Emyda vittata.*—Of five specimens examined in Colombo (July), the presence of trypanosomes could be demonstrated in only one individual, and in very small numbers.

2. *Nicoria trijuga.*—Three individuals from Colombo lake (July) : one heavily infected with hæmogregarines, one slightly infected, and one in which no parasites could be detected.

3. *Testudo elegans.*—Two individuals from Sigiriya (Sept.) showed no blood parasites.

Comments.—The trypanosome found in *Emyda vittata* is that already described by Miss Robertson under the name *T. vittatæ* [Robertson (1908) and (1909)]. The hæmogregarine from *Nicoria* is *H. nicoriæ* (Castellani and Willey, 1904).

Lizards.

Examination of the blood of twelve species of Lacertilia gave the following results :—

A.—*Infected.*

1. *Hemidactylus leschenaultii.*—At Trincomalee (Sept.) nearly every individual examined was infected with *Hæmocystidium*

simondi, Castellani and Willey. Some individuals harboured trypanosomes and hæmogregarines in addition. A single specimen from Hab-rana (Aug.) was infected with trypanosomes. (See remarks below.)

B.—*Not infected.*

2. *Calotes ophiomachus.*—Eight individuals (Colombo, July).

3. *Calotes versicolor.*—Twenty-five specimens from Colombo (July) and one from Peradeniya (Aug.).

4. *Ceratophora stoddartii.*—Three individuals (Peradeniya, Sept.).

5. *Hemidactylus depressus.* — Six individuals (Trincomalee, Sept.).

6. *Hemidactylus frenatus.* — A single specimen (Trincomalee, Sept.).

7. *Hemidactylus triedrus.*—One individual from Colombo (Aug.), one from Peradeniya (Aug.), and two from Trincomalee (Sept.).

8. *Lygosoma punctatum.*—Five specimens (Peradeniya, Aug.).

9. *Lyriocephalus scutatus.*—Three specimens (Peradeniya, Aug.).

10. *Mabuia carinata.*—Three individuals from Colombo (July), two from Peradeniya (Aug.), one from Colombo (Sept.), and one from Peradeniya (Sept.).

11. *Sitana ponticeriana.*—One individual (Trincomalee, Sept.).

12. *Varanus bengalensis.*—A single specimen (Trincomalee, Sept.).

Comments.—It is curious to find that all the lizards—geckoes excepted—harbour no blood Protozoa. In Europe and in Africa (*cf.*, for example, Wenyon's recent work, 1908*a*) the lizards are frequently infected with hæmogregarines, but Asiatic lizards appear to be much less frequently so. The absence of Protozoa in the blood of Indian lizards was remarked by Berestneff (1903). Since then Minchin (1907) has described a hæmogregarine (*H. thomsoni*) from a Himalayan lizard (*Agama tuberculata*), but facts with regard to the infection of other Asiatic lizards are extremely scanty.

Hæmocystidium simondi, which I found in the Trincomalee specimens of *Hemidactylus leschenaultii*, was discovered and described by Castellani and Willey (1904), and has since been observed by Miss Robertson (1908). I was fortunate enough to be able to work out a part of the life-cycle of this organism. the description of which I shall publish elsewhere.

The trypanosomes which I found were those described by Miss Robertson (1908) as *T. leschenaultii*. Another form which she observed in *H. leschenaultii* and *H. triedrus*, and named by her *T. pertenue*, I never encountered.

It is perhaps worthy of comment that I have—in common with previous workers—never found Protozoa in the blood of *Hemidactylus depressus*, although it lives in the jungle in company with the infected geckoes.

Filariæ were found in the blood of several *Calotes versicolor*. These have already been described by Castellani and Willey. I found a similar *Filaria* in the blood of the *Varanus* from Trincomalee.

Miss Robertson (1908) apparently also found no Protozoa in the blood of most Ceylon lizards, for she says: "The common *Calotes* and the beautiful Brahminy lizard ...... and the skink and the horned up-country lizard were all negative, so also the common little house gecko who lives on the wall and eats flies."

Snakes.

I have been able to examine sixteen different species of snakes. As I hope shortly to describe in detail the results of my investigations into the life-histories of the hæmogregarines of Ceylon snakes, I will here give merely a brief record of my observations:—

A.—*Infected.*

1. *Dipsadomorphus forstenii.*—Blood containing hæmogregarines in large numbers. A single individual (Colombo, Aug.).

2. *Dipsadomorphus ceylonensis.*—One individual, slightly infected with hæmogregarines (Peradeniya, Aug.).

3. *Dryophis mycterizans.*—The green whip snake was found to harbour a hæmogregarine (though not invariably) at Colombo (Aug.) and Peradeniya (Sept.). A single individual examined at Trincomalee (Sept.) was negative.

4. *Naia tripudians.*—A single cobra (Peradeniya, Sept.) was infected with hæmogregarines.

5. *Tropidonotus stolatus.*—Out of four individuals examined, two showed no blood parasites (Peradeniya, Aug.; Trincomalee, Sept.). One individual (Colombo, July) had spirochæts in its blood. (See p. 77.) One individual (Peradeniya, Aug.) was infected with trypanosomes (see p. 77) and hæmogregarines.

6. *Zamenis mucosus.*—Rat snakes were always infected with hæmogregarines at Colombo (Aug.) and Peradeniya (Aug.). One individual examined at Trincomalee (Sept.) was not infected.

B.—*Not infected.*

7. *Ancistrodon hypnale.*—Two individuals from Hakgala (Sept.) and one from Kandy (Sept.).

8. *Cerberus rhynchops.*—One individual from Negombo (Sept.) and two from Colombo (Sept.).

9. *Dendrelaphis tristis* (= *Dendrophis pictus*).—Two from Sigiriya (Sept.), one from Trincomalee (Sept.), and one from Peradeniya (Sept.).

10. *Helicops schistosus.*—Two specimens: one small (Colombo, Aug.), the other very large (Colombo, Sept.).

11. *Hydrus platurus.*—A single specimen (Colombo, July).

12. *Lycodon aulicus.*—A single young individual (Colombo, Aug.).

13. *Oligodon sublineatus.*—Four individuals from Peradeniya (Aug. and Sept.).

14. *Python reticulatus.**—A single snake caught in Colombo (July).

15. *Tropidonotus asperrimus* (= *T. piscator*).—One individual from Colombo (Aug.), five from Trincomalee (Sept.), and four from Colombo (Sept.).

16. *Viper russellii.*—A single young specimen (Peradeniya, Sept.).

Comments.—Hæmogregarines have not been previously recorded from *Dipsadomorphus forstenii* or from *D. ceylonensis*. Hæmogregarines are recorded already from *Zemanis mucosus* and *Dryophis mycterizans* in India by Patton (1908), and from *Z. mucosus* in Ceylon by Miss Robertson (1908). The latter also found hæmogregarines in three other Ceylon snakes: *Chrysopelea ornata*, *Naia tripudians*, and "a large python."

A hæmogregarine has been described from *Naia tripudians* by Simond (1901), Laveran (1902), and Patton (1908). Patton (1908) gives a list of eleven Indian species of snake which harbour hæmogregarines.

I did not succeed in finding *Hæmogregarina mirabilis* (Castellani and Willey) in *Tropidonotus asperrimus*.

Birds.

The only bird I examined was a kingfisher shot at Peradeniya. No Protozoa were found in its blood. Castellani and Willey (1905) record *Hæmoproteus* (*Halteridium*) from the blood of crows (*Corvus splendens* and *C. macrorhynchus*), from the babbler (*Crateropus striatus*), and from the owl (*Scops bakkamœna*).

Mammals.

I examined very few mammals. None showed Protozoa in the blood.

Uninfected.

1. *Funambulus palmarum.*—A single individual (Colombo, July).
2. *Lepus nigricollis.*—One young individual (Peradeniya, Sept.).
3. *Pteropus medius.*—A single specimen (Peradeniya, Sept.).
4. *Tragulus meminna.*—Two individuals (Colombo, Aug.). A peculiarity in the blood corpuscles of these animals seems worthy of record. It was found that, although the leucocytes are large, the red corpuscles are extremely small. In fact, I have never encountered such small erythrocytes in any animal before. In *T. meminna* they have a diameter of only about 2·5 μ.

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* This, of course, is not a native Ceylon snake. It is not known how it came to be in Colombo.

B.—Record of Animals examined for Intestinal Protozoa.

An examination of the alimentary canal of various animals was undertaken, in addition to the examination of the blood just recorded. Below are the results. The animals examined were few compared with those in which a blood examination was made.

Amphibia.

1. *Bufo melanostictus.*—I examined the contents of the large intestine in a few individuals both at Colombo and at Peradeniya. In all the animals examined both *Trichomonas* and *Trichomastix* were found. These animals were indistinguishable from *Trichomonas batrachorum* and *Trichomastix batrachorum* which occur in the European frogs and toads. As I have given a detailed description of these forms elsewhere (Dobell, 1909), I will say no more about them here.

A flagellate, which appeared to be identical with the *Octomitus* of the English frog, was also found (*cf.* Dobell, 1909).

In one *B. melanostictus* from Peradeniya a new species of *Nyctotherus* was present. (See p. 75.)

2. *Ixalus leucorhinus.*—A single individual examined in Peradeniya appeared to have absolutely no Protozoa of any sort in its gut.

3. *Rana tigrina.*—Individuals were examined both in Colombo and in Peradeniya. The following Protozoa were found :—

In the large intestine :—An *Entamœba*, indistinguishable from *E. ranarum*, Grassi (*cf.* Dobell, 1909); three flagellates—*Trichomonas*, *Trichomastix*, and *Octomitus*—which appear to be identical with the corresponding organisms in *Rana temporaria* in Europe (*cf.* Dobell, 1909) ; the following Ciliata :—*Opalina*, a small multinucleati species, which was not examined in stained preparations ; large and small *Balantidium* (see p. 74) ; and *Nyctotherus macropharyngeus* (Bezzenberger, 1904). At Peradeniya the oocysts of a coccidian (?) were found. (An examination of the epithelium of the small intestine proved negative.)

In the duodenum :—*Balantidium*, sp. (See p. 74.)

4. *Rhacophorus maculatus.*—This animal was found (Peradeniya) to harbour an *Opalina* and a *Nyctotherus*, both apparently new. (See pp. 76 and 75.) The latter appears to be the same as that found in *Bufo melanostictus* from the same locality.

Remarks.—No intestinal Protozoa seem to have been described from Ceylon frogs and toads hitherto, though Bezzenberger (1904) has described a number of ciliates from various " Asiatic " Anura (localities not given). Further remarks upon the intestinal Protozoa of Amphibia will be found on p. 74.

Lizards.

1. *Hemidactylus leschenaultii.*—One specimen (Habarana) had Trichomonads, and another undetermined flagellate in the large intestine. These were not studied further.

2. *Lygosoma punctatum.*—Several animals were examined at Peradeniya, but no Protozoa were found in the gut.

3. *Lyriocephalus scutatus.*—One individual examined at Peradeniya. Beyond the spores of a coccidian (?) nothing was found. (Epithelium of small intestine negative.)

4. *Mabuia carinata.*—All the individuals examined were found to harbour both *Trichomastix* and *Trichomonas*. (See p. 77.)

Snakes.

I examined only three snakes for intestinal Protozoa:—*Zamenis mucosus* and *Lycodon aulicus* were both negative; *Dryophis mycterizans*, however, contained *Trichomonas* and a *Trichomastix*, which closely resembled the organism which I have already described from *Boa constrictor* (Dobell, 1907). I did not make a careful study of these organisms.

Mammals.

At the instigation of Dr. Willey I made an examination of the contents of the stomach of the two mouse deer (*Tragulus meminna*), which came into my hands at Colombo. In both animals the stomach was literally seething with oligotrichous ciliates, belonging to the family Ophryoscolecidæ, Stein.

These ciliates were discovered by Dr. Willey, but have not as yet been described. At his suggestion I preserved a quantity of the organisms, of which I hope to publish a full description shortly.

Molluscs.

Whilst at Trincomalee, in September, I examined eight species of lamellibranchs, in order to find out whether they harboured spirochæts. These organisms were found in the crystalline style of only two species: *Venus* (*Meretrix*) *casta* and *Soletellina acuminata*.

Dr. Willey had previously noticed spirochæts in these two species, but had not described them. I hope to publish a full account of my observations on these organisms shortly.

Arthropods.

I examined several specimens of the large scorpion, *Palamnœus indus*, in Colombo (July), all with negative results so far as Protozoa were concerned.

Six individuals of the common myriopod, *Polydesmus saussurii*, Humb., collected at Avisawella in July, also showed no Protozoa, though all were infected with a nematode worm, an *Oxyuris* or allied genus.

Another myriopod, *Spirostreptus lunelii*, Humb., from Avisawella (July), also proved negative.

Some white ants, *Calotermes militaris*, from Peradeniya (August), were more interesting. They contained Trichonymphids, a *Nyctoherus*, and a spirochæt, all apparently new. (See p. 80.)

II.—DESCRIPTIONS OF SOME NEW FORMS.

In this part of the paper some of the new, or hitherto undescribed, forms which are recorded in the preceding section are described in greater detail.

The Parasites of Frogs and Toads.

I have already noted the presence of a hæmogregarine in the blood of *Rana tigrina* (p. 67). As I have already remarked, it seems to be identical with *H. berestneffi* of the Indian frog. There is only one other blood parasite which I have to describe.

(1) *Trypanosoma*, sp., of *Rana tigrina*.

This organism resembles the more slender forms of *T. rotatorium* of the European frog. When living the posterior end is bluntly pointed, and the animal usually has a ribbed appearance like that of *T. rotatorium*, but the ribs are only one or two in number (*cf.* fig. 12). There is a well-developed undulating membrane extending about halfway along the organism and ending in a free flagellum of moderate length (*cf.* fig. 12). The trophic nucleus is ovoid, and situated near the anterior end. The kinetic nucleus is a small deeply-staining granule about midway between the trophic nucleus and the extreme posterior end.

Like *T. rotatorium*, this trypanosome is difficult to fix in blood smears. Most of the stained specimens which I obtained were badly distorted. Fig. 12 is drawn from one of the most favourable fixed and stained animals which I encountered, but it makes the animal appear a good deal stouter than it appears when alive.

The average length of the trypanosome, so far as I have been able to determine from the few well-preserved specimens which I obtained in my preparations, is between 30 μ and 40 μ, including the free flagellum.

BALANTIDIUM.

As already recorded, I found species of *Balantidium* inhabiting the duodenum and the large intestine of *Rana tigrina*.

(2) *Balantidium ovale*, n. sp.

This name I propose for the common species of *Balantidium* which occurs in the large intestine of *R. tigrina*. The animal is very like several other species already described. It differs from *B. helenæ*, Bezzenberger, only in size. Bezzenberger describes this species as occurring in *R. tigrina*, *R. cyanophlyctis*, *R. limnocharis*, and *R. hexadactyla*, but he does not state from what parts of Asia the frogs came. He gives 110 μ × 60 μ as the average dimensions. The average size of my forms, however, is about 80 μ × 50 μ. Apart from this, Bezzenberger's description of *B. helenæ* applies equally well to *B. ovale*. The peristome has the same form, the meganucleus is kidney-shaped, lying posteriorly, with the micronucleus in the hollow. I have omitted to figure the organism, as Bezzenberger's figure of *B. helenæ* is almost identical.

I found numerous animals undergoing division, and also found encysting and encysted forms. These present no essential differences from what has already been described in other members of the genus. The cysts are ovoid, and measure ca. 54 μ × 44 μ.

In addition to the large forms just described, I found numerous smaller forms—also dividing actively—which were identical in every way except in size. They were only about two-thirds the size of the larger animals. Whether these represent another species or not, I am unable to decide.

(3) *Balantidium hyalinum*, n. sp.

I propose this name for the organism which occurs in the duodenum of *R. tigrina*. It does not differ markedly from other duodenal forms, namely, *B. duodeni*, Stein (in *Rana esculenta* and *R. temporaria*), and *B. rotundum*, Bezzenberger (in *R. esculenta*, var. *chinensis*). It is often present in large numbers in the small intestine, and when alive its protoplasm is more hyaline than that of any other *Balantidium* which I have seen.

The organism (fig. 19) is oval, with a straight mouth extending almost to the middle of the body. The meganucleus is posteriorly placed, and is ovoid. The micronucleus can nearly always be seen at one end of the meganucleus, not in the middle (*cf.* fig. 19). There is one contractile vacuole. In the anterior region the curious striated or granular triangular area, which is characteristic of *B. duodeni* and *B. rotundum*, is usually clearly seen (see fig. 19). As in these forms also, the cilia are long and well developed over the whole body. The average dimensions are ca. 74 μ × 56 μ.

(A curiously long and slender form has been described by Bezzenberger—under the name *B. gracilis*—from the small intestine of *Rana hexadactyla* and *R. cyanophlyctis*.)

NYCTOTHERUS.

In addition to *Nyctotherus macropharyngeus*, Bezzenberger,* which I found in *R. tigrina* in Colombo, I found a species of *Nyctotherus* in *Bufo melanostictus* and *Rhacophorus maculatus* at Peradeniya. It appears to be the same species in both hosts, and I propose to name it—

* This is a very large species. Its most striking feature is its very long and spirally wound pharynx.

(4) *Nyctotherus papillatus*, n. sp

The animal has the usual reniform appearance characteristic of the genus. Those taken from the large intestine of *B. melanostictus* measured ca. 120 μ in length, whilst those from *R. maculatus* were distinctly larger, the largest attaining a length of 170 μ. In other respects they were identical.

The pharynx extends to the median line, is sharply curved into an almost perfect semi-circle, and has a well-marked spiral twist. The anus opens just dorsally to a well-marked papilla at the extreme posterior end of the animal. There is one contractile vacuole, situated close to the anus. The meganucleus is in the usual position anteriorly, but appears to be reniform or horseshoe-shaped, with the ends directed ventrally, so that it appears to be ovoid when seen from the side. A micronucleus was not always seen, but was sometimes visible lying on the meganucleus.

A curious little diverticulum of the pharynx just at its point of junction with the mouth was nearly always observable. It passes dorso-posteriorly for a very short distance, and then appears to end blindly. I have never seen this curious little structure in other species of the genus.

OPALINA.

Rana tigrina, as I have already noted, was found to harbour a multinucleate species of *Opalina*, which I observed in the living state only. A pretty species of *Opalina* was found in *Rhacophorus maculatus* at Peradeniya, and I was able to study it more carefully. As it seems to be new I propose the name—

(5) *Opalina virgula*, n. sp.,

for the organism. Its characteristics are as follows. The general shape of the body is that of a large flattened comma; that is to say, there is a large bulge on one side anteriorly (see fig. 17). It thus resembles *O. obtrigona* (parasitic in the European tree frog *Hyla arborea*) more closely than any other of the dozen or so species of *Opalina* hitherto described.* Some of the individuals are long and slender, and others are stouter and more rounded, but all have this general appearance. The body is flattened, *i.e.*, elliptical in transverse section, and the cilia are distributed over the body in lines, as in other species. Large individuals may measure 170 μ, or rather over, in length, and 50 μ in breadth at the broadest part of the anterior end.

The animal is multinucleate. All the nuclei in my preparations (picro-acetic acid, Delafield's hæmatoxylin) appear as rather loose masses of chromatin granules (see fig. 17). Other slightly stained bodies are also present in the endoplasm. They appear to be the bodies which Metcalf calls "endosarc spherules," and which occur in other *Opalinæ*.

* *Cf.* Metcalf's (1909) recent monograph on the genus.

In company with these larger forms were a number of smaller forms. These I take to be young forms. They are the shape of a flattened spindle, and contain few nuclei (see fig. 18). Possibly they are organisms which are on their way to encystment. The small form figured (fig. 18) measured 38 $\mu \times 13$ μ.

Bezzenberger (1904) has described *Opalinæ* from *Bufo melanostictus*, *Rana cyanophlyctis*, *R. limnocharis*, *R. hexadactyla*, and *R. esculenta*, var. *chinensis*, but he does not state from what part of Asia these animals came.

Intestinal Parasites of Lizards.

Parasitic flagellates were found in the gut in only two lizards: *Hemidactylus leschenaultii* and *Mabuia carinata*. Both these hosts contained both *Trichomonas* and *Trichomastix*, but a careful study was made of those in *Mabuia* only.

{ *Trichomonas mabuiæ*, n. sp.
{ *Trichomastix mabuiæ*, n. sp.

I have elsewhere described (Dobell, 1909) in detail the structure of *Trichomonas* and *Trichomastix batrachorum*. The two organisms from *Mabuia* have a structure which is exactly similar. My chief reason for noting these organisms here is that they furnish a striking confirmation of what I have already described in the structure of the frog and toad parasites.

Trichomonas mabuiæ (fig. 11) attains a length of 30 μ, and it is quite easy to observe *in the living animal*, under an oil immersion, all the details of structure which I have already described in the much smaller *T. batrachorum*. Structures which, in the latter, were frequently only made out in stained preparations, and with considerable difficulty, can be seen in *T. mabuiæ* with the greatest clearness. The relations of the nucleus, axostyle, blepharoplast, and undulating membrane are exactly as I have already described them. To describe the forms from *Mabuia* would be merely to repeat what I have already written. I will therefore content myself with figuring *Trichomonas mabuiæ*, and would refer any one interested in the structure of these organisms to my earlier paper.

The Parasites of Tropidonotus stolatus.

As recorded on p. 70, I found three parasites in the blood of this snake: a hæmogregarine, a spirochæt, and a trypanosome. The last two are new; the first is probably the same as the "*Danilewskya*" described in *T. stolatus* from Tonkin by Billet (1895). [*Cf.* also Dobell (1908).]

(1) *Trypanosoma tropidonoti*, n. sp.

I propose to give this name to the new trypanosome which I found in the blood of a *T. stolatus* at Peradeniya (see figs. 13, 14).

When observed in the fresh blood of the snake the organism exhibited no characteristics which would distinguish it readily from many other trypanosomes. It was actively motile, with a short free flagellum terminating the undulating membrane, which extended along about half the length of the body. The posterior (aflagellar) half of the body was drawn out to a sharp point. Though the trophic nucleus was easily visible in the living animal, the kinetic nucleus was observed only after staining. The cytoplasm was finely granular in appearance and uniform throughout.

In smears stained by Giemsa's method, the following structure was observable (see figs. 13, 14):—

The body is sharply pointed at both ends, with the trophic nucleus lying near the middle as a homogeneous pink mass of granules. The flagellum and undulating membrane appeared the same as in the fresh preparations, but the kinetic nucleus, with the origin of the membrane, &c., could now be made out accurately. The kinetic nucleus itself is a small granule staining a deep purple with Giemsa's stain. It is remarkable on account of its position. Sometimes it was situated well behind the trophic nucleus (fig. 13), but at other times it was placed actually in contact with it (fig. 14). Intermediate positions were also seen. The latter arrangement, *i.e.*, in contact with the trophic nucleus, gives the animal an appearance suggesting an organism which is halfway between a *Crithidia* and a *Trypanosoma*. The average length of the organism (including the free flagellum) is 30 μ–40 μ.

So far as I am aware, only two trypanosomes have been recorded from snakes hitherto: *T. erythrolampri* (Wenyon, 1908) from *Erythrolamprus æsculapii* (tropical America), and *T. naiæ* (Wenyon, 1908*a*) from *Naia nigricollis* (Africa). Only one of these was satisfactorily investigated as regards its nuclear apparatus (*T. erythrolampri*), and it is a curious fact that it shows the same peculiarity which I have pointed out above in the case of *T. tropidonoti*. The two organisms are, in fact, very closely similar in other respects also.

Another trypanosome in which the kinetic and trophic nuclei are in close proximity has recently been described—under the name *T. pertenue*—by Miss Robertson (1908) from the blood of the Ceylon geckoes, *Hemidactylus triedrus* and *H. leschenaultii*.

(2) *Spirochæta tropidonoti*, n. sp.

This is the first record of a spirochæt from the blood of a snake. It is therefore much to be regretted that my observations on it are exceedingly scanty.

Only a single *T. stolatus* was found harbouring the organism. In the fresh blood preparations the spirochæts were rare, and in the stained smears made from the same blood they were still more difficult to find. Through a most unfortunate accident most of my stained preparations were lost before they had been carefully examined.

No ticks were found on the snake, but one is tempted to suggest that these animals, which are common on many snakes, are the carriers of the spirochæt.

The living spirochæts (fig. 15) appeared as slender, flexible, corkscrew-like organisms, actively motile, and closely resembling *S. duttoni* in general form. In length they measure ca. 15 μ, and their breadth is probably about 0·5 μ, though I have not been able to obtain sufficiently accurate measurements of the latter.

In the films stained by Giemsa's method the organisms were coloured a uniform pink.

In a single instance (fig. 16) I observed an organism which appeared to be on the point of dividing into two. But whether division had been longitudinal or transverse it was impossible to decide. The thickness of the organism certainly suggests the latter mode of division.

The Hæmogregarine from Crocodilus porosus.

Hæmogregarines have already been described from crocodiles in various parts of the world. Simond (1901*a*) appears to have been the first to record hæmogregarines from Crocodilia. He described (1901, 1901*a*) a form, under the name *H. hankini*, from the Indian gavial; and he further noted (1901, p. 320) that the same organism occurred in *Crocodilus porosus* (?), and stated that Marchoux had found a similar parasite in a Senegal crocodile.

Börner (1901) almost simultaneously described a hæmogregarine from *Crocodilus frontatus* and *Alligator mississippiensis*, and gave it the name *H. crocodilinorum*. If these prove to be the same species, then the priority of name rests with *H. hankini;* for, as Simond points out, his account was published a month before that of Börner. It is probable, therefore, that the Ceylon form from *C. porosus* is *Hæmogregarina hankini*, Simond.

Minchin, Gray, and Tulloch (1906) figure a hæmogregarine from a Central African crocodile, and this organism is repeatedly mentioned in subsequent reports of various sleeping sickness commissions.

The form which I found in the Ceylon crocodile bears a close resemblance to many of the figures of Simond and Börner.

All the individuals which I examined were in red blood corpuscles from the circulating blood. They all presented the appearance shown in figs. 9, 10; that is to say, they were all large, doubled-up individuals. Sometimes the two halves were approximately equal in thickness (fig. 9), but sometimes one was considerably thicker than the other (fig. 10). In preparations stained by Giemsa's method the nucleus always appeared as a compact mass of deep purple granules (figs. 9, 10). In length the animals (doubled up) measured from 12 μ to 15 μ.

In the absence of more material, I can do little more here than record and figure the organism.

The Parasites of White Ants.

(1) *Gymnonympha zeylanica*, n. g., n. sp.

As already recorded (p. 74), I found the termites* (*Calotermes militaris*) which I examined at Peradeniya infected with a protozoon belonging to the family Trichonymphidæ.

The Trichonymphids are characterized by possessing a large number of flagella, which originally gave rise to their inclusion among the Ciliata. [See Butschli (1887), S. Kent (1882), &c.] I have little doubt, however, that they are really referable to the Mastigophora (*cf.* Doflein, 1909). It is curious to note that Leidy (1877), who first gave us an accurate description of these organisms, remarks—speaking of *Trichonympha*—that they are "of obscure affinity, but probably related with the Turbellaria on the one hand, and by evolution with the Ciliate Infusoria on the other."

The organisms which I found in Ceylon do not appear to belong to any of the genera hitherto described. [See Leidy (1881), Grassi (1888), Grassi and Sandias (1893), Frenzel (1891).] *Leidyonella* (Frenzel, 1891) is the form which appears to approximate most nearly to my organisms.

As far as I am aware, no Trichonymphids have been described from Asiatic white ants before, but it seems highly probable that these parasites occur in white ants throughout the world. They were apparently discovered by Lespes in Europe in 1856, and were subsequently described in North America (Leidy), in the Argentine (Frenzel), and in Europe (Grassi and others). The closely allied form *Lophomonas* is a frequent parasite of the common cockroach, *Stylopyga orientalis*.

Gymnonympha zeylanica, as I propose to name the new organism, is distinguished by possessing comparatively few flagella, which are confined entirely to the anterior end of the body, as in *Jœnia* and *Lophomonas*, but there is no axostyle present.

The general form of the animal (see fig. 1) is roughly ovoid or pyriform, but the body is so plastic that its shape is constantly undergoing change during life. At the extreme anterior end the body is drawn out into a small conical process surrounded by a curious vesicular cap (fig. 1). Where the cap unites, by its edges, with the conical process, the flagella arise, apparently in a single ring round the base of the cone. The length of the largest forms is about 150 μ. The flagella measure only about one-half of the length of the body. Running backwards from the point of origin of the flagella, a series of striations can be seen extending for about one-third of the length of the organism. These striations appear to be situated in the investing cuticle.

* All the individuals examined were workers.

The nucleus is round, and measures about 15 μ in diameter. It is composed of a mass of small chromatin granules surrounded by a clear achromatic membrane. It usually lies at the anterior end of the animal.

Inside the body, especially in the posterior region, a number of particles of wood can usually be seen. How they are ingested I am unable to say, as I have never observed an animal in the act of taking them up, nor is a mouth present, as far as I have been able to make out.

In addition to these larger forms just described, I always found smaller animals possessing a somewhat different structure. The anterior end and arrangement of the flagella was different, and the nucleus was situated posteriorly (fig. 2). I think these small forms probably represent young stages in the life-history of *Gymnonympha*, but in the absence of any very definite intermediate forms, I must leave this an open question for the present. These small forms were usually about 30–40 μ in length.

No animals in division, or at different stages in the life-cycle, have I been able to find.

(2) *Nyctotherus termitis*, n. sp.

I propose this name for the new species of ciliate which I found in the termite. Hitherto no *Nyctotherus* has, I believe, been recorded from white ants.

N. termitis differs but slightly from several other members of the genus. It resembles *N. ovalis*, Leidy, of the common cockroach (*Stylopyga orientalis*) closely in general structure. The body is roughly ovoid, with the gullet situated near the middle, and running in obliquely with a very slight curvature (see fig. 21). It does not extend more than about halfway across the animal. There is a well-marked, though narrow, anus, near to which—on the ventral side—the single contractile vacuole is situated (see fig. 21). The meganucleus is ovoid or slightly horseshoe-shaped, and a micronucleus can sometimes be seen lying in close contact with it. At the level of the meganucleus the body shows a more or less strongly marked constriction. Another similar constriction can be seen about halfway between this and the extreme anterior end. (*Cf.* fig. 21.)

The animal attains a length of 60–70 μ, and a maximum breadth of rather more than 40 μ.

It is rather a striking fact that the white ant should harbour a *Nyctotherus* so closely resembling that of the cockroach, when it is remembered that the Trichonymphids are also confined to these two hosts.

(3) *Spirochæta termitis*, n. sp.

Some of the termites which I examined proved to be heavily infected with spirochæts. As these have not been previously described—so far as I am aware—I propose the name *S. termitis* for them.

It is of interest to note that Leidy (1877) found "a Spirillum" present in the gut of *Termes flavipes* (North America); and Grassi and Sandias (1893) also record "Spirilla" in the European termites which they investigated (*Calotermes flavicollis* and *Termes lucifugus*). It seems to me highly probable that reinvestigation of these organisms would show them to be really spirochæts.*

When alive, *S. termitis* is a long, slender, and very active organism. It moves rapidly backwards and forwards with the wriggling, flexible motion characteristic of the spirochæts. A well-marked bending and rolling up of the body may frequently be seen.

The organisms which I observed (fig. 20) varied considerably in size, both as regards length and breadth. The longest individuals measured rather over 60 μ, but the breadth was never more than 1 μ, and often less.

The ends are pointed, and do not appear to bear free flagellar processes, such as are said to occur in some spirochæts (*e.g.*, *S. buccalis*). Neither in the living organism nor in stained preparations have I seen an undulating membrane.

In films stained by Giemsa's method the organisms stained a uniform pink, or occasionally showed an indistinct granular structure. Owing to their slenderness it is exceedingly difficult to make out their internal structure.

I found no forms which could be regarded with certainty as showing stages in division, though some of the longest organisms—in stained preparations—occasionally exhibited a break towards the middle of the body (fig. 20, longest individual), which suggested that transverse division takes place.

Concluding Remarks.

I wish, in conclusion, to summarize some of the more interesting points which the observations recorded in the foregoing pages have brought to light.

In the first place, I would emphasize the fact that my investigations are not, and do not pretend to be, in any way exhaustive. I have merely examined such animals as chance allotted to me. Also in no case did I examine more than a small number of individuals of any one species. Many animals, moreover, were examined with entirely negative results, and I am fully sensible of the fact that no definite deductions can be drawn from these few negative instances. The record of these cases has been given solely for the use of subsequent workers along similar lines. Nevertheless, apart

* Since writing the above, I have been able to consult the full account of these organisms by Leidy (1881). His description and figures leave no doubt in my mind that his organisms were really spirochæts. Curiously enough, he has named the organisms *Vibrio termitis*. If mine are the same as the North American forms, the correct name is therefore *Spirochæta termitis*, Leidy emend. Dobell (non *Sp. termitis*, Dobell).

from these inconclusive negative results, I have obtained a few positive records, which appear to me to justify a few general remarks before I conclude.

A point of some interest is in connection with the distribution of the protozoan parasites is frogs. I have found, as recorded in previous pages, that the Ceylon frogs harbour a set of Protozoa exactly parallel to the set which one finds in European frogs. In both one finds two kinds of blood Protozoa: Hæmogregarines and Trypanosomes. In both one finds three genera of flagellates in the large intestine: *Trichomonas*, *Trichomastix*, and *Octomitus* (*Hexamitus*). In both one finds an *Entamœba* in the large intestine. In both one finds ciliates—belonging to the three genera: *Opalina*, *Balantidium*, and *Nyctotherus*—in the large intestine. In both, finally, one finds a ciliate of the genus *Balantidium* inhabiting the duodenum. The three flagellates and the amœba correspond in general appearance so closely in the Ceylonese and European frogs that I cannot distinguish them from one another.

Again, the Ceylon crocodile has been found to harbour a hæmogregarine, which resembles not only that described from the Indian gavial, but also those found in African crocodiles and the Mississippi alligator.

Then in the snakes. Apart from the new spirochæt which was found, one finds hæmogregarines which resemble not only those found in snakes from other parts of Asia (India, Tonkin, China, Java, &c.), but also those in snakes from Europe, from Africa, from North and South America, and from Australia. The only snake trypanosome which I found is closely similar to another previously described from a tropical American snake. Further, one Ceylon snake was found to possess a *Trichomastix* very like that which I have already described from a South American *Boa constrictor*. A similar organism occurs in all probability in European snakes.

Then, in the case of the white ants, similar interesting finds have been recorded. Ceylon termites harbour a flagellate belonging to the remarkable family Trichonymphidæ. These parasites have previously been found in termites in Europe, North America, and South America. The only other host of trichonymphids is the cockroach. It is therefore of interest to find that the Ceylon termite harbours a ciliate of the genus *Nyctotherus*, which very closely resembles that of the common cockroach, *Stylopyga orientalis*. This is a fact not without interest for the systematic entomologist. Lastly, the Ceylon termite possesses a spirochæt, and there are indications that the North American and European termites harbour a similar parasite.

Some further parallels could be added to this list, but it is perhaps unnecessary to develop this theme any further. Yet it seems to me that these facts are of something more than purely protozoological interest.

It will not perhaps be superfluous to point out once more that I have, in company with other workers on Indian and Ceylon forms, found that lizards do not appear to be infected with blood Protozoa to anything like the same extent that European and African lizards are.

One other point, in conclusion, appears to me worthy of comment. Wherever I have found trichomonads, I have always found both *Trichomonas* and *Trichomastix* associated together. This supports, I think, to some extent the view of Doflein, who believes that these two "genera" are in reality merely forms of one and the same organism. For my own part, however, I prefer to consider them as distinct genera for the present, mainly on the ground that no real intermediate forms have ever been discovered. This is, however, a matter of but small importance.

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DESCRIPTION OF PLATE.

(The figures are not drawn to scale. The actual dimensions of the various organisms depicted are given in the text. Figs. 1, 2, and 20 were drawn under Zeiss 3 mm. apochromatic oil immersion × comp.–oc. 12. Figs. 3–10 and 12–15 were drawn under Leitz 1/12 in. oil immersion. Figs. 11, 16–19, and 21 were drawn under Zeiss 2 mm. apochromatic oil immersion, comp.–oc. 6.)

Fig. 1.—*Gymnonympha zeylanica*, n. g., n. sp., a trichonymphid from the intestine of *Calotermes militaris*. (Picro-acetic acid, Delafield's hæmatoxylin and eosin.)

Fig. 2.—Small trichonymphid, from same preparation as preceding. (Probably a young form ?)

Figs. 3–8.—*Hæmogregarina*, sp., from *Rana tigrina*. (Osmic vapour, Giemsa.)

Fig 3.—Large intracorpuscular form.

Figs. 4, 5, 6.—Various free forms from the blood plasma.

Fig. 7.—Encapsuled form in a red blood corpuscle. (Living animal.)

Fig. 8.—Empty sheath of parasite lying in red corpuscle. (Dry film ; absolute alcohol, Giemsa.)

Figs. 9, 10.—*Hæmogregarina*, sp. (? *H. hankini*, Simond), from blood of *Crocodilus porosus*. (Dry films ; absolute alcohol, Giemsa.)

Fig. 9.—Doubled-up organism, with limbs approximately equal in thickness.

Fig. 10.—Form with slender doubled-up "tail."

Fig. 11.—*Trichomonas mabuiæ*, n. sp., from the large intestine of *Mabuia carinata*. Large individual. (Sublimate alcohol, Delafield's hæmatoxylin and eosin.)

Fig. 12.—*Trypanosoma*, sp., in blood of *Rana tigrina*. (Osmic vapour, Giemsa.) A red corpuscle is shown in outline.

Figs. 13 and 14.—*Trypanosoma tropidonoti*, n. sp., from the blood of *Tropidonotus stolatus*. (Osmic vapour, Giemsa.) The body is stained blue, the trophic nucleus pink, edge of membrane with flagellum red, the kinetic nucleus deep purple.

Fig. 13.—A form in which the kinetic nucleus is situated some distance posterior to the trophic nucleus. (Red corpuscle in outline.)

Fig. 14.—Form in which the kinetic nucleus is in contact with the trophic nucleus.

DOBELL—PARASITIC PROTOZOA FROM CEYLON.

Figs. 15, 16.—*Spirochæta tropidonoti*, n. sp., in the blood of *Tropidonotus stolatus.*

Fig. 15.—Living organism, beside a red corpuscle. Heart blood.

Fig. 16.—Organism dividing into two. (Dry film; absolute alcohol, Giemsa.)

Fig. 17.—*Opalina virgula*, n. sp., from large intestine of *Rhacophorus maculatus.* (Picro-acetic acid, Delafield's hæmatoxylin.)

Fig. 18.—Small *Opalina*, from same preparation as preceding. Probably a young individual.

Fig. 19.—*Balantidium hyalinum*, n. sp., from duodenum of *Rana tigrina.* (Sublimate alcohol, Delafield's hæmatoxylin.)

Fig. 20.—*Spirochæta termitis*, n. sp., from the gut of *Calotermes militaris.* Various forms are depicted. (Dry film; absolute alcohol, Giemsa.)

Fig. 21.—*Nyctotherus termitis*, n. sp., from intestine of *Calotermes militaris.* (Picro-acetic acid, Delafield's hæmatoxylin and eosin.)

NOTES ON THE FRESH-WATER FISHERIES OF CEYLON.

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(With one Plate and three Text Figures.)

[The following notes are taken from Dr. Willey's preliminary account of the Inland Fisheries of Ceylon in the Administration Reports of 1908 and 1909.—Ed.]

THE object of the inquiry is to obtain biological and, as far as may be possible, statistical information about the indigenous marketable fishes, to devise measures for arresting a decline of the fisheries, and to introduce one or more useful species from abroad. As no records have been kept in former years, it is impossible to demonstrate that a progressive reduction in the amount of the catches is in fact taking place. There seems to be a general impression that this is the case ; and it is evident that the clearing of forests for plantation purposes must re-act upon the water systems of the cultivated districts by silting up the tributaries of the rivers. The more the country is brought under cultivation, by so much the more should attention be directed to the habits of the food-fishes. And this is about all that can be, and perhaps all that need be, said on the subject of the decline of the fisheries. The illegal use of dynamite and narcotic poisons is not a danger which threatens the entire fish-fauna ; and it may be assumed that the steps which are already taken to prevent the application of these objectionable methods of capturing fish are adequate.

The present investigation is mainly concerned with the fresh-water fisheries of the Western and the North-Central Provinces, the former being selected as typical of river fishing, the latter of tank fishing. In this part I shall refer chiefly to certain aspects of the fishing industry in the Western Province. In the first place, however, it is necessary to note that for the understanding of this question it is important to realize at once and for all the essential economic difference which exists in Ceylon between sea fishing and estuarine fishing on the one hand and inland fishing on the other. Speaking generally, it may be said that there is no independent fresh-water fishing industry in Ceylon. What takes place is merely a collateral pursuit subservient to paddy cultivation and cattle raising. Sea and estuarine fishing is a main industry of the maritime districts ; river and tank fishing is a collateral industry of the interior.

Fig. 8.—Man holding a "kemina" at Hanwella. The narrow end is covered by a coconut cap.

The Barawe Fishery.—The Barawe reserve near Hanwella is a low-lying wooded tract, through which the Pusweli-ganga flows into the Kelani-ganga. After heavy rain the country is under water, and I have myself been compelled, in the month of May, to travel by boat for some distance down the high road from near the Hanwella resthouse. Hanwella is a good type of inland fishing station, people said to belong to the "Padduwa" caste being more or less permanently engaged in fishing by various methods; and the produce is brought into the village bazaar for sale in improvized markets at the roadside.

On the Pusweli-ganga, upwards of a mile from the resthouse, the Barawe line-fishermen work singly from very small log boats called "mas marana oruwa," from which they catch excellent food-fishes, such as the walaya (*Wallago attu*), telliya (*Mastacembelus armatus*), and moda (*Lates calcarifer*), besides several species of the carp family (*Cyprinidæ*). Fishes caught in the water-courses are called "ela malu," in contrast with "weli malu," which are taken from inundated fields. Of the latter, the lula (*Ophiocephalus striatus*) is the most important, and the batakola-telliya (*Rhynchobdella aculeata*)* one of the most interesting. They also capture in baskets great quantities of a small cyprinoid fish called saliya (*Amblypharyngodon melettina*); females of this species, three inches in total length, are egg-laden in December. In the Ihivetiya-ela, an arm of the Pusweli-ganga, a portion was fenced off at either end from the main stream in December, 1907, and I saw about thirty men, women, and children paddling about in the muddy water, each provided with a large conical hand basket ("eswattiya"), with which they scooped up small fishes, transferring them to bags carried on their backs, occasionally also capturing a large river prawn.

Stretching a wattle fence (vetiya or veta) across an ela is a frequent practice. A narrow passage may be left at one end of it, and this will be occupied by a long bamboo fish-trap, closed at the narrow end by a half coconut shell. The fence is made of impenetrable, close-set slips of bata-li or wild bamboo; the fish-trap ("kemina") (fig. 8),† about 7 feet long, is made of slips of una-li or plantation bamboo. Strips of bamboo are steeped in water to season them, and are kept soaking for eight days preparatory to the final splitting.

The "karakgediya" is a basket open at both ends, shaped like a truncated cone, about 25 inches high, made of Ixora sticks (ratamvela); each stick is pointed below, and the whole bound together above, leaving a hole just large enough to receive a man's arm. It is used in swampy fields; the broad end with the pointed sticks is presented to the bottom at a venture, and the hand inserted through the arm-hole to grope for a possible catch.

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* I recorded this species from Ceylon for the first time in "Nature," Vol. 77, 1908, page 345.

† For the three illustrations accompanying this report I am indebted to Mr. O. S. Wickwar, who accompanied me on one of my visits to Hanwella.

They also construct elaborate fixed traps called " mas-ge " or " mas-kotuwa " ; these are tall fish-mazes, about 20 feet high, made of the same materials as the fences. They project high out of the water when the latter is low, but during flood time they may be entirely submerged. For example, May 9 was a day of great rain at Hanwella, and the entrapped fishes could only be taken in the early part of the day, before the waters had covered up the mas-kotu. Up to the present I have not found an opportunity of seeing fish taken out of a mas-kotuwa. When I visited Hanwella in December, 1907, they had fallen into temporary disuse, only being worked during the rains ; and I was told that there had been a mas-kotu fishery in the previous month of November ; May and June are the chief months for this fishery in the Kelani Valley. The mas-kotu may thus be defined as flood kraals, in contrast with the ja-kotu, which are fair weather kraals. An important carp, the hiri-kanaya (*Labeo dussumieri*), is taken in the mas-kotu at Hanwella ; and occasionally, though not in my experience, the lela (*Barbus tor*).

Another piece of fishing gear employed by the Barawe fishermen is the " baru-dela " or casting net, the manipulation of which requires a great deal of skill. Other nets are the " atanguwa " or hand net ; and the " pala-dela," a net stretched between two poles, terminating in a small-meshed bag.

Being much impressed by the intensive character of the Barawe fishery, I applied to the Mudaliyar of the Hewagam korale (Mr. H. A. Pieris) for information as to whether it had ever been more productive than it is now ; whether there had been any notable fluctuations in the annual catches ; and whether or not he considered the methods of fishing unduly destructive of immature fish, leading to the diminution of the local fish supply. The Mudaliyar replied that the fishery had been more productive in times past owing to the fact that " the forest is now being gradually cleared of its timber, which causes the streams to dry up faster than in former years " ; there had been no noticeable fluctuations ; and he did not think that the present methods of fishing in his district were unduly destructive. This, of course, is a matter of opinion, which should be discussed by a competent local fishery committee. I would point out here, however, that the fencing of natural water-courses so as to hinder the normal migrations of fishes, and the " muddying " of permanent waters so as to inhibit the normal respiration of fishes, are practices which call for comment. The deliberate stirring up of the mud in order to foul the water belongs to the same category as the use of dynamite and vegetable poisons ; or at least modern conditions of existence render it necessary to classify them together. The stirring up of mud is done sometimes by men, sometimes by buffaloes. Wakwella on the Gin-ganga, near Galle, seems a likely enough place for a fishing station, but in fact is disappointing. In August I tried to obtain a sample of the fishes frequenting those waters. The boatmen offered to put up a fence across the creek opposite to the resthouse at midnight; then they would place a buffalo at some distance away towards the head of the creek, to trample up the mud, thus causing the fish to collect at the fence in their efforts to escape from the source of disturbance, where they could be taken in the early morning in baskets. I decided, rightly or wrongly, against it.

It should be added that, besides the species which I have mentioned above, several other first-rate food-fishes are habitually caught by the Barawe fishermen, *e.g.*, river-eels, ganga-anda (*Anguilla bengalensis*), the butter-fish, walapota (*Callichrous bimaculatus*), the eight-barbed three-spined catfishes, ankutta (several species of *Macrones*), the fresh-water gobies, weligowa (*Gobius giuris*) and kudupuwa (*Eleotris fusca*), the fresh-water garfish, moralla (*Belone cancila*), the climbing perch, kavaiya (*Anabas scandens*), and the koraliya (*Etroplus suratensis*). These are retained for home consumption and for sale in the roadside market at Hanwella opposite to the resthouse, although the neighbouring planters derive their fish supply from Colombo through the Kelani Valley Railway. When there is a superabundance, some of the larger fishes may be salted and kept for a few days.

The "Wala" Fishery.—The floods of this country are a principal factor in the inland fisheries, exercising as they do a beneficent, protecting, and distributing influence. They afford natural close seasons for river fishes; and they enable mud-loving and air-breathing fishes to spread themselves over the surrounding lowlands. A wala is a pit or depression in the ground in which flood water will remain for a long time after the inundation which filled it has subsided. They vary in extent from a few square yards to about a quarter of an acre; the esteem in which they are held can be gauged from the fact that each wala has its own distinctive name; the fishing of them requires co-operation, and the fishing rights are therefore vested in a body of related families, the time of fishing being decided by the able-bodied men. It would be possible to register the recognized fishing walas of a district, but it has not occurred to anybody to do so; such a return would be useful, and might be advantageously ordered by Government.

As an example of primitive pond-culture the wala fishery is both interesting and important, and should on no account be stigmatized as "puddling," or mentioned disparagingly as one of those methods which "ought to be stopped." On the contrary, it is the beginning of systematic pisciculture, and is, or should be, capable of further development.

The pits are left to be watered and stocked by floods, there being little attempt to assist nature, except by slight excavation and banking. At the proper time the water is baled out by means of winnowing baskets ("hal-kula"), or by large, wooden, irrigating scoops (yotu-kanda) suspended from crossed poles (figs. 9 and 10), according to the size of the wala. Wala-fishing goes on in places where no other fishing is available, and is one of the most prolific sources of fish supply for villages throughout the low-country, including the immediate environs of Colombo.

At Tebuwana on the Kalu-ganga there is no river fishing worth mentioning, but a considerable wala-fishery takes place during the dry weather which follows floods. The ponds contain stagnant water, and by repeated baling out of muddy water deep pools are formed in them, where fish accumulate sometimes in large numbers. I inspected one such pond, and witnessed the operation of emptying it ; it was called the Kohila-wala, because formerly an edible root (kohila) grew where the pond now is, some still remaining on the banks. The digging out of the yams and the subsequent flooding and scooping out of fish from the mud at certain spots has made three deep holes, in one of which there were signs of abundant fish. The baling took place on January 25. They commenced by deepening an efferent channel and allowing the surface water to flow away through it ; then they dammed it up and started baling the water over the dam. In this case the baling was done by four men working two "hal-kula," each provided with two pairs of flexible handles held by a man on each side with both hands. The men swing the baskets between them and work away for three hours or more. The catch they said was not up to the average ; it consisted chiefly of madaya (*Ophiocephalus punctatus*), kavaiya (some were egg-laden), magura (*Clarias magur*), a few hunga (*Saccobranchus fossilis*), lula, ankutta, and batakola-telliya. Each hunga was knocked on the head before being taken out, on account of the dangerous pectoral spines. The total weight of fish caught was about 22 lb., and the value in the local market was put at Re. 1·50 only, an absurdly low figure,* but then it was not going to be sold for cash. As it was, the division of the spoil gave rise to much bickering, and one woman apparently refused to be comforted.

The walas occur in places where shade is afforded by adjoining vegetation ; an overhanging tree makes a difference to the inhabitants of a pool. One of the symptoms of the decline of fisheries in certain parts of late years is the failure of the old walas ; and this is attributed to forest clearing in the neighbourhood, which has a two-fold effect, removing shade and increasing silt, large quantities of soil being washed down from the adjacent clearings. The filling up of walas by the deposition of sediment in consequence of forest clearing has been noted by the Maha Mudaliyar in connection with the Attanagala-oya, which flows past Henaratgoda. It may be mentioned here that the alleged decline of inland fisheries as a whole

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* Of course, this only applies to one small wala; the total value of the wala catches in a given district would be something considerable; and the same wala may be baled out three or four times in the year.

FIG. 9.—A "wala" at Hanwella being baled out by means of an irrigation scoop ("yotu-kanda") over a low bund.

FIG. 10.—Another view of the same "wala."

has been attributed to various causes from first to last, but not once I believe publicly to what is perhaps the most deep-seated cause of all, namely, forest clearing.

Undersized fishes are destroyed in the wala system of fishing, but not to such a great extent as by netting; and it should not be forgotten that the capture of egg-laden females is as wasteful as the netting and trapping of immature young. It would appear that there is no practical method of stopping the waste; if it is excessive, the only way to counterbalance it is by establishing nurseries and hatcheries; and when one considers the small monetary value of the inland fisheries at their best, the idea that hatcheries in connection with the rivers of the Western Province would repay the expense of their upkeep seems to be excluded, at least for many years to come. There can be no doubt that they would be beneficial, and the installation of one inland hatchery should be seriously contemplated.

Night-lines and River-fishing.—As with the Kelani-ganga, so with the Kalu-ganga, the main rivers do not yield the main fishery; this is found in their affluents, the Pusweli-ganga and the Kuda-ganga respectively. The main rivers are, however, exploited to some extent by means of night-lines. At Tebuwana, on the occasion referred to in the preceding section, having taken a large number of madaya from the wala, two men who were noted experts at moda-fishing said they would go that evening between 7 P.M. and midnight to fish for moda or other large fish with rod and line, using madaya as live bait. Only one of them kept his courage to the sticking point, and, after some persuasion, was induced to go; but there was a deval-maduwa close by, and the noise of people crossing the river to attend the festival was fatal to good fishing. The man said afterwards that he had had two bites of "guru-tambaya," but had failed to land the fish.

The rod employed is a strong inflexible bamboo rod, which is supported over crossed or forked sticks from the shore. At several points along the banks of the river when travelling by boat one may notice a forked stick driven into the ground with a low semi-circular rampart in front of it, an ambuscade for lying in wait for moda, &c. The whole is called "malu bana."

There is no doubt of the fact that river fish as food are scarce in Ceylon; a trivial indication of this state of things is to be found in the circumstance that, as a rule, the last place in which to expect a dish of fresh fish is at a riverside resthouse. At Tebuwana estuarine fish from Kalutara are procurable; at Badureliya and Anguruwatota sardines are offered.

On February 12 I travelled from Badureliya to Anguruwatota on an untented raft supported by three dug-outs, in order to ascertain whether there might be any sign of an active fishery along the tributaries of the Kalu-ganga. Gliding gently along the Magura-ganga we passed deep pools in which large fish are known to lurk;

and here and there are cylindrical fish-traps (kemina). A place called Maguruwaka overlooks the confluence of the Kuda-ganga, Pelen-ganga, and Magura-ganga. This is the likeliest looking situation for a hatchery and fresh-water biological station that I know of in the Western Province. Here there were fishing boats at work, netting and angling, whipping the side deeps and catching black-blotched, four-barbed petiya (*Barbus pinnauratus*) and black-striped dandiya (*Rasbora daniconius*). This region is known as Molkawa, and the fishery may be conveniently referred to as the Molkawa fishery.

Farther down the Kuda-ganga I came upon a catch of fish made by two canoes with pole net (pala-dela), pan-rena (a fish-guide or trace of bleached coconut leaves),* and kalavel (poisonous creeper). Small carp kept rising in a helpless floundering fashion to the surface, whence they were lifted by hand and thrown ashore ; a great quantity of frothy scum covered the surface of the water at this point. In one of the boats there were two large walaya, 24½ and 25½ inches long respectively, with a combined weight of 4½ lb. The complete outfit for a Kuda-ganga fishing boat consists of a mass of bleached coconut leaflets, a net between two stakes, and some kalavel. A mile or so farther down the river I picked up a dead petiya (*B. pinnauratus*), 8½ inches long, weighing ¼ lb., a male in an immature condition.

A lethal weapon sometimes employed along these rivers is the "kaduwa," consisting of a series of iron barbs riveted to an iron shaft. One in use on the Magura-ganga had 19 barbs placed close together, so as to form a toothed blade about a foot long ; the handle, 2 feet long, was secured by a rope. The man who held it was waiting near some rocks for an "ara" (*Ophiocephalus marulius*) to appear. If he should succeed in striking a large fish, it might swim away with the implement were it not secured by a line after the manner of a harpoon.

A Koraliya Nursery.—As I have indicated above, the native walas are merely used as collectors. If anything is to be done for their improvement and development, some scheme of protected walas will have to be devised so that some of them can serve as nurseries. The obvious difficulty, namely, the circumvention of floods, is one which can only be met by concerted action based upon local knowledge.

The carp family (*Cyprinidæ*), though numerically strong, does not figure so prominently in the list of marketable fresh-water fishes in Ceylon as it does elsewhere. Of the non-predaceous indigenous low-country fishes which are amenable to cultivation, one of the most important, numerically and dietetically, is the koraliya (*Etroplus suratensis*), a member of the family Chromides. This

* For further remarks on pan-rena, reference may be made to my fishery observations in *Spolia Zeylanica*, Vol. V., 1908, page 150.

species is one of those which, like the lula, nurse their brood, standing by to keep off the many enemies which prey upon spawn and fry. Its habits are known to the fishermen. It is captured in nets and in kraals, and unfortunately is netted on its spawning grounds. I inspected some of the latter in February and saw a koraliya, as it appeared, selecting a spot amongst aquatic roots in the river at Kalutara, for the purpose of depositing its eggs, as early as February 6. The spawning season is from the middle of February to the middle of April, and again about November, according to the statements of the fishermen. The aggressive pursuit of the spawning and brood-nursing fishes, involving the destruction of the eggs by the dragging of the nets, should be discouraged. Early in March I suggested to the Assistant Government Agent (Mr. J. Conroy) a method of protection of the breeding sites as an experiment. Three weeks later when I went to Kalutara to see how the experiment was working I found the river in flood and the sites concealed. This observation explains the assertion contained in an earlier part of this report, that the floods provide natural close seasons for the river fishes. The spawn is the most vulnerable part of the koraliya's economy ; and the systematic capture of fishes during the exercise of their parental care cannot be defended.*

The koraliya is known to attain the length of a foot ; and as the body is very high in proportion to the length, a full-sized fish is an object worthy of attention. It is netted in large numbers at a very tender age, 2 to 3 inches in total length (including the tail-fin), being utilized at this stage as curry stuff. It is also netted in quantity at a middle age, 5 to 7 inches, still immature.

Introduction of Gourami.—The gourami (*Osphromenus olfax*) is a fresh-water fish belonging to Java, which has been introduced into Europe as an aquarium fish, and into Mauritius, Cayenne, and India as a food-fish. It is recorded as attaining a length of 2 feet and a weight of 20 lb. ; but it seems doubtful whether 20 lb. of muscle can be concentrated into a length of 2 feet. However that may be, it has long been known to possess an " exquisite flavour " ; and has quite recently been characterized in the Cambridge Natural History as " one of the best flavoured fishes of the Far East."

Under these circumstances I had no hesitation in recommending Government to communicate with the Government of Mauritius in order to ascertain definitely whether the culture of the gourami is carried on there with conspicuous success. This was done, and a reply duly arrived, forwarding papers relating to this matter, and adding " that if it is desired to introduce the gourami in Ceylon, this Government will be glad to arrange for a supply of young fish being sent." The gourami, it appears, is not made the object of methodical cultivation in Mauritius, but, when desired, it is

* River fishermen throughout the Panadure and Kalutara Totamune have been warned against the practice.

transplanted from one place to another. A gentleman who has interested himself in acclimatization experiments in Mauritius, Mr. A. Daruty de Grandpré, states that the rearing of the gourami is very easy, as it will exist in any kind of fresh water, flowing or stagnant: its habits are herbivorous and insectivorous, and it is therefore valuable as a consumer of mosquito-larvæ: it constructs a nest amongst aquatic herbs, where it deposits its eggs, which are defended by the male.

About the middle of the year (1909), hearing that Mr. M. Kelway Bamber, F.I.C., F.C.S., was leaving on a visit to Java, and would be willing to secure some gourami for Ceylon, I wrote to him a letter giving recommendations for dealing with the fish in transit, and on September 15 Mr. Bamber returned to Colombo with a small consignment of young gourami, from 6 to 8 inches in length. Soon after their arrival in Colombo one or two died, and the remainder, 24 in number, were placed in a circular cement tank, 8 feet in diameter, in the grounds of the Colombo Museum, in which top-minnows had been kept for a long time previously. The tank was covered over by a cadjan roof, but the heat was too great and the light too intense, and in spite of all that was done for them they did not thrive. Some of them were afflicted with a skin disease; in others the eyeballs began to protrude, and this went on to such an extent that half of the eyeball projected from the socket. The symptoms of *malaise* finally became so distressing that I decided to send 20 of them to Peradeniya in three tubs covered with mosquito netting on October 14. The three remaining survivors, with eyes starting out from their sockets in a pitiful manner, were removed to a glass aquarium situated in a verandah and provided with bamboo cylinders and tiles, into and under which they could retreat; here they have subsisted upon boiled rice, minced raw liver, and worms; to my surprise, in course of time, the eyes gradually worked back into the sockets. These three individuals have been transferred once more to the Museum tank; one of them blind in one eye.

The score of gourami arrived in Peradeniya in good condition, and were turned into the large pond in the Gardens. As mentioned, this happened in October last, and it will be interesting to ascertain, in due time, whether the fishes have spawned; to encourage and assist them to spawn, fascines or small bundles of twigs should be placed here and there in the pond.*

Anguluwa.—The largest fishes taken in the Panadure river, besides eels, are "tambalaya" (*Lutjanus jahngarah*) and "moda"

[* On November 5, 1910, Mr. E. E. Green and I made an examination of the pond at Peradeniya and found no signs of the gourami. Two native fishermen were employed, and they used a vertical net somewhat like a Seine net. After an exhaustive search they declared that there were no fish in the pond. The pond overflows into the Mahaweli-ganga, and it is probable that the fish have escaped to the river, although the ledge which guards the overflow would render this difficult but not impossible.—Ed.]

(*Lates calcarifer*). Some of the most abundant fish caught in the weir traps are called "anguluwa," of which there are two kinds: "tora-anguluwa" (*Arius falcarius*) and "wel-anguluwa" (*Macrones gulio*). The former species produces large yolky eggs; the latter produces the usual small eggs of bony fishes. After the female of the "tora-anguluwa" has laid a batch of eggs, each measuring about half an inch in diameter, enclosed in a transparent membrane, the male takes the soft eggs into his capacious mouth and keeps them there for many days until they hatch out as large fry, retaining the fry until the yolk is absorbed. The eggs which are thus carried about in the mouth of the male are called "kate-viju," as distinguished from the "bade-viju" in the ovaries of the female; the fry in the mouth are the "kate-petaw." The actual process of ingesting the eggs has not been observed.

When the mouth of an ovigerous male is examined, the cavity is found to be stretched to its utmost capacity so as to hold 15 or more eggs (see Plate, fig. 1). In this position the eggs are exposed to the respiratory current of water as it passes through the gill clefts, and at the same time they are protected from enemies. The œsophageal passage at the back of the pharynx is closed, and the palatine teeth are usually found to be greatly reduced as compared with those of females and of normal males (see Plate, fig. 7). The palatine teeth attain their greatest development in the female, and very rarely a small paired round group of vomerine teeth is to be found (see Plate, fig. 6). The intestine of the ovigerous male is generally shrunken to very narrow dimensions and devoid of contents.

The ovaries of an adult female contain a very great number of eggs in different stages of growth, but of these only a few become mature at a time, and there is a great contrast in size between the mature and the immature ovarian ova. In one case there were only 10 large eggs in the right ovary and 8 in the left. In another there were 21 large eggs in the right ovary, 24 in the left.

Anguluwa is also caught in the Angulu Eliya lake on leaded lines baited with prawns, attached to kitul floats, resembling the "thathe" used in Nuwarawewa, as described above.

Atukotuwa.—A very common and at the same time a very dainty fish in the Panadure river is the "koraliya" (*Etroplus suratensis*). Some time ago a statement appeared in the local press to the effect that this species is a bony fish of no importance. As it is one of the best of the estuarine fishes in Ceylon, the statement was probably based upon a misunderstanding, perhaps a confusion with the "kavaiya," which has the reputation of being bony and thick-skinned, though a valuable agent in the destruction of mosquito larvæ.

In the Panadure lake it is captured in a wide-meshed "baru-dela" in the following manner. Two men proceed in a boat on a prospecting tour, carrying with them a quantity of leafy twigs, which they place upon the bottom, near the shore, in $\frac{1}{2}$ to $\frac{3}{4}$ fathom, marking the spot in the centre with a long branch surmounted by a leafy crown which rises above the surface. They bait the ground with a meal consisting of fried poonac mixed with plain kurakkan, which they call "koraliya-kema." Then they retire to a distance for about half an hour, and on returning cast the "baru-dela" over the central mark, picking out the "koraliya," if any happen to be caught, from under the leaded edge of the net as it lies upon the bottom.

In the Angulu Eliya lake "koraliya" is caught in an ingenious manner in artificial submerged thickets, called "atu-kotu" (singular atu-kotuwa). Twigs and branches are piled up in a circular area 8 or 10 feet across, surrounded by poles driven into the bottom to mark it out and to keep the branches from drifting away with the current. This is left for two or four weeks, until the sticks exhibit a copious growth of algæ, called "penda," upon which the koraliya feeds. When ripe for the catch, the whole is enclosed within a close-set bamboo tat preparatory to the fishing. The circumference of an "atu-kotuwa" measures about 60 feet; the tats or "peleli" rise $2\frac{1}{2}$ to 3 feet out of the water, in spite of which some "koraliya" succeed in leaping over it and in making good their escape.

If the arrangements are completed in the afternoon, the fishing takes place early on the following morning. Two men get inside the enclosure, where the water has a depth of 4 to 5 feet, and commence handing out the larger branches to a third man outside, who places them in another pile close by. When the place is clear, a man takes a deep hand net (atanguwa) and carries it round the circle, keeping close to the tat all the time. The other man is meanwhile continuing the clearing and splashing in the centre to drive the fishes to the circumference. When the net has collected a fair number of fishes, it is emptied into a boat outside and returned for a fresh supply. In this way about 150 "koraliya" of all sizes up to $7\frac{1}{2}$ inches in total length were collected in my presence, and very few fishes of other kinds besides. The larger sizes of "koraliya" are worth about 6 cents each; the bulk of the catch was taken immediately to Moratuwa; they said the total value was Rs. 2, but the value was probably under-estimated.

The custom of erecting "atu-kotu" commences in the Panadure lake abreast of Kaduruduwa, a coconut-planted islet about half a mile long, opposite to the Durawa village of Gorakana.

Many other important and interesting food-fishes abound in the Panadure river. I will only mention here another prominent kraal fish, the "ileya" (called "lilawa" at Weligama), *Megalops cyprinoides*, which also frequents the Kelani-ganga estuary; and a large line fish, the "kana-magura," *Plotosus canius*. Both of these species live for many hours out of water, rather an exceptional fact in the herring family, to which *Megalops* belongs.

Moda Fishery at Kalutara.

Koraliya, anguluwa, and other fishes are caught in quantity in the Kalu-ganga estuary, but the chief speciality of this station is the moda fishery. The moda (*Lates calcarifer*) is an estuarine perciform fish of superior quality and large size, which so far as is known spawns in the sea. It is captured at many other stations in the low-country, including Elephant Pass, where it occurs in company with another well-known game fish, *Polynemus tetradactylus*, which is called kalawa in Sinhalese, kalemin in Tamil, bamin in Malayalam.

Other food-fishes observed at Elephant Pass in November, 1909, may be mentioned here incidentally as showing an interesting association of species at that station.

Arius falcarius, 15 inches long; anguluwa Sinh., kelaru Tam.

Belone strongylura, 15 inches; the usual vernacular name for species of Belone is morala. Also in Panadure river under name habareliya.

Chanos salmoneus, the milk fish; weka Sinh., palei Tam. Not actually taken during my stay, but occurring during flood time.

Chatœssus nasus; koiya Tam., katu-goiya Sinh. A Clupeoid fish, remarkable in possessing a hard muscular gizzard such as occurs in the gray mullets. It is also found in lake Tamblegam and in the Panadure river, wheie it is called katu-massa.

Chrysophrys berda, the calamara or black teralei.

Elops saurus; manna Tam., renawa Sinh. Also in the Panadure river.

Etroplus suratensis; o'ti Tam., koraliya Sinh.

Gerres limbatus; teralei Tam.

Gerres lucidus; teralei Tam.

Hemirhamphus xanthopterus.

Mugil olivaceus, a gray mullet; manalei Tam., godaya Sinh.

Platycephalus insidiator; eriyal Tam., mudu-weligowa Sinh. Also frequents the Panadure river.

Plotosus canius.

Sillago sihama, the kalanda; common at Panadure and Negombo.

Synaptura orientalis, a flat fish.

These are all common food-fishes, but I have not seen the bamin elsewhere than at Elephant Pass. I have examined another species, *Polynemus plebeius*, from the sea at Weligama.

The moda is frequently seen in the Kalutara fish market, and I obtained some returns from a party appointed for the purpose through the Kachcheri in order to ascertain the average quantity and value of this particular species put upon the Kalutara market within a limited period. It is caught mostly by angling near the railway bridge, sometimes by netting near the mouth of the river, presumably as the fishes are entering from the sea or descending from the river. It is rather remarkable that, so far as I know, there is no record at Kalutara of moda having been caught in the sea. The weight ranges from 1 lb. to 20 lb., and the value from 30 cents to Rs. 9.

Ophiocephalus marulius.—This fish, which has been mentioned above, attains a larger size than does its relative the lula, reaching a weight of 12 to 15 lb. Colonel Gordon Reeves informs me that some small fishes called "gunarow," 3 to 4 inches long, were sent to him in May from Rajjammaana on the Amban-ganga, which he took to be the young of *O. marulius.* He liberated them into his stew pond at "Wiltshire," Matale. They are described as having "large irregular blotches of claret colour on their upper parts, more especially towards the tail." The exact identification of these young fishes would be interesting, as nothing is known about the reproduction of *O. marulius.*

Improvement of Inland Fisheries.

Pisciculture means the preservation of the spawn and fry of fishes, the stripping or expressing of ova from mature fishes and their artificial fertilization, the prohibition of ceitain methods of fishing, and the regulation of existing fisheries in tanks and rivers.

There are many instructive analogies between agriculture and pisciculture sufficient to justify the conjunction of a Board of Agriculture and of Fisheries. The variations in the growth of plants according to quality and elevation of soil is comparable with the growth of fishes in correlation with the size and latitude of rivers. The quantity of fish which can be raised as food in a given bulk of water depending upon the area and depth, but above all upon the usually unknown richness or poverty of the primary food supply in the water, is comparable with the quantity of vegetable food which can be raised per acre of ground; and the liability of cultivated fishes and plants to fungoid and other pests is another common character. Besides these points of correspondence, there are other contrasts which should not be lost sight of, *e.g.*, the difficulty of transporting the ova of fish as contrasted with the ease with which the seeds of plants can be carried about; the expense of maintaining a nursery of young fishes as compared with the automatic working of a nursery of young plants; the migratory habits of grown fishes as compared with the stationary habits of grown plants. When a thousand selected plant seeds are put into the ground, a thousand seedlings may germinate on the spot and be subsequently planted out; but when a thousand fish fry are emptied into a river or tank, they "swim gaily away," and unless very particular attention is paid to them they may never be heard of again.

Prohibition of certain methods of fishing and the establishment of close seasons for certain fishes are difficult measures, which can only be based upon a close familiarity with local conditions. Each river system and each tank area have to be treated separately on their own merits. Illegitimate fishing, such as the use of poison and dynamite and the wholesale damming of water-courses, does not usually take place in the vicinity of towns, but in more or less remote tributaries. On the other hand, the destruction of young fishes in paddy fields is a matter which calls for special attention, and reference should be made on this subject to the Report on Pisciculture in South Canara, by H. S. Thomas, Collector of South Canara, 1870, a copy of which has been procured through Government at my recommendation for the Museum Library. The point which requires comprehensive discussion is the destination of the waste water from paddy fields. If this water flows back into a river, or into an irrigation canal, the inundated paddy fields act as an efficient nursery for young fishes, provided that they are allowed free scope and are not trapped prematurely. Under such conditions a system of paddy fields is the model for a combined hatchery, nursery, and stock pond.

Artificial fertilization and hatching require hatcheries and stock ponds which would be useful for re-stocking, with due discrimination, both village tanks and city tanks. Replenishing the supply of fishes means turning immature fishes into fishable waters, where they can continue to grow to a marketable size; unfortunately no size is too small for curry. But if Government undertook this work, somebody would have to pay and be paid. Recourse to artificial fertilization may be unnecessary in certain cases where the seasons and localities of natural spawning are known. I have published in *Spolia Zeylanica*, Part XXIII., December, 1909, an account of my observations on the nesting habits of lula, the principal fresh-water food-fish of Ceylon, though not the largest. I am now in a position to add that an allied species of *Ophiocephalus*, also used extensively as food and as bait for larger fishes, namely, *O. punctatus*, called "madaya" or "mada-karaya," makes its nest amongst inshore rushes, though without the definite clearing that lula prepares, and in such spots, where there is an abundance of microscopic food for the ensuing fry, it deposits pale amber-coloured eggs with a single glistening oil-globule, which float at the surface like the eggs of lula, from which they could hardly be distinguished unless their parentage was known. I had seen a shoal of very young fry of "madaya" accompanied by their parents in a paddy field "wala" at Bellana, near Matugama in the Kalutara District, in April, 1908; and on October 29, 1909, I saw a nest of the floating eggs in the Hunupitiya arm of the Colombo lake, behind Bishop's College, close to the shore, where there was a great quantity of the spherical aggregates of the colonial infusorian, *Synura*. I brought away some of the eggs and hatched them out, feeding the fry, after the yolk had been absorbed, on lake plankton, which I collected myself.

The "kavaiya" (*Anabas*) and the "koraliya" (*Etroplus suratensis*) occur almost entirely in the maritime districts, and are therefore not suitable for stocking waters too far inland.* The eggs of "koraliya" are attached to the lower surfaces of stones and logs and are watched over by the male. On May 21, 1909, a koraliya nest was found in the Wellawatta canal, in the part called Pamankada-ela, near the Spinning and Weaving Mills, beyond the Hilapane palama on the road to Nugegoda. I went there about 11.30 A.M. and saw the adults, both male and female, keeping guard. When the man who was with me advanced his hand to the small stone projecting from the bank of the canal under which the eggs were attached, the smaller, male, with cross markings conspicuous over fore body, approached and pecked at the man's fingers. The larger, female, kept a little in the background in deeper water. Each time the man touched the stone the male bit at his hand. The eggs were attached contiguously in a single layer on the underside of the stone, which was partially imbedded in the earth at the base of the bank of the canal. Some of the eggs were white, indicating failure and death. The living eggs were in an advanced stage of development, the embryo being formed and the yolk pigmented. The yolk is yellow, opaque, and darkly pigmented, but no pigment was present in the eye. The circulation of the blood is active, and the embryo can change its position within the egg membrane. In an egg under observation the free end of the membrane was already ruptured, and at one moment the head was partially extruded, exposing the eyes and the heart, and was then withdrawn again. The surface of the egg appeared minutely rogulose. The length of the egg, without the short stalk, is 2 mm., the width 1 mm., slightly narrower at the free end. Within 24 hours after finding the nest one of the eggs hatched out, the top of the egg membrane lifting up like a lid; there is still no pigment in the eyes, and no mouth; length 5 mm. On the second day after hatching pigment begins to appear in the eyes, and on the third day, when the larva is 6 mm. long, the mouth opens and respiratory movements commence; foreign particles were noted adhering to what looked like a cement organ at the front of the head. The eggs of koraliya are very difficult to rear when removed from their proper habitat. On May 23, and again on June 1, more eggs were found attached to coconut husks, branches, and stones at Hunupitiya, Colombo, opposite the Buddhist temple. On October 28, 1909, another series of koraliya eggs containing formed embryos with pigmented yolk sac was found at Hunupitiya, in the Colombo lake, attached to the outer surface of a short length of water-logged bamboo stem. This species is, therefore, a perennial spawner.

On May 26 a native tile (uluketa) was brought to me from Welikada with a large patch of green waving spawns attached in

* Kavaiya occurs in the great tanks, as at Kanthalai and Minneriya.

contiguous clusters to the concave side of the tile on long transparent stalks. Out of water the appearance was that of a growth of green algæ, or like a green scum. The egg tubes, each of which contains a single egg at the slightly swollen distal free extremity, are connected with a shapeless basal stolon which adheres to the tile and is beset with débris, whereas the tubes are clear and separated from the stolon by constrictions. The length of the egg tubes varies from 3 to 8 mm. The egg, as stated, lies in the distal dilated extremity; it has green yolk with many oil-globules, and a diameter of about 0·5 mm. When the head of the embryo is formed and the tail detached from the yolk, the embryo lies at full length with the head pointing towards the base of attachment; later, when the tail begins to jerk, the embryo can change its orientation, but just before hatching it is again found with head pointing to the base of the egg tube. The latter is nothing more than the enormously extended egg membrane; a tube with its contained larva stretched at full length measured 6½ mm., the larva 2 mm.; at hatching the total length of the larva is 2·25 mm. These remarkable eggs proved to be the spawn of the fresh-water goby, *Gobius giuris*, called "weligowa," an important food-fish; they are, however, difficult to rear without special appliances. On June 6 a fresh lot of weligowa eggs was found in a piece of iron piping, together with the parent fish, in the Hunupitiya division of the Colombo lake; and on July 28 I saw another deposit of the spawn, attached to the underside of a coconut leaf stalk in about 3 feet of water in the Colpetty arm of the lake.

On August 31 a half-spent spawning "kendeya" (*Barbus dorsalis*), accompanied by a batch of adhesive eggs, was brought from the Colombo lake. The eggs measured 0·75 mm. in diameter, with a pale grayish translucent yolk nearly uniformly granular. The eggs had been caught in the act of being laid, and were apparently unfertilized.

The above notes, necessarily fragmentary, will be found useful as giving indications of spawning seasons and habits, of which very little has been previously known in Ceylon. It seems to be the rule that solitary fishes or those that go about in pairs make nests and guard them; gregarious fishes or those that go about in shoals do not generally make nests. The deposited eggs of such common fishes as kavaiya (*Anabas*), hunga (*Saccobranchus*), and magura (*Clarias*) are still unknown.

Lula is a predatory fish with excellent qualities. As mentioned above, it can be dried when obtained in superabundance; a statement to the effect that lula is unsuitable for salting or drying in *Spolia Zeylanica*, Vol. V., 1908, p. 145, &c., requires to be modified; the practice of drying is carried out locally, but not generally. Other fishes in Ceylon which are worth cultivating on account of their value as nutriment are also predatory. There seems to be no non-predatory, nest-building species in Ceylon of equal value with the lula. The mahseer occurs in up-country rivers (Maskeliya), but apparently is not very common in Ceylon; and it is unsuitable for tank cultivation, being a migratory river fish of a pronounced type.

It thus appears that there is a distinct scope in Ceylon for the cultivation of a non-predatory food-fish, such as the gourami, which would fill a gap in the fauna without displacing any native species. The recognition of a natural deficiency in the fauna of the inland waters of Ceylon is one of the chief practical results of this investigation, and indicates clearly that the already attempted introduction of the gourami should be persevered with. Whenever the fishes arrive in Ceylon from abroad they should be carefully acclimatized in a Government stock pond, and by no manner of means turned loose indiscriminately. When in due course the time comes for them to be distributed amongst selected public waters, it would be useful to mark them by affixing to the base of the dorsal fin with silver wire a small silver or aluminium label with a current number impressed upon it, the fishes so marked to be returned to the water if by chance they are captured; and every time they are taken to be noted by some arrangement with local headmen. Whatever method of marking and recording be adopted, the principle remains the same, namely, to effect the introduction systematically and at considerable pains.

EXPLANATION OF THE PLATE.

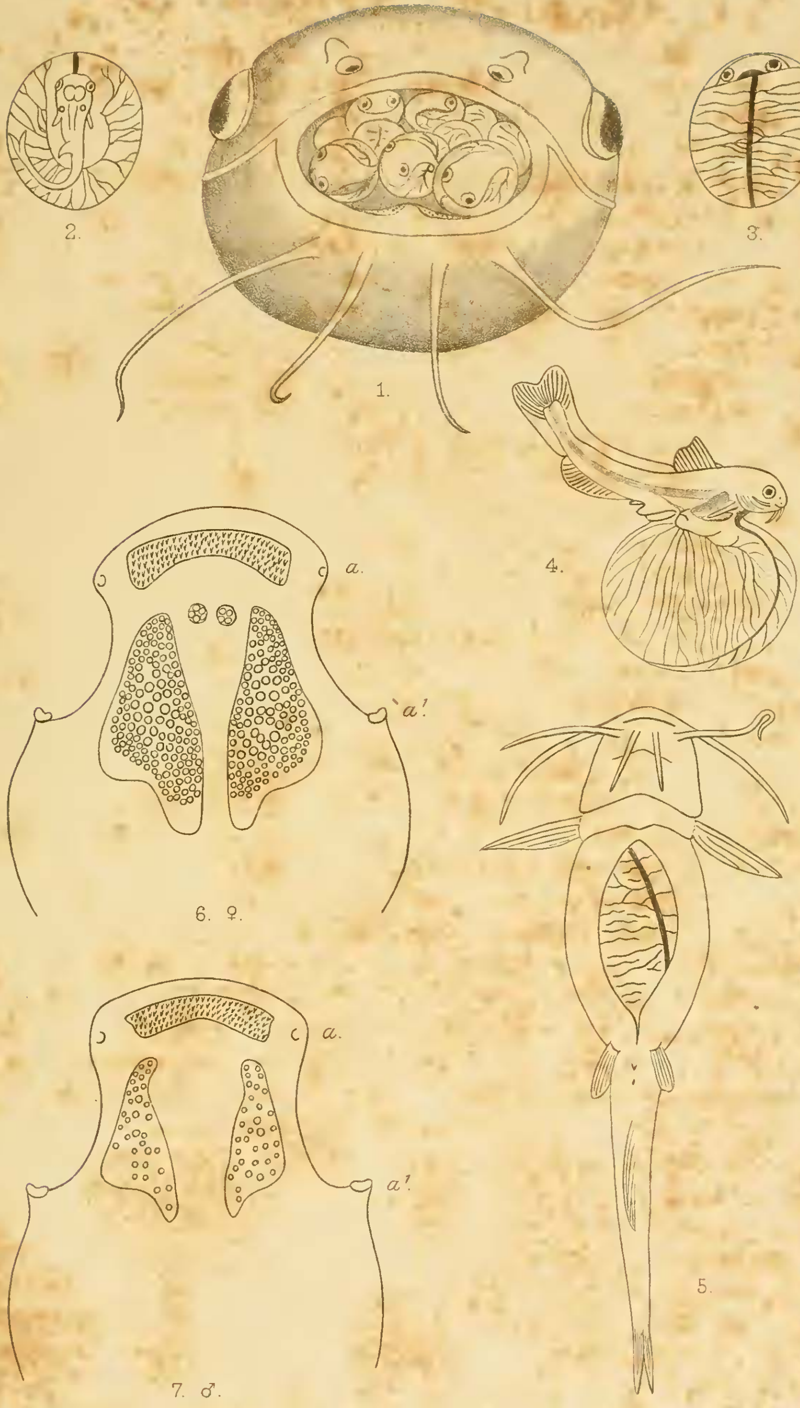
Arius falcarius from Angulu Eliya, August, 1909.

Fig. 1.—Frontal view of ovigerous male, with mouth agape, exposing the eggs with their contained embryos in the buccal cavity. Note the convexity of the gular region.

Fig. 2.—Embryo lying upon the yellow yolk inside the egg membrane, showing the paired efferent vessels of the yolk sac. The distal end of the efferent vessel is seen in front of the head, below which it enters the heart. Very slightly enlarged.

Fig. 3.—Lower view of preceding, to show the unpaired efferent vessel of the yolk sac.

Fig. 4.—Embryo (same stage as fig. 2) released from the tough elastic egg membrane by puncturing the latter with a needle. Total length of embryo about 21 mm.



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ARIUS FALCARIUS.

Fig. 5.—Ventral view of advanced mouth fry to show partial enclosure of yolk sac by the larval parietes. Total length 50 mm.; tail-fin deeply forked, lobes rounded. When alive there is a prominent white brow-spot on the level of the hinder quarter of the eyes in dorsal view.

Fig. 6.—View of palate of adult female $14\frac{1}{2}$ inches long. The palatine tract on each side measures 25×12 mm., and the teeth are present in full strength; between their anterior ends there is an exceptional pair of round vomerine groups. *a*, angle of gape; *a′*, angle of jaw, acetabulum formed by the quadrate; the lower jaw has been removed.

Fig. 7.—View of palate of adult male 11 inches long; size of palatine tract 17×8 mm.; no vomerine teeth; palatine teeth weak and sparse.

NOTES.

5. *Rambling Notes :—*

Life of the Leaf Insect.—The development of the common "Leaf Insect" (*Pulchriphyllium crurifolium*) is very slow. When kept in captivity eggs are constantly hatching out, and it is difficult to keep count of the separate broods. By isolating an insect, immediately after its emergence from the egg. I have ascertained that it takes about eight months to complete its development. This particular insect was isolated on November 25, 1909, and appeared in its mature form on July 26 of the present year. The actual time occupied in its development has been 243 days. In its adult stage the insect may live for a month or more. These figures are for the female insect. The development and subsequent life of the male will be much shorter.

A Cannibal Bat.—(*August 7.*)—I found the remains of a small bat in my verandah this morning, together with the wings and feathers of a "sun-bird" (*Cinnyris zeylonicus*), under circumstances plainly indicating that it had fallen a victim to a carnivorous bat, probably a species of *Megaderma*, of which we have two species (*lyra* and *spasma*) in Ceylon. Of *Megaderma lyra* (the Indian Vampire Bat), Blandford writes : "During the day this bat hides in caves, old buildings, roofs of houses, &c. The food may consist partly of insects, but it is certain that *Megaderma lyra* feeds on smaller bats, for one was detected and observed in the act by Blyth, and it probably lives chiefly on small vertebrata."

A large Green Viper.—(*September 15.*)—An unusually large specimen of the "Green Viper" (*Trimeresurus trigonocephalus*) was brought to me to-day. It had been suspended by the neck, and was almost dead. However, it appeared to recover when the ligature was removed.

September 16.—The recovery of the viper was only temporary. It died this afternoon, after bringing up a half-digested rat. It is quite the largest specimen that I have seen. Boulenger quotes 31 inches as the limit of size. This specimen has a total length of 40 inches, of which the tail occupied only 6¾. Its girth across the middle of the body is 3½ inches. The head, which is very evil-looking, has a breadth of 1¾ inches. It is of a beautiful grass green colour, with irregular elongate black dorsal patches, from which branches are given off enclosing large rounded areas on each side ; these enclosed areas are disposed asymmetrically.

This viper, in spite of its villainous physiognomy, is reputed to be the least dangerous of any of our venomous snakes, with the possible exception of the tiny *Callophis*, about the venom of which little or nothing is known. There are no recorded cases of death or of serious illness from the bite of the Green Viper. It is possible, however, that the amount of venom that could be injected by such a large specimen as that here described might result in more serious consequences.

A Passenger-carrying Beetle.—The "Dung Beetles" (*Coprini*) are very generally infested by large numbers of parasitic mites, which can scarcely be classed as passengers. But a specimen of *Scarabæus gangeticus* recently flew into my room and—when captured—was found to be carrying a number of small winged flies These flies appeared to be in no way inconvenienced by the somewhat complicated process of unfolding and furling of the wings of the

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meet it, making repeated pounces at the insect as it fluttered against the wire gauze. This particular butterfly, by the way, is supposed to mimic *Papilio hector*—a species that exhibits warning colours, and is credited with distasteful properties. It is doubtful if a squirrel would have much chance of capturing an uninjured butterfly in the open.

Crows and their Ways.—In the last number of *Spolia* I described the chase of a full-grown hare by a crow. I have since rescued a young leveret from the unwelcome attentions of a pair of these omnivorous birds. When I came upon the scene the baby hare had its back against a high bank and was pluckily fighting the two crows, making feints at them with its front feet whenever they tried to approach too close. The crows appeared to be distinctly afraid of a front attack. They sidled about, just out of

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SPOLIA ZEYLANICA, *Vol. VII., Part XXVI., December, 1910.*

CORRECTION SLIP.

Since writing my note on "A Passenger-carrying Beetle," a note on the subject has appeared in "The Entomologist's Monthly Magazine" for December, 1910 (p. 275), in which the fly has been described as a new species, under the name of *Limosina equitans*, Collins (Fam. *Borboridæ*).

E. E. GREEN.

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A Passenger-carrying Beetle.—The "Dung Beetles" (*Coprini*) are very generally infested by large numbers of parasitic mites, which can scarcely be classed as passengers. But a specimen of *Scarabæus gangeticus* recently flew into my room and—when captured—was found to be carrying a number of small winged flies These flies appeared to be in no way inconvenienced by the somewhat complicated process of unfolding and furling of the wings of the beetle. Nor did they willingly leave the insect when handled, but accompanied it into the poison bottle. It is probable that the flies (which have been determined as a species of *Borborus*) breed in the store of dung laid up by the beetle for its own family, and find this method of transport an easy way of obtaining access to a store of suitable food.

Palm Squirrel and Butterfly.—I do not think that the common little striped squirrel (*Sciurus palmarum*) has ever been considered in the light of a possible enemy to butterflies; but the following occurrence apparently shows that this animal may occasionally indulge in an insect diet. I have some large open-air breeding cages in front of my laboratory. A pair of *Papilio polytes* (the female of the *hector* form) occupied one of these cages. Looking across at the cage one morning I noticed the female butterfly fluttering about in a rather excited manner, and a squirrel following every movement—from the outside of the cage. It continued its fruitless chase for at least a quarter of an hour. When the butterfly flew off to the opposite side of the cage, the squirrel raced round to meet it, making repeated pounces at the insect as it fluttered against the wire gauze. This particular butterfly, by the way, is supposed to mimic *Papilio hector*—a species that exhibits warning colours, and is credited with distasteful properties. It is doubtful if a squirrel would have much chance of capturing an uninjured butterfly in the open.

Crows and their Ways.—In the last number of *Spolia* I described the chase of a full-grown hare by a crow. I have since rescued a young leveret from the unwelcome attentions of a pair of these omnivorous birds. When I came upon the scene the baby hare had its back against a high bank and was pluckily fighting the two crows, making feints at them with its front feet whenever they tried to approach too close. The crows appeared to be distinctly afraid of a front attack. They sidled about, just out of striking distance, but showed their impatience by picking up bits of sticks and biting them viciously. I am afraid that the defenceless little animal would have had small chance of eventual escape if I had not interfered. I drove the birds away and placed the hare in a cage, liberating it the next day when the crows had found other occupation.

Our local crow is the larger and more formidable hill species, *Corone macrorhyncha.* They are most pertinaceous marauders of the fowl yard. Newly-hatched chickens have to be confined within coops where these birds abound. They are systematic robbers of birds' nests, and frequently kill other birds. I saw a pair of crows single out a parrot from a small flock, drive it away from its companions, and knock it to the ground. There the parrot showed fight, and kept the crows at bay until I came to the rescue. I picked up the parrot (getting severely bitten for my kind intentions), drove off the crows, and liberated the victim, which appeared to be uninjured. In a moment the crows reappeared and took up the chase. The parrot was brought to earth again, and was rescued a second time. On this occasion I thought it best to keep it in confinement until the crows had lost sight of their anticipated prey.

The amusing manner in which a crow will bamboozle a dog out of a bone has been described more than once, but may be repeated again from personal experience, as I have seen the game played with my own dog on my own lawn. The manœuvre is always worked by a pair of the birds. The dog is happily engaged with a bone on the grass. One of the conspirators quietly takes up his position behind, while the other approaches the dog from in front. The dog growls, but the crow gradually sidles nearer. Finally the dog leaves his bone and drives off the intruder. Having easily effected this, he returns expecting to enjoy his meal in peace. But, in the meantime, the second crow has seized his opportunity and has removed the bone of contention to the branch of a neighbouring tree, where he is joined by his comrade. I have seen the same tactics employed against a domestic fowl that had secured a savoury morsel.

E. ERNEST GREEN.

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6. *The Ceylon Giant Tortoise.*—The following letter was written by me to the "Indian Field" in answer to a correspondent who had confused the famous Colombo tortoise, which died in 1894, with one which is supposed to be still living at Matara:—"I have had my attention drawn to an article in the 'Indian Field,' which speaks of a giant tortoise at Matara. There is no doubt that if such a tortoise exist at Matara, it is not the one which was found in Colombo at the time of the British occupation in 1796. This famous tortoise lived for many years in the grounds of a villa called 'Uplands,'

in Mutwal, near Colombo. When 'Uplands' was sold to the Government in 1894, for the purpose of building a graving dock, the animal was removed to Victoria Park, Colombo, where it survived only a week. It must have been considerably over a hundred years old at the time of its death. For nearly twenty years before its death the tortoise was totally blind, but this infirmity did not prevent it from roaming over the 'Uplands' grounds. It is stated that when the bell was rung for meals, the tortoise would make its way to the bungalow to be fed. The shell and stuffed skin of this famous old tortoise are now in the Colombo Museum, so that I am able to supply the measurements of the animal. Total length from snout to tip of tail, 5 feet; highest point of carapace above the ground, 2 feet; length of shell, 3 feet 4 inches; width of shell, 2 feet; circumference of shell, 10 feet. This 'Uplands' tortoise was a specimen of *Testudo elephantina*, a species which is still to be found in Aldabra, an island to the north of Madagascar, where it is preserved by the British Government. There appears to be no record of the circumstances in which this interesting specimen was brought to Ceylon."

Since the above was written, the Librarian of the Museum has directed my attention to an article by M. Sauzier on "La tortue terrestre gigantesque de Colombo" in "La Petite Revue." The writer throws doubt on the suggestion made by the "Ceylon Observer" (April 25, 1870) that the tortoise was sent from Java as a present to one of the Dutch Governors of Ceylon, since Java does not possess any indigenous giant tortoise. He is disposed to believe that the Colombo tortoise came from Mauritius, which was occupied by the Dutch up to 1710. He agrees with the "Observer" that the tortoise was over two hundred years old at the time of its death. There appears to be no reliable information on this point.

Lydekker in his book "Mostly Mammals" has erroneously stated that the Colombo tortoise died in 1897, and was a specimen of *Testudo sumeirei*, and Gadow in his volume of "Amphibia and Reptiles" in the Cambridge Natural History has repeated these errors. The Colombo tortoise differs from *T. sumeirei* in having a small nuchal plate at the anterior end of the carapace.

There are four closely allied species of Testudo found in Aldabra, and these are now grouped together as one species. These are *gigantea*, *elephantina*, *hololissa*, and *ponderosa*, and as the name *gigantea* is the oldest, it claims priority. So that the Colombo tortoise now bears the name *Testudo gigantea*.

Since writing this note I have been informed by Mr. P. E. Pieris, C.C.S., that there is a giant tortoise living at present near Galle. This is probably the "Matara tortoise" referred to by the correspondent of the "Indian Field." Mr. Pieris has promised to get further information on this point.

JOSEPH PEARSON.

7. *An interesting Frog.*—Mr. E. E. Green has handed over to me a curious frog from Maha Illuppallama, which has been identified as *Cacopus globulosus*, described by Günther in "The Reptiles of British India." Its chief interest lies in the fact that it is distended in an extraordinary manner so as to look like a ball, from which the head and limbs project. Günther states that this distension is caused by a fluid contained in the abdominal cavity. A brief examination shows that this is not the case, and that the fluid-containing cavity is none other than the subcutaneous lymph sinuses which are greatly enlarged in this form. The dorsal sinus is especially spacious, and has a height of 15 mm. from floor to roof. (The length of the frog from mouth to vent is 75 mm.) In Günther's account he speaks of the distension of a female specimen being due to the growth of the ovaries, and his description suggests that the ovaries grow into the large cavity on the back. This is not possible, as the subcutaneous lymph sinuses are separate from the cœlom. There is only one other species in this genus, namely, *Cacopus systoma*, which differs but slightly from *C. globulosus*, and which resembles it in the robust appearance due to the enlargement of the subcutaneous lymph sinuses. This interesting character is not given in the diagnosis of the genus either by Günther or Boulenger.

JOSEPH PEARSON.

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8. *The African Land Snail in Ceylon.*—A very large specimen of *Achatina fulica* was sent to me in September by the Hon. Mr. C. T. D. Vigors, Government Agent, Western Province, from a garden at Moragalla, in Beruwalbadda of the Kalutara Totamune. The total weight of the animal and shell was 13 ounces, and the length of the shell from the apex to the base was 6½ inches. This appears to be the largest specimen of this species recorded from Ceylon.

JOSEPH PEARSON.

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9. *Symphyla of Ceylon.*—When turning over stones and logs of wood, both in the neighbourhood of Kandy (1,500–2,500 ft.) and at Pattipola (6,000 ft.), a minute white centipede is frequently found. The group—Symphyla—to which it belongs is one of exceptional interest anatomically, as it helps us to bridge over the wide gap between insects and the centipede-like ancestor, from which they are commonly supposed to have been derived. In spite of the interest of the group, however, hardly anything is known of its embryology and little of its habits.

The common species in Ceylon is identical with one found abundantly during the rains, and more rarely in dry weather in the compound of the Indian Museum, Calcutta. I have already described it (1910) under the name *Scutigerella unguiculata*, Hansen, sub sp. *indica*, and recorded its known distribution.

On going through my Ceylon material prior to incorporating it in the general collection of the Indian Museum, two specimens of another species of Symphyla—*Scutigerella orientalis*, Hansen—were discovered. Hansen records the species from Java, Sumatra, Koh Chang Island (Gulf of Siam), and Bankok; but I know of no previous record from Ceylon. These two specimens were found at Pattipola on July 2 or 3 of this year (1910), but I have no recollection of the circumstances under which they were found. It is, however, almost certain that they came from the jungle, as almost the whole of my collecting was done there. *S. orientalis* is both longer and stouter than *S. unguiculata* (*indica*), this difference being very evident even to the naked eye. The latter attains a length of little (if at all) over 4 mm.; but my specimens of the former are both about 6 mm. long.

The Symphyla are always minute, but when examined under a strong hand lens they can at once be distinguished from the young of other centipedes by the presence of a pair of (stout and unjointed) cerci, which project backwards from the last segment of the body. Hansen (1904) gives tables, descriptions, and figures, from which it is easy to identify any of the species known to him. Since he wrote, Imms (1908) has described one additional Oriental species, *Scutigerella subunguiculata*, found by himself in the Himalayas; and I have described (1910) the common Ceylon and Calcutta form—*S. unguiculata* (*indica*).

List of Works referred to.

1904. Hansen, H. J. .. "The Genera and Species of Symphyla," Q. J. M. S. (N. S.), XLVII., 1904, pp. 1–101, Pl. I.–VII.

1908. Imms, A. D. .. "On a New Species of Symphyla from the Himalayas," Journ. Linn. Soc., Zool., XXX., 1909, pp. 252–255, Pl. XXXI.

1910. Gravely, F. H. .. "On a Subspecies of *Scutigerella unguiculata*, Hansen, found in Calcutta," Rec. Ind. Mus., V., 1910, pp. 157–159, text fig.

F. H. GRAVELY.

NOTES ON A NEW LAND PLANARIAN FROM CEYLON.

By Dr. Iwaji Ikeda.

(With Plate IV. and one Text Figure.)

IN March last Professor R. C. Punnett kindly handed me an interesting animal which was caught at Namunukula, Ceylon, by Dr. Willey, then the Director of the Museum at Colombo. At first I took the animal to be a land nemertean, but it soon became clear that I was dealing with a land planarian. Further examination has revealed the fact that the animal is not only an undescribed form of the Rhynchodemidæ, but it also possesses several remarkable characters, some of which are quite new to the family. Moreover, some of these peculiarities are similar to certain typical characteristics of the family Cotyloplanidæ. The following is a brief description of this curious land planarian, representing a new genus and a new species. I wish to record my thanks to Professor Punnett, who kindly gave me the valuable specimen in connection with my studies.

Pseudartiocotylus ceylonicus, n. gen. et n. sp.

The single specimen (Plate IV., fig. 1) was preserved in formaline and was in a fairly good condition, except that it was torn near the posterior end. The body, which is nearly round in section, is about 28 mm. long and 2 mm. thick at its broadest part. The anterior end is much broader than the posterior, which is pointed. Anteriorly the body is conspicuously compressed dorso-ventrally so as to form a distinct head-flap, which is turned upwards. On the ventral side of the head-flap there is a small depression, which is shallow but well defined, lying just in front of the anterior termination of the sole. Anteriorly and laterally the depression is bordered by a prominent ridge of a horseshoe shape, while posteriorly it becomes shallower, and gradually merges into the general ventral surface. By means of sections it has been ascertained that this ridge represents anterior portions of the so-called glandular margins ("Drüsen-Kante"), which are developed slightly below the lateral margins of the body, and extend backwards to about 3·5 mm. from the head-apex. Fuller description of this structure will be given later. At the very tip of the head there is present a small colourless spot (see Plate IV., figs. 1 and 3) measuring about 0·6 mm. in diameter, which is, as I shall try to prove later, a sensory organ not hitherto described in land planarians. Two small deeply-pigmented eye-spots (see Plate IV., figs. 1 and 3) are situated slightly behind the above organ.

On the dorsal side the colour of the animal is dark brown mixed with a light violet tint, both ends, especially the anterior, being much more lightly coloured. There are three black dorsal stripes, the medium one being narrower than the two others. On account of the deep ground colour on the greater part of the body the stripes are more clearly defined at the two extremities, particularly at the anterior end, where the ground colour is much lighter. The colour of the ventral surface of the body is grayish, excepting a median colourless band represents the sole, which is slightly elevated.

The sole extends almost the whole length of the body, but ends abruptly behind the ventral depression of the head-flap. Near its anterior end the sole is a little broader, so as to show a special area (see Plate IV., fig. 4) about 0·4 mm. long. Close to both lateral edges of this swollen area are two fine parallel ridges (see Plate IV., fig. 4). On examining the sections it is seen that these two ridges are ciliated, as also is the shallow groove between them. The mouth is a small elliptical slit near the middle of the sole. The genital opening is about 5 mm. behind the mouth.

All three kinds of the "Stäbchen" (von Graff) are met with in the epidermal layer. Rhammites and chondrocysts generally occur together, and are very widely distributed almost over the entire body-surface, excepting the sole and that part of the head-surface which lies above the brain and is dorsal to the horseshoe-shaped glandular ridge. The chondrocyst (see Plate IV., fig. 5, *ch*) is a relatively large and oblong body, nearly homogeneous in structure, which is lightly stained with hæmatoxylin. It is found almost always surrounded by a number of long and slender rhammites (*rm*). The latter are easily distinguished from other "Stäbchen" by their thread-like shape and curled, pointed endings. In those narrow regions which are hemmed in between the sole and the glandular margins (inclusive of the ridge), the two "Stäbchen" are sparsely scattered, and the chondrocysts are rather indistinctly outlined (see Plate IV., fig. 8). The rhabdites are straight thick bodies pointed at both ends (see Plate IV., fig. 8, *rd*), and are moderately stained by hæmatoxylin, more lightly than the rhammites, but more deeply than the chondrocysts, so that they are readily distinguished. The rhabdites are remarkably scarce. They are only found in those regions which lie between the sole and the glandular margins, and extend posteriorly only as far as the ventral ciliated organs. They are never found in company with chondrocysts or rhammites. The presence of the three sorts of "Stäbchen" and the peculiar distribution of the rhabdites mark definite, though not very important, points of distinction between the present species and other members of the Rhynchodemidæ, since the latter, according to von Graff,* form a group in which the three "Stäbchen" rarely occur together, and the rhabdites, if present, are usually scattered over the whole body-surface (as in *Dolichoplana*), or over both the dorsal and ventral

* Von Graff, Ludwig: Monographien der Turbellarien, II. Triclada Terricola (Land Planarien). Liepzig, 1899.

surface of the head. Further description of the distribution of the rhabdites in the horseshoe-shaped depression of the head will be given later in connection with the sensory and the glandular margins.

Among the various epidermal glands, the erythrophile and the marginal glands need only be referred to here, as the others have less direct relation to the classification. The erythrophile glands (Plate IV., fig. 5, *ep*) are in this species uniformly distributed over the entire surface, though they are a little more densely aggregated in the sole-epithelium. They are readily recognized by their coarse granular contents, which have a strong affinity for eosin stains. The presence of the erythrophile glands and the chondrocysts in the epidermis seems to preclude any direct generic relationship of the present form to *Platydemus*, in which the two structures are completely absent.

The marginal glands in this species are well developed, and have their openings on the glandular ridges and on the glandular margins. Their posterior limit is about on the same level as that of the ovaries, being about 3·5 mm. from the head-tip. The glands are very large and long, reaching nearly to the brain or the lateral nerve cords and the gut (Plate IV., figs. 6 and 8, *mg*). They have an extremely oblique course from behind forwards, except at the head-apex, where they run directly downwards to open on the prominent ridge of this region (see Plate IV., fig. 6). The present species is peculiar in having both the erythrophile and the marginal glands, since, according to von Graff, these two glands rarely occur together in the land planarians. Hence he states that "im Allgemeine en erythrophile Körnerdrüsen der Haut und Kantendrüsen einander ausschliessen scheinen, da es nur zwei Formen giebt, bei welchen beide zusammengefunden werden. Es sind dies *Dolichoplana feildeni* und *Polycladus gayi*, doch kann ich wenigstens von letzter Species bestimmt angesehen, dass die Kantendrüsen derselben gar nicht den Charakter der Kantendrüsen der übrigen Landplanarien an sich tragen, sondern sich mehr als eine lokale Anhäufung von birnförmigen erythrophile Drüsen darstellen. Es liegt dem nach hier derselbe Fall vor wie bei *Rhynchodemus terrestris*, wo in der Umgebung der Sinneskante—also an der Stelle pflegen—eine dichtere Anhäufung erythrophile Körnerdrüsen zu beobachten ist."* It may be mentioned here that the present species is only remotely related to the genus *Dolichoplana*, since it lacks the important generic character of having the longitudinal parenchyme muscles developed only on the ventral side of the body. Von Graff's view of the relation between the erythrophile and the marginal glands may explain the nature of another kind of marginal glands which are found in the present species on the inner or ventral border of the glandular ridge (see Plate IV., fig. 8, *mg*). These

* Von Graff, *op. cit.*, p. 66.

secondary marginal glands, as they may be termed, appear to have several characters which are intermediate between those of the erythrophile glands and the true marginal glands; for instance, they are larger than the first, but much smaller than the second; they are stained less intensely with eosin than the first, and are also stained very lightly with hæmatoxylin. The erythrophile granules are more minute than those of the true erythrophile gland. As fig. 8 represents, these secondary marginal glands form a thin layer (two or three cells thick in section) immediately below the glandular ridge. The two zones in which both sorts of marginal glands open to the exterior are separated from each other by a narrow area of the epidermis, which is characterized by containing a few closely-set rhabdites (see Plate IV., fig. 8, *rd*). There is a similar distinct layer of rhabdites more ventral to that just mentioned (see Plate IV., fig. 8, *rd*). Between the two rhabdite layers is interposed a narrow clear space of the epidermis (see Plate IV., fig. 6 and 8, *sm*), probably corresponding to the so-called sensory margin known in many land planarians.

The structure, which may be compared with the "Sinneskante," is seen, in transverse sections through the glandular ridges, to be a narrow clear space of the epidermis (about 0·02 mm. wide) lying between the two rhabdite-layers. Its most characteristic features are the total absence of nuclei in the epidermis of this region, and also the absence (probably apparent) of the basement membrane (see Plate IV., fig. 8, *sm*). The epidermis is here represented by a group of faintly stained fine threads which frequently anastmoose. These threads are directly continuous with a small, clear, and compact mass of elongated cells, which are certainly nucleated. The cells run parallel to each other and obliquely to the epidermal surface. I have not been able to detect any distinct connection of the above cells to the nerve-fibres, which abound in the neighbouring parenchymatous tissue. Nor have I found any ciliary appendages either on the sensory margin or on the whole epidermis, excepting that of the sole.

Although there are still some points to be elucidated in the histology of the sensory tissue described above, I cannot entertain any doubt as to the homology of this structure with the "Sinneskante" observed by von Graff in many land planarians. Three chief points of homology may be noticed: (1) the absence of nuclei in the external plasmic layer; (2) the direct connection of the latter to the underlying nucleated spindle-shaped cells; and (3) the absence or imperfect formation of the basement membrane. If the above homology be accepted, the species under examination differs in a striking manner from other land planarians with regard to the relative positions of the sensory and glandular margins. In all previously known cases the former invariably lies to the latter, while in the present case the relative positions are reversed. Lastly, it must be added that that horseshoe-shaped depression which is bordered by the glandular ridge of similar shape has nothing to do with the so-called "Sinnesgrübchen," but seems rather to be an artificial effect, due to the contraction of the radial parenchyme muscles, which are specially well developed in this region, and extend from the ventral side of the brain to the dermal layers forming the roof of the depression (see Plate IV., figs. 6 and 8).

The structure of the single eye-like organ (see Plate IV., fig. 9, *ao*) at the head-tip presents some points of interest. Fig. 9 represents a median saggital section through a small portion of that region of the head which contains the organ. Here it is represented by a special clear part of the epithelium, which lies above a region of parenchyme, which is peculiar in having none of the fine pigment granules which are elsewhere present in great abundance. In this region the epidermis (*ao*) contains neither nucleated cells nor any sort of epidermal glands, but consists merely of a plasmic layer, which takes the stain faintly, and which contains minute vacuoles and irregular radial striations, as if to indicate cell boundaries. In the parenchyme underlying this part of the epidermis there are ordinary parenchyme-cells, together with a few muscle-fibres and numerous nerve-fibres (*npl*). There is also a thin cell-layer composed of slender nucleated cells, which lie vertically on the basement membrane and the dermal musculature. Owing to the inadequate fixation of the specimen, I have not been able to make out what relations exist between the outer non-nucleated plasmic layer and the inner nucleated layer. But from the close resemblance to the similar structures already described on the sensory margin, I am inclined to regard both layers as actually continuous with each other through the basement membrane.

A striking feature of the present species is the presence of paired ciliated organs on the sole. Seen in sections the groove itself (Plate IV., figs. 7 and 10, *co*) is rather shallow, and is bordered on either side by a comparatively prominent ridge. The cilia which cover the surface of the organ as well as the sole (see Plate IV., fig. 10, *s*) are longest on the ridges, shortest on the sole, and of an intermediate length in the groove. The epithelium lining the groove and ridges is formed of nucleated cells, which stain fairly, and have a coarsely reticulated plasma. The nuclei are perceptibly smaller than those of the neighbouring epithelial cells. The ciliated epithelium which lines the groove and ridges does not contain any "Stäbchen" or epidermal glands, and is sharply separated from the overlying parenchyme by the distinct basement membrane and the two dermal layers (*dm*). The parenchyme in this region is rich in fine branches of the nerve fibres (see Plate IV., fig. 10, *npl*), which are probably connected with the ciliated organ. When I detected these curious organs, I supposed they might be something similar to the suckers of the Cotyloplanidæ. But this is merely superficial, since both organs are entirely different in their histological structure.

No particular mention need be made of the epithelial layer of the sole, except to point out that the epithelium is composed of a single layer of cubical ciliated cells, which are interrupted by numerous erythrophile and cyanophile glands. The "Stäbchen" never occur in this region, though a very few rhammites are often found in that part of the epithelium which passes over from the sole to the inner ridge of the ciliated organ (Plate IV., fig. 10, *rm*). I have carefully examined the sections of the sole to ascertain if there were any sinking of the sole-epithelial cells into the parenchyme, as von Graff has observed in many species of the genus *Rhynchodemus*. But I have not recognized this phenomenon in a single case. This fact and the presence of the well-developed marginal glands must be regarded as evidence against the direct relationship of the present form to the genus *Rhynchodemus*.

The structure of two eyes is essentially the same as described and figured by von Graff* in *Platydemus grandis*, Spencer. The only point of difference is that the vitreous body filling the interior of the eye-camera is represented in the present case by a homogeneous substance perforated by many irregular clear spaces; consequently there is no indication of any trace of the prismatic structures, which are, according to von Graff, always present in the so-called "Retina-Augen." But I fear that the deviation shown in the present instance is not actual, but is probably due to the improper fixation of the eye tissues.

As mentioned above, the longitudinal parenchyme muscles (see Plate IV., fig. 7, *lpm*) are, as in all genera of the Rhynchodemidæ, except *Dolichoplana*, developed all round in the parenchyme as a thick and continuous sheet surrounding the gut and the central nerve cords.

The two ovaries are situated about 3·5 mm. from the head end. They give rise to two slender oviducts, which run straight backwards along the dorso-lateral side of the two nerve cords. The testes are numerous, roughly 50 to 60 on each side, and are arranged generally in two irregular alternate rows. Their anterior extremities are about 0·5 mm. behind the ovaries, and they extend posteriorly as far as the mouth. The two vasa deferentia run posteriorly along the inner side of the oviducts. I regret that owing to my careless manipulation while cutting the body with the scissors the connection of the common duct of the vasa deferentia with the penis was destroyed. Consequently I have not been able to determine how the common male duct enters into the penis, and how the latter opens to the male atrium. In the attached semi-diagrammatic figure representing the copulatory organs the broken parts are indicated by dotted lines. At the level of the common genital opening (*go*) the male atrium (*ma*) communicates with the underlying female atrium (*fa*),

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* Von Graff, *op. cit.*, p. 144, figs. 1 and 2, in Taf. L.

which is about 0·2 mm. wide. This female atrium is connected posteriorly with a long tubular cavity (*ut*), which is about 1 mm. long and 0·1 to 0·15 mm. wide. The walls of the atrium and the tubular cavity are of the same structure, that is, the inner columnar ciliated cells, the outer thick muscular layer, and the outermost thick covering of the tubular glands. The glandular duct (*gd*), which is also invested with the tubular glands, opens into the female atrium by a small pore which lies on the left side and at the anterior end of the tubular cavity. The short proximal portion (*va*) of this duct is much narrower and less glandular than the greater distal part; the former may probably be the so-called vagina. The glandular duct gives off a slender canal, which swells abruptly into a spacious cavity (*sr*) directed posteriorly and nearly horizontally.

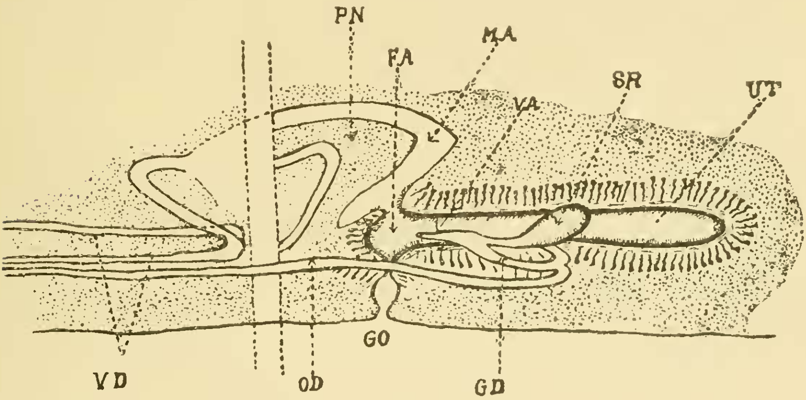

Fig. 1.

A semi-diagrammatic figure showing the copulatory organs seen from the left side: *fa*, female atrium; *gd*, female glandular duct; *go*, common genital opening; *ma*, male atrium; *od*, oviduct on the left side; *pn*, penis; *sr*, seminal receptacle; *ut*, uterus; *va*, vagina; *vd*, vas deferens.

The latter cavity communicates in a peculiar manner with the middle part of the tubular cavity (*ut*) through a broad aperture. The walls of this cavity, too, are essentially of the same structure as those of the atrium and the tubular cavity, so that we may admit that these three cavities were originally derivatives of one cavity or primary female atrium. It is, however, somewhat difficult to clearly identify these different compartments with von Graff's diagrams illustrating the types of the copulatory organs. From the point of view of some structural and topographical analogies, I will call the three cavities respectively the female atrium, the uterus (the tubular cavity), and the seminal receptacle. That the uterus and the glandular duct communicate with each other by a connecting passage is a remarkable fact, which has been known only in *Artiocotylus speciosus** (the Cotyloplanidæ). Von Graff states:

* Von Graff, *op. cit.*, pp. 201 and 209. Text figs. 58 and 59.

"Die merkwürdige Erscheinung an den weiblichen Copulationsorgan der vorliegenden Art (*A. speciosus*) ist nun aber der Umstand, dass von der Stelle, wo der unpaare Drüsengang in die Vagina einmündet, ein kurzer Verbindungsgang zum Trichter des Uterusstieles abgeht und dadurch eine Communication mit dem Uterus herstellt. . . ."* In that species, too, the connecting passage "empfängt ebensowenig als der Uterus Schalendrüsen." Then, the two structures in question differ slightly from each other in their respective relative positions and degrees of development; that is, in *Artiocotylus speciosus* the structure is a simple canal passage, which arises from the proximal part of the uterus and ends in the vagina, while in the present species it is a spacious thick-walled cavity connecting the middle part of the uterus to the proximal end of the glandular duct. Thus, the female genital ducts are compared in this manner, and also when the probably superficial resemblance shown by the ventral ciliated organs and the suckers is borne in mind, the two otherwise remotely related forms may appear to exhibit a very close relationship. But at present I am not in a position to decide whether this interesting similarity has any phylogenetic significance.

From the description and some collations so far given with regard to the principal specific characteristics, it will be manifest that the present species belongs to the Rhynchodemidæ, and cannot be legitimately attached to any of the seven genera composing this family. In some external characters several of the seven genera bear more or less close relationships to the present species. The following table will make clear the comparison :—

X means that the animal possesses the character of the heading under which it is placed. O means that the animal does not possess the character of the heading under which it is placed.

	Sole Ridge.			Sensory Margin.		Glandular Margin.		Body Form.			Cephalic Furrow.	
	Narrow.	Wide.	Absent.	Present.	Absent.	Present.	Absent.	Roundish and Elongate.	Roundish, Long, and Slender.	Depressed and Elongate.	Present.	Absent.
Rhynchodemus ..	X	O	O	X	O	O	X	X	O	O	O	X
Microplana ..	O	O	X	O	X	?		X	O	O	O	X
Amblyplana ..	X	O	O	O	X	O	X	X	O	O	O	X
Nematodemus ..	O	O	X	?		?		X	O	O	O	X
Platydemus ..	O	X	O	X	O	X	O	O	O	X	O	X
Dolichoplana ..	X	O	O	X	O	X	O	O	X	O	O	X
Othelosoma ..	X	O	O	?		?		X	O	O	X	O
Present species ..	X	O	O	X	O	X	O	X	O	O	O	X

* Von Graff, *op. cit.*, pp. 210–211.

Thus, as regards the above-mentioned characters, *Dolichoplana* seems to most resemble the present form, next *Platydemus* and *Rhynchodemus* in order. Even *Dolichoplana* can hardly claim direct relationship to the present species, when we take into consideration those characters relating to the distribution of the longitudinal parenchyme muscles and the structure of the female copulatory organs. *Platydemus* is characterized by having a broad sole and by lacking the erythrophile glands and the chondrocysts of the integument. Besides, the unpaired sensory organ, the paired ciliated organs, and the reversed relative positions of the marginal and the sensory margins are remarkable characters, all of which indicate clear points of difference between the present species and the established genera of the Rhynchodemidæ.

For these reasons I propose to establish a new genus and species for the animal as follows :—

Pseudartiocotylus ceylonicus, n. g. et n. sp.

The genus may be diagnosed as follows : The body is elongate and rounded, and the anterior end is blunt and flattened on the ventral side. The glandular margins are well developed in the head region and lie dorsal to the sensory margins, which are poorly developed. The sole is narrow but distinct, and in its anterior part is modified into two-paired ciliated organs. Beside the two "Retina-Augen," a single unpaired sensory organ is present at the head-apex.

As already referred to, *Pseudartiocotylus ceylonicus* bears a curious resemblance to *Artiocotylus speciosus* in having similarly constructed female genital organs. Whether this implies more than a chance resemblance ought not to be hastily decided from the present observations made on the single specimen. Similar hesitation must be expressed with regard to the resemblance between the ciliated organs of the present species and the suckers of *Artiocotylus speciosus*. I hope to have in the future a further opportunity of studying these interesting points. Here is von Graff's view of the origin of the suckers of the Cotyloplanidæ : "Auch die Familie der Cotyloplanidæ ist keine natürliche Gruppe und die Gattungen *Cotyloplana* und *Artiocotylus* weisen nach dem Baue ihres Nervensystems und ihrer Musculatur—von dem aberranten Typus der Geschlechtsorgane bei *Artiocotylus* gang abgesehen—auf völlig getrennte Ursprünge hin. Der für die praktische Systematik so brauchbare Charakter der Saugnäpfe dürfte also in jeder der beiden Gruppen selbstständig erworben sein." *

* Von Graff, *op. cit.*, p. 285.

The following eight species of the Rhynchodemidæ have been described from Ceylon :—

(1) *Rhynchodemus nematoides*, Loman.
(2) *Rhynchodemus ceylonicus*, von Graff.
(3) *Amblyplana teres*, von Graff.
(4) *Amblyplana hæckeli*, von Graff.
(5) *Nematodemus lumbricoides*, von Graff.
(6) *Platydemus thwaitesi*, Moseley.
(7) *Dolichoplana feildeni*, von Graff.
(8) *Dolichoplana nietneri*, Humbert.

All the above species have been found to be distinct from the present species in their external characteristics. Some principal points of difference may be mentioned as follows :—

(1) *Rhynchodemus nematoides :* yellow ground colour; four dorsal stripes.

(2) *Rhynchodemus ceylonicus :* yellow ground colour; three dorsal stripes are distinct throughout the length of the body.

(3) *Amblyplana teres :* body is relatively short and thick; a deep reddish-brown colour; no dorsal stripes.

(4) *Amblyplana hæckeli :* yellow ground colour; four dorsal stripes.

(5) *Nematodemus lumbricoides :* grayish-brown ground colour; one dorsal stripe.

(6) *Platydemus thwaitesi :* ground colour is nearly the same as in the present species, but the three dorsal stripes are distinct from the ground colour.

(7) *Dolichoplana feildeni :* the body is very large; six dorsal stripes.

(8) *Dolichoplana nietneri :* body is very large; six dorsal stripes.

Lastly, it may be added that I have examined some references* dealing with a few species of the Rhynchodemidæ which appeared later than von Graff's Monograph, but no allied forms have been found in them.

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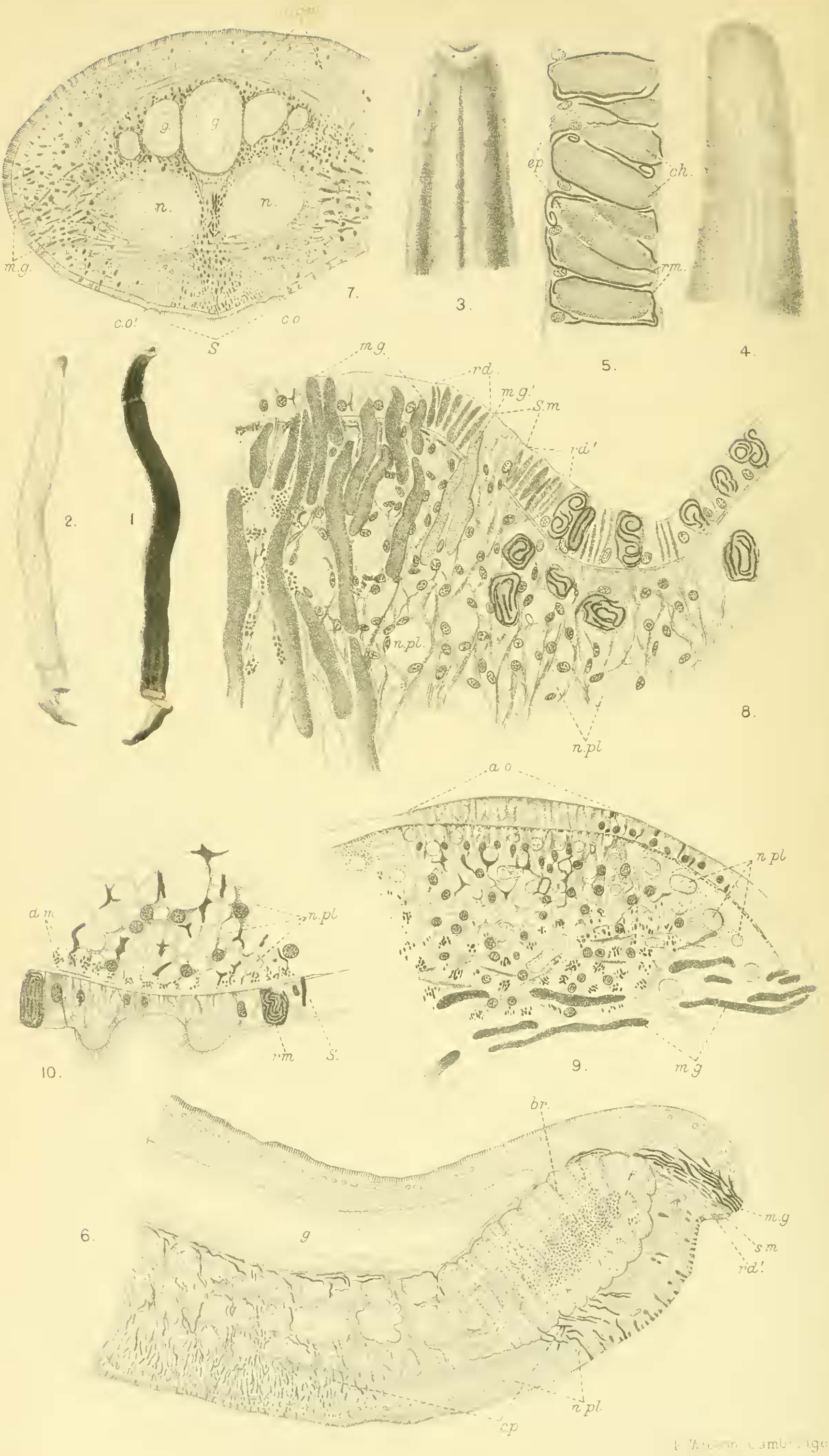
* Mell, C.—Die von Oscar Neumann in Nordost-Afrika gesammeltan Land Planarien (4 n. sp. of *Amblyplana*, 3 sp. of *Platydemus*), Zool Jahrb., Abt. Syst., Bd. 20, 1904.

Laidlaw, F. F.—On a land planarian from Herule, Male Atoll, with a note on *Leptoplana pardalis*, Laidlaw (*Rhynchodemus ceylonicus* ?), Fauna and Geogr. Maldive Laccadive Archip., vol. 2, 1903.

Scharff, R. F.—New planarian (*Rhynchodemus Howesi*), Abstr. Journ. Roy. Micro. Soc., London, 1900.



E. Wilson, Cambridge.

EXPLANATION OF THE PLATE.

Fig. 1.—Coloured sketch of the animal in the preserved state, seen from the dorsal side. × 2.

Fig. 2.—Ventral view of the animal; the mouth and the genital opening are represented at the middle and the hinder part of the sole. × 2.

Fig. 3.—Enlarged dorsal view of the head-end, to show the glandular ridge, the eyes, and the apical (sensory) organ. × 14.

Fig. 4.—Enlarged ventral view of the head-end, to show the sole and the paired ciliated organs on the sole. × 14.

Fig. 5.—Portion of the epidermal layer, taken from a lateral side of the skin. × 400. *ch* chondrocysts, *ep* erythrophile glands, *rm* rhammites.

Fig. 6.—One of the median sagittal sections of the head-end. × 40. *br* brain, *cp* cyanophile glands, *g* anterior termination of the gut, *mg* glandular margin and marginal glands, *npl* nerve-plexus of the skin, rd^1 rhabdites-layer below the sensory margin (*sm*).

Fig. 7.—Cross-section through the ciliated organs. × 40. *co* ciliated organs, *g* gut, *pm* longitudinal parenchymatous muscles, *mg* marginal glands and glandular margin, *n* nerve-cords, *s* sole in section.

Fig. 8.—Portion of the ventral side of the head, taken from a median saggittal section of the head. × 400. *mg* marginal glands and glandular margin, mg^1 secondary marginal glands, *npl* nerve-plexus, *rd* and rd^1 outer and inner rhabdites-layers, *sm* sensory margin.

Fig. 9.—Portion of the head-apex with the apical sense-organ, taken from a median saggittal section of the head-end. × 230. *ao* apical organ, *mg* marginal glands, *npl* nerve-plexus.

Fig. 10.—Ciliated organ in a cross-section. × 400. *dm* dermal longitudinal muscles, *rm* rhammite, *s* sole-epithelium.

SOME NOTES ON THE CEYLON PEARL-INDUCING WORM.*

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THE present series of barren years on the Ceylon Pearl Banks has provided opportunities for extensive scientific research, which under other conditions would have been impossible. It is, however, extremely unfortunate that during these blank years the few oysters essential for scientific work have been almost unavailable. The only bed which now exists is confined to an inshore area, and the oysters found thereon only rarely contain the pearl-inducing parasite. Consequently the investigations on this interesting worm have been severely hampered by lack of material, and the research work has had to be directed into other channels, such as the investigation of the part played by currents with relation to exotic spat, the examination of rays and sharks for Cestode parasites, &c. Whereas normal oysters often each contain from 30 to 100 pearl-inducing parasites, the scattered oysters now remaining rarely contain a single one, and 200 to 300 oysters may commonly be examined without finding a single larva. This condition is doubtless due to the inshore position of the oysters.

Most people are familiar with the old ideas as to the nature of pearls, viz., that they were the tears of Nereids, or mysteriously consolidated drops of dew, or caused by lightning flashes. These poetic beliefs were subsequently superseded by others, which attributed the origin of pearls to grains of sand, abortive eggs, calculi, and the like.

It was only in 1859 that the naturalist Kelaart, working on the spot, made the discovery that the formation of pearls was intimately connected with the occurrence in the oyster of "worms," and all subsequent work by other naturalists has only further proved and elucidated Kelaart's statements and observations. In 1894 Thurston confirmed Kelaart's results, and further identified the worm as the larva of some Platyhelminthian (flat worm). The extensive investigations made by Professor Herdman in 1902 further showed that the worm was a Cestode (Tape-worm), round the larvæ of which pearls are formed.

* From the Ceylon Marine Biological Laboratory (Ceylon Company of Pearl Fishers, Limited).

A pearl is therefore the sarcophagus of a parasite, whose nearest relations include human and other animal tape-worms, all varieties of human hydatids (or Echinococcus), as well as those parasites which cause the "stagger disease" in sheep and goats, &c.

The normal and typical life-history of Cestodes in general is too well known to require full repetition here. The adult worms occur exclusively in vertebrates (with the exception of *Archigetes*, which may become adult in the cœlom of *Tubifex*), where they inhabit the internal organs. The larva or cysticercus may occur either in an invertebrate or in a vertebrate. The transference of the larvæ to the final host takes place quietly, during a meal. Thus, the larvæ of *Tænia solium* occur in the tissues of the pig. If present, and if the flesh of this animal is eaten by man in an improperly cooked condition, the larvæ become adult tape-worms in the human intestine. From these adults, eggs are passed out in the fæces, and the omnivorous habits of the pig lead to the re-infection of this animal, and thus the cycle goes on. Homologous stages of *Tænia serrata* occur between dogs and mice, and many other instances might be cited.

The life-history, however, is not always of this type. In *Hymenolepis murina* both stages occur in the rat without the intervention of a second host, the larvæ inhabiting the villi and the adult worm the intestinal cavity of the same animal. Such a life-history is said to occur in *Hymenolepis nana* found in man.

The larvæ of *Bothriocephalus latus* probably first enter some invertebrate host, and are then eaten by a pike or trout. If the infected fish are eaten by man, the parasites develop in the intestine into adult worms, which often attain a length of 30 feet. There are thus three hosts. With reference to this particular tape-worm, it is interesting to note that the primary larvæ are the only larvæ in the group Cestoda known to be ciliated.

Further complications in the life-history of Cestodes are also known. Thus, *Tænia solium* is found adult in man. "The danger of its presence in the body of man, or in the flesh of the pig, lies in the fact that the larva or bladder worm (known as *Cysticercus cellulosæ*) can live in the most varied organs. Thus, if by accident a mature proglottis be eaten, the embryos bore their way into the wall of the stomach, and entering the portal vein may reach in time the muscles, the brain, the eye, or even the heart itself, and attain the cystic condition. Even more disastrous may be the result should some ripe joints of a mature worm work their way from the intestine back to the stomach. Should this happen (and though it has not been directly proved, the possibility is to be reckoned with) the result would be the release of vast numbers of embryos capable of inflicting fatal injury on the host. An abnormal Cysticercus of this species is probably *Tænia* (*Cysticercus*) *acanthotrias*, Weinl.*

* Gamble: "The Cambridge Natural History." Worms, Rotifers, and Polyzoa, p. 79.

The hydatids thus produced represent culs-de-sac in the life-history of the parasite. It is to be noted that whilst the life-history of a Cestode is usually—almost always—completed in two hosts, the parasites may vary their hosts and occur adult in many genera. Instances of this kind are too numerous to mention here. The cysticercoid stages are in many instances equally adaptable with reference to their hosts, but it is to be noted that should the cysticercoid enter a primary host which is not eaten, or does not form the food of the second host, the life-history is never completed, and the larvæ eventually die.

The preceding details have been given in order to elucidate more fully the life-history of the pearl-inducing parasite, and to facilitate the understanding of what are obviously abnormal conditions and situations which occasionally befall the larvæ found in the pearl oyster.

Professor Herdman found that the globular cysts which normally occur in the tissues of the oyster were the larvæ of a Cestode, which was named *Tetrarhynchus unionifactor*, Shipley and Hornell. When the infected oysters were eaten by the ray, *Rhinoptera javanica*, the worm became adult in the latter fish. A further stage also occurred in the oyster in the form of an encysted but young Tetrarhynchid occurring on the intestinal wall, but no stage was found strictly intermediate in development between the widely different globular cyst in the oyster and the encysted but young Tetrarhynchid occurring on the wall of the oyster's gut.

Free-swimming Cestode larvæ were found in the tow-net taken on the banks, but, as Herdman says, "it is still uncertain whether the free-swimming larvæ found on the Muttuvaratu Paar really belong to the life-history."*

In addition to the two stages found in the oyster, and the adult found originally in *Rhinoptera javanica*, and later in *Tæniura melanospilos* (large rays), other megacestoid stages were found in *Balistes* (a small file-fish). Since these file-fish were known to feed on oysters, it was pointed out that, although the life-history was probably direct from oyster to Rhinoptera, it might be found that *Balistes* formed an intermediate host. "A more minute examination, however, renders the connection between the parasites of the pearl oyster and those of the file-fish a doubtful one,"† and, again, "the more advanced larvæ from the pearl oyster have arrived at a later stage in development than the larvæ found in *Balistes*." ‡

The life-history of this interesting parasite was worked out thus far as a result of Professor Herdman's investigation. Since that time the life-history has been further studied as time and material

* "Ceylon Reports," Vol. V.
† Shipley and Hornell. Vol. II., Herdman's "Ceylon Reports."
‡ *Loc. cit.*

allowed, and the following notes indicate some of the results obtained.

(1) *The Free-swimming Stage.*

Although the plankton, both superficial and deep, has been collected and examined three times daily for two seasons, no Cestode larvæ have ever been found. This negative result falls in line with results obtained elsewhere. In any case it would be obviously impossible to identify an adult specimen from a free-swimming larva, even should such larvæ exist. So far as is known, only the larvæ of *Bothriocephalus latus* are ciliated and free-swimming, although it is possible that some larvæ may be free-swimming without being ciliated.

Little indeed is known regarding the earliest stages of many genera of Cestodes.

Whilst examining the ripe proglottides from a specimen of *Tetrarhynchus rubromaculatus* (?) obtained from the spiral valve of *Trygon kuhli* (which feeds exclusively on Polychætes and small bivalves), I noted that the segmenting eggs, issuing in immense numbers from a rupture in a proglottis, were ciliated, a phenomenon I have not seen noted elsewhere.

Up to the present nothing is known as to how the larvæ of *Tetrarhynchus unionifactor* enter the oyster, and the same may be said of most marine species of Cestode larvæ. We do not know whether the larva is free-swimming, or whether it bores its way into the primary host, or whether it is ingested along with the food. In pearl fishing this question is of little importance, but the exact condition of affairs would be interesting as rounding off our knowledge of this interesting parasite.

(2) *The Globular Cyst in the Oyster.*

Figures of these cysts are given in Vols. II. and V., "Ceylon Reports," and they represent the earliest stages known of *Tetrarhynchus unionifactor*. They are considered to be post-hexacanth stages. They vary in size. Some are as large as a pin's head, whilst others are quite microscopic. There are all sizes intermediate between them, but they are all exactly similar in structure and development, and their only point of difference is purely that of size. It has been shown that these larvæ multiply endogenously, that is to say, daughter cysts may arise within the parent cyst, and become liberated by a temporary rupture of the parental wall. Although the initial infection of the oyster is but slight, it may become extensive merely by endogenous reproduction of this kind, quite apart from a further infection from outside sources. This endogenous multiplication also accounts for the very varying sizes of larvæ found in the oyster.*

* Southwell: "Ceylon Marine Biological Reports," Part IV., 1910.

These cysts are widely distributed in the tissues of the oyster, and occur particularly in the liver, in the mantle, and along the base of the gills. As many as 120 have been counted in a single oyster, although the number varies very considerably.

The globular cysts which occur in *Placuna placenta* (the window-pane oyster found in the backwaters of Trincomalee) are exactly similar to those found in the pearl oyster. In the cystic stages found in *Placuna*, Willey* also observed endogenous reproduction. In the examples quoted and figured by him the reproduction was polygenetic, as several cysts were liberated at a time from the parent cyst. In the globular cysts found in the pearl oyster the endogenous reproduction has only as yet been observed to be monogenetic (one cyst being born at a time from each parent cyst), but there can be little doubt that, when more oyster material is available, this endogenous reproduction will be found to be polygenetic, as in the larvæ inhabiting *Placuna*. A similar multiplication has also been noted in *Polycercus*—bladder stage of *Tœnia nilotica* from *Cursorius europœus*.†

It is round the cystic stages which occur in the pearl oyster that the orient or cyst pearls are formed. Other pearls are also found in the oyster, but they have no organic nucleus. Such pearls are termed muscle or seed pearls. Their origin is obscure, but they are always found near the muscle insertions, and are believed to be formed round a calcospherule of excretory origin, or by the sheer of muscles moving in different planes.

The percentage of globular cysts in the oyster which ever become the nucleus of a pearl is very insignificant indeed. Occasionally several hundred oysters can be examined each containing 20 or 30 cysts, and not a single pearl is to be found. This fact lends colour and probability to the belief that only such cysts which, for some unaccountable reason, die in the tissues of the oyster become nuclei of pearls.

Figures of sections of decalcified pearls showing a nucleus exactly similar to the larva found in the tissues of the oyster are given by Herdman in Vol. V., "Ceylon Reports" (Pearl Production, Plate II.), and there can be no doubt that this larva is the prime factor in pearl production, although very rarely grains of sand have been found in the centre of pearls.

It has already been observed that no stage in the life-history of the pearl-inducing worm has as yet been obtained earlier than the globular cyst occurring in the oyster. This globular cyst is in many ways different from stages known to occur in the life-history of other Cestodes, such as *Bothriocephalus latus* or *Tœnia nilotica*.

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* "Report on the Window-pane Oyster of the Eastern Province," June, 1907. *Spolia Zeylanica*, Vol. V., Part XVII.

† Haswell and Hill: "On Polycercus, a proliferating Cystic Parasite of the Earthworms" (Proc. Lin. Soc. N. S. Wales (2), Vol. VIII., 1894.

This fact was emphasized by Shipley and Hornell, who remarked: "Under slight pressure, as first seen it (the pearl-inducing larva) exhibited a striking resemblance to a tiny Trematode, or it might be mistaken for a large Gregarine." * The figure nearest approaching that of the larva found in the pearl oyster is that of the onchosphere of *Tænia cucumerina* given by Gamble in Vol. II., "Cambridge Natural History" (after Grassi and Rovelli).† There can be no doubt, however, that the larva is a Cestode. The possession of calcareous corpuscles, of spines on the collar, and of the protrusible proscolex-like head are all essentially Cestode characters, and doubt only arose on account of the isolated and more or less unconnected state of development of the globular cyst.

(3) *Encysted Tetrarhynchids on the Wall of the Gut in the Pearl Oyster.*

These are by no means rare, and are in almost every case confined to a particular part of the wall of the gut, about one inch from the anus and on the terminal part of the gut. They often occur in clusters of three or four. They are small (about 1 mm.), but appear to be adult in every way, save that strobilization has not commenced. This encysted young Tetrarhynchid is quite dissimilar to the globular cysts found in the same oyster. In the latter case the larvæ are so young that the Cestodian characters are but ill-defined. In the former case a normal and full-grown Tetrarhynchid head is present. No stage or stages have been found intermediate between them, and the evidence that they are both stages in the life-history of the same parasite rests on circumstantial evidence and on evidence obtained by feeding experiments. We shall, however, refer to this matter again later.

(4) *The Adult Pearl-inducing Worm, "Tetrarhynchus unionifactor."*

The adult stage of the pearl-inducing worm was obtained by Hornell from the stomach of *Rhinoptera javanica*—a gregarious ray—and also later from the intestine of *Tæniura melanospilos*. In spite of the fact that hundreds of fish, including at least fifty large rays of various genera and species, and also a large number of Carchariidæ, have been repeatedly and carefully examined during the last five years, the adult has never since been found, except in *Ginglymostoma concolor*, during the feeding experiments of 1909 and 1910, described in Parts IV. and V., "Ceylon Marine Biological Reports." This is a most remarkable fact, especially as the research, having been repeatedly fruitless, was carried on with increasing energy.

* Shipley and Hornell. Herdman's "Ceylon Reports," Vol. II., p. 20.

† And Herdman notes the resemblance in many ways to the larva of Acrobothrium figured by Giard and to the "figures idéales" of early stages of Tetrarhynchids given by van Beneden.

Trawling has been almost continuous during every season. The fish caught have all been carefully examined, and although not less than 8,000 Cestodes, distributed over 24 genera and 77 species, have been collected, the adult *Tetrarhynchus unionifactor* has never been obtained.

It would almost appear that this fact in itself is sufficient proof that the adult of the pearl-inducing worm is not *Tetrarhynchus unionifactor*. We have noted that (1) no larvæ have been found in an earlier stage of development than the globular cysts found in the oyster, (2) that although encysted Tetrarhynchids occur in the oyster, no stage intermediate between the globular cyst and the young Tetrarhynchid has been found to *prove* that both these stages in the development belong to the same worm. Finally, we have seen that the adult has never been found in any of the Plagiostomi trawled on the banks during the last five years.

The evidence afforded by the feeding experiments, described in Part IV., "Ceylon Marine Biological Reports," is important. An area was isolated in the open sea by means of expanded metal having a 4-inch mesh. Into this area large specimens of the following fish were placed : *Trygon walga*, *Tæniura melanospilos*, *Ginglymostoma concolor*, *Rhynchobatus djeddensis*, *Serranus undulosus* (4 feet), *Tetrodon stellatus*.

These fish were first medicated with male fern extract and castor oil, and then fed exclusively on oysters for several weeks.

The results were roughly as follows :—

Tetrodon stellatus and Serranus undulosus lived in a healthy state, but no adult Cestodes were found in them.

Rhynchobatus djeddensis.—These specimens all died within three days. They are dwellers on mud, and I attribute their death to the fact that they do not feed on oysters. No Cestodes found.

Ginglymostoma concolor.—Adductor muscle of oyster found in stomach. Thirty-eight specimens of *Tetrarhynchus unionifactor* in spiral valve (other Cestodes also found), and fifty-one *Tetrarhynchus unionifactor* in another specimen.

Tæniura melanospilos.—*Tetrarhynchus herdmani* only in spiral valve.

These results are described fully elsewhere,* and the point that immediately concerns us is the fact that *Tetrarhynchus unionifactor* was obtained in numbers on two separate occasions.

Since the adult worm was never obtained by me on any other occasion, even though numbers of the same species of fish were examined, it seems almost certain that these specimens were developed from the larvæ in the oysters eaten, and there are many points which favour this view. The mere fact that the adults were obtained by feeding is in itself almost sufficient to prove that they

* "Ceylon Marine Biological Reports," Parts IV. and V.

are the adult of the pearl-inducing worm, for it is difficult to believe that their occurrence in the *Ginglymostoma* was a mere coincidence each year.

The line sketch given of this worm in Vol. V., " Ceylon Reports," gives no details of the adult structure, which is somewhat unfortunate. A figure is, however, given in Part V., " Reports from the Ceylon Marine Biological Laboratory."

The absence of the adult worm in the fish caught during the last five years is doubtless incident on the fact that oysters have practically been absent from the banks over this period.

My own observations point to the fact that the fish found on the banks have steadily decreased in number during the last few years. It seems probable that the fish have migrated to other feeding grounds, particularly those species which feed on molluscs. Whereas the molluscan fauna of the banks is usually abundant, I have not found more than six specimens during the last two years, even though diving, trawling, and dredging has been carried on almost daily. This fact serves to show that other molluscs suffer equally with the oyster, and it seems natural to explain the absence of predatory fish as due to the lack of food over the plateau.

We have seen that the adult pearl-inducing worm has up to the present been found in three species of fish, viz., *Rhinoptera javanica*, Hornell; *Tæniura melanospilos*, Hornell; and *Ginglymostoma concolor*, Southwell.

There seems to be no reason for associating the adult worm exclusively with *Rhinoptera javanica.* In fact, it is somewhat surprising to find that the adult worm has been found in this species, since the fish has only as yet been caught on the muddy basins of Dutch Bay, Portugal Bay, and near the Mannar channel. It seems likely that the adult worm occurs in all Plagiostomes which eat oysters, and I should not be surprised to find that subsequent research proved this to be the case.

It is now well known that very many species of Cestodes occurring in marine fishes in Ceylon have several hosts, and there is every reason for believing that the same is true of *Tetrarhynchus unionifactor.*

Some species of fish, such as *Rhynchobatus djeddensis*, possess tremendously powerful jaws with undulating, continuous, plate-like rows of teeth. It seems natural to suppose that fish possessing a powerful apparatus of this kind should feed on oysters and other molluscs. I have, however, had numerous proofs that they do not. Of ten specimens of *Rhynchobatus djeddensis* placed in the nursery for feeding experiments, not one survived the third day. Their normal habitat is on muddy and weedy basin in two to four fathoms, where they feed almost exclusively on crabs. They will die of starvation with oysters under their nose, and it may be taken as a general rule that fish normally living on a muddy basin of this kind do not eat oysters. Examples include *Rhynchobatus djeddensis*, *Myliobatis nieuhofii*, *Pteroplatea micrura*, *Pristis cuspidatus*, and possibly *Rhinoptera javanica*, all of which most probably have their own particular article of food.

(5) *Encysted Tetrarhynchids in Teleosts.*

There are many Teleosts which feed on oysters. Amongst them may be mentioned—

(1) All members of the genus *Tetrodon*.
(2) *Balistes mitis*, *Balistes undulatus*, and *Balistes stellatus*.
(3) *Lutjanus argentimaculatus*, and possibly other members of this genus.
(4) *Serranus undulosus*, and possibly other members of this genus.

The above list is not intended to be a complete one, but oysters have been found in the stomachs of all the species named. Tetrarhynchid cysts only are in almost every case (and particularly in *Balistes*, *Lutjanus*, and *Serranus*) found in numbers in the intestines. Cysts have not been found in any species of the genus *Tetrodon*. These combined facts led to the original idea that *Balistes* might be an intermediate host of the pearl-inducing worm, although later Shipley and Hornell pointed out the difference between the Tetrarhynchids found encysted in the oyster and those encysted in the intestines of *Balistes*. Several species of Tetrarhynchids occur encysted in the intestines of the Teleosts previously named, and they are undoubtedly derived from the cysticercoids present in the different molluscs eaten.

Encysted forms of *Tetrarhynchus unionifactor* also occur, particularly in *Balistes* and *Serranus*. Recent work has shown that the encysted form of *Tetrarhynchus unionifactor* which occurs in *Serranus* and *Balistes* is exactly similar to that encysted in the oyster. Shipley and Hornell appear to have been wrong in stating that "The more advanced larvæ from the pearl oyster have arrived at a later stage in development than the larvæ found in *Balistes*."* It is certain that my encysted *Tetrarhynchus unionifactor* from *Balistes* is not the same species as those described by these authors from *Balistes*. However, the fact remains that encysted Tetrarhynchids have been obtained from *Balistes* and *Serranus* which are exactly similar to the encysted Tetrarhynchid found in the oyster. The spines and general appearance are exactly similar, and the only difference noted was that those found encysted in Teleosts were very slightly larger than those obtained from the oyster.

* "Ceylon Reports," Vol. II., p. 78.

It is to be noted here that we have been referring above to the *encysted Tetrarhynchid*, and not to the globular cyst found in the oyster.

What is the significance of the stage of *Tetrarhynchus unionifactor* found in these Teleosts?

There can be no shadow of doubt that they are derived from the oyster. But in no case are the cysts further developed than those normally found in the oyster. These fish are not intermediate hosts, but carriers, and they illustrate the fact that the larvæ of *Tetrarhynchus unionifactor* can live in various hosts and in various organs, just as we have seen to be the case in the cysticercus of *Tænia solium* and other Cestodes. If oysters are eaten by *Balistes* (or *Serranus* and *Lutjanus*), two things happen to the cysts in the oyster:—

(i.) The encysted Tetrarhynchids in the oyster are transferred to the *Balistes*, where they encyst in the mesenteries, without developing any further.

(ii.) The globular cysts in the oyster are dissolved, and the larva is liberated; it migrates, develops into a young Tetrarhynchid—the same stage is in (i.)—and encysts on the mesenteries.

It might be argued from the preceding, that since the globular cysts develop into young Tetrarhynchids in *Balistes*, that therefore *Balistes* is a secondary host.

We would point out, however, that the globular cysts often develop into young Tetrarhynchids in the oyster itself, and further, that if oysters are eaten by certain Elasmobranch fish, both the globular cyst and the young Tetrarhynchid become adult directly in the Elasmobranch. Similarly, it is almost certain that should *Balistes* be eaten by a suitable Elasmobranch, the young Tetrarhynchid would become adult. The stages occurring in *Balistes* and in the oyster are the same. *Balistes* is not an intermediate host, but merely a carrier. In this way it may be useful in the life-history of the parasite, without being in the least necessary. If the species or specimen of *Balistes* is small, the encysted larva has a favourable chance of completing its life-cycle.

In the case of *Serranus undulosus*, which likewise contains encysted and young Tetrarhynchids of many species, and including *Tetrarhynchus unionifactor* (but more rarely than in *Balistes*), specimens often measure 4½ feet in length and 10 to 12 inches in diameter. It is difficult in these cases to postulate a Plagiostomous host large enough to eat a fish of these dimensions. In these cases we can but logically assume that the life-cycle of the various Tetrarhynchids contained in these large Teleosts are never completed. They are culs-de-sac in the life-history of the parasite, a circumstance simulating the occurrence of hydatids in man, where the larvæ giving rise to the disease have, owing to their adaptability within various hosts, lost themselves in the maze of their own liberties, and where the life-history is, of course, never completed.

It is a significant fact that in Ceylon no adult Cestodes have ever been found in any Teleosts, even though larvæ are numerously distributed within the order. This fact is most peculiar, but so far as I know it is a usual and well-known phenomenon, except amongst the family of Cestodes named Bothriocephalidæ, adult forms of which occur in the salmon and in *Gadus*.

Possibly adult forms of Cestodes may be found later in Ceylon Teleosts, but up to the present a most careful scrutiny has been fruitless.

Conclusion.—It will be obvious from the preceding that there still remains much to be done before all the stages in the life-history of the pearl-inducing worm are fully known. Work on the elucidation of this problem has been seriously hampered during the last few years by the lack of material.

There can be little doubt, I think, that the life-history of this parasite is direct from the oyster to such fish of the group Plagiastomi as feed on them, and that the stage found in various Teleosts is accidental, not necessary, and may be useful or otherwise. It would be interesting (1) to discover undoubted larvæ prior to their entering the oyster; (2) to ascertain the exact way in which they enter the oyster; (3) to ascertain why certain cysts produce pearls and the vast majority do not; (4) to find stages between the globular cyst and the young Tetrarhynchid. These details are necessary to round off our knowledge of this worm.

Although these questions remain unsolved, infection of the oyster continues, and is never found faulty, except in such reef forms as occur in very shallow water where one supposes that the necessary fish seldom approach.

THE SPECIES OF CEYLON PEDIPALPI.

By F. H. Gravely, M.Sc.,

Assistant Superintendent in the Indian Museum, Calcutta.

(With one Text Figure.)

IN a recent paper on the Pedipalpi of Ceylon (1910) I published some notes on the habits of these curious creatures. Since this was written I have been able to inquire into their specific characters more fully than was then possible, and have in consequence to correct my identifications of some of the Tartarides. And further specimens of the long-armed form of the small jungle species of *Phrynichus* have now been obtained, which place beyond doubt its claim to rank as at least a definite variety. The object of the present paper is to supply correct identifications of the Tartarides, referred to in my previous one, which will involve the description of two new species, and to describe more completely this long-armed variety of *Phrynichus pusillus*.

TARTARIDES.

Mr. Pocock, when writing the Arachnid volume of the " Fauna of British India and Ceylon," was able to fit all the species there referred to into two genera, *Schizomus*, Cook, and *Trithyreus*, Kraep., following the classification adopted by Kraepelin in a volume of " Das Tierreich." He distinguished the genera by the width of the division of the posterior plate of the carapace, a character which I found to be greatly affected by the method of preservation adopted.

In 1905, several years after Pocock's volume in the " Fauna " series was published, Hansen and Sörensen succeeded in getting together for study a very representative collection of Tartarides of both sexes from various localities in both hemispheres ; and together they published a monograph, in which the classification and specific characters of the tribe were dealt with by Dr. Hansen in a way that had never been possible before. In this paper the number of species is extensively added to, but no additional genera are recognized. Indeed, the distinction between the old genera *Schizomus* and *Trithyreus* is regarded as of only sub-generic value. These sub-genera, moreover, are re-defined, so that the distinction between them comes to be not the actual width of the median suture of the posterior thoracic plate, but, whether (in *Schizomus*) or not (in *Trithyreus*) the reticulate markings of these plates are continued across it.

Hansen records from Ceylon only the two species of Tartarides referred to in the "Fauna" volume as having been found there: *Schizomus* (*s. str.*) *crassicaudatus*, Cambr., from Peradeniya, where they were found "under dead leaves and rubbish by M. Ferdinandus in the Royal Botanic Gardens," and *Schizomus* (*Trithyreus*) *suboculatus*, Poc., from Pundalu-oya and Maturata.* With regard to the latter species, he states that the type (and only) specimen described by Pocock was immature—when full grown it is rather

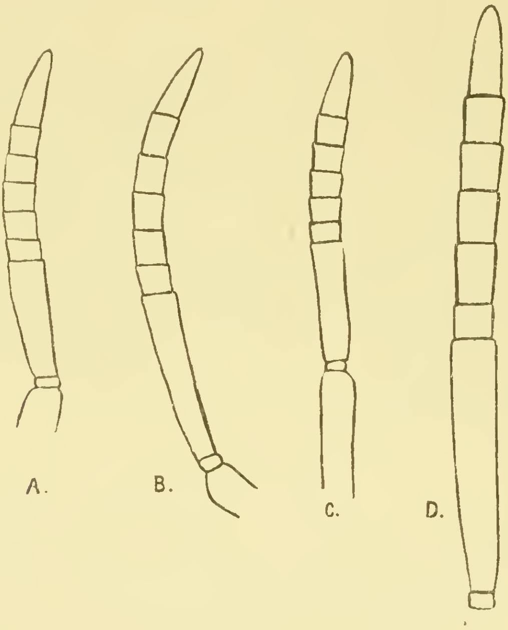

FIG. 2.

Foot of first leg of female of each species of Tartarides known from Ceylon. × 60.

A. *Schizomus* (*s. str.*) *crassicaudatus*, Cambr. (camera-lucida drawing).

B. *Schizomus* (*Trithyreus*) *peradeniyensis*, n. sp. (camera-lucida drawing).

C. *Schizomus* (*Trithyreus*) *vittatus*, n. sp. (camera-lucida drawing).

D. *Schizomus* (*Trithyreus*) *suboculatus*, Poc. (after Hansen).

a large form; and he re-describes both species very fully. A comparison of my specimens with these careful descriptions shows that only the specimens found under bricks, &c., belong to the species *Schizomus* (*s. str.*) *crassicaudatus*. This is in apparent

* The original label of the Maturata specimens bears the inscription "Maturata. Galles" according to Hansen. This, however, is unintelligible as it stands, and I am indebted to Mr. Green for a suggestion that "Galles" refers to the Sinhalese word "gala" (= a rock), and that what is probably meant is "Maturata hills."

contradiction to the type of habitat recorded for the specimens found by M. Ferdinandus, from which the species was originally described; but although the majority of my specimens were found under bricks, a few came from under stones, &c., among the sticks and dead leaves between the roots of the huge rubber trees near the Curator's office in the Gardens, and from small piles of stones mixed with rubbish, but always on or bordering upon open ground; presumably, therefore, the rubbish from which M. Ferdinandus's specimens came had accumulated in some open situation.

The similar but larger form, the female of which was found so abundantly in the shrubberies of the Gardens, and which in my previous paper was confounded with *Schizomus crassicaudatus*, proves to be distinct, and to belong to the sub-genus *Trithyreus*, as defined by Hansen; it is a new species allied to *S.* (*T.*) *suboculatus*, Poc. The small green form also belongs to this sub-genus, and is also new. It is not, however, very closely allied to *S.* (*T.*) *suboculatus*, Poc., with which I identified it before seeing Hansen's elaborate description of mature specimens. These two new species may be described as follows:—

Genus **Schizomus,** Cook (Sub-genus **Trithyreus,** Kraep.).

Schizomus (*Trithyreus*) *peradeniyensis*, n. sp.

S. crassicaudatus (part), Gravely, 1910.

♂ Unknown.

♀ Resembles the female of *S.* (*T.*) *suboculatus*, Poc., in all points described by Hansen, except the following: Eye-spots wanting.* In the first (antenniform) legs the femur is slightly longer than the tibia, and the foot is barely two-thirds as long as the tibia and about fourteen times as long as deep; the second metatarsal joint is only two-thirds as long as the tarsus, being slightly shorter than the sum of the five proximal tarsal joints; the second tarsal joint is not unusually long, being scarcely as long as the third; the terminal tarsal joint is somewhat longer than the sum of the two proximal tarsal joints, and about two-fifths as long as the metatarsus. In life the dorsal colour is greenish-gray or brownish (never dark olive-green), varying considerably in different specimens, and passing into a somewhat reddish tint at the anterior end of the carapace and towards the extremities of the legs, the whole of the cheliceræ being reddish-brown; ventrally the colour is paler and more

* When specimens are seen from above, a pair of ill-defined whitish patches will almost invariably be noticed in the position occupied by eye-spots in forms which bear them; but a careful examination of well-illuminated specimens in different positions under a Zeiss binocular microscope leads me to believe that these patches are in all cases due to the reflexion of light from the polished sides of the head immediately above the bases of the cheliceræ, the chelicerae being partially visible through the carapace.

distinctly reddish at the anterior end. In spirit the ground colour is brown.

Length.—Up to five and a half millimetres.

Schizomus (*Trithyreus*) *vittatus*, n. sp.

S. suboculatus, Gravely, 1910.

♂ Unknown.

♀ *Cephalothorax.*—Eye-spots present, whitish, in marked contrast to the surrounding green colour. Cephalic sternum longer than broad.

Arms.—Moderately slender, slightly less than half as long as the body. Trochanter with its lower front angle (about 90°) inconspicuous and much rounded, anterior margin convex. Lower angle of femur not very sharp, very slightly further from the basal than from the distal end of the upper margin of the joint. Patella almost three times as long as deep. Claw a little less than half as long as the upper margin of the tarsus.

First legs.—Rather slender, about equal to the body in length. Coxa terminating a little behind the anterior border of the gnathobase of the chelicera. Femur a little longer than tibia. Foot not quite as long as tibia (about seven-eighths of its length), scarcely nine times as long as deep, deepest at the end of the metatarsus; second metatarsus scarcely as long as the sum of the five proximal joints of the tarsus; terminal tarsal joint not quite as long as the sum of the three proximal joints, and slightly more than half the length of the whole metatarsus.

Fourth legs.—About as long as body; femur rather more than half as long as deep.

Tail.—Short and stout, scarcely four times as long as deep, somewhat swollen in the middle; three jointed, the third joint slightly longer than the sum of the other two.

Colour.—Dorsal sclerites dark olive-green, in striking contrast with the pale integuments which connect them together, and which appear on the abdomen as whitish or somewhat orange-coloured, intersegmental bands nearly one-fourth as broad as the dark green tergites, the posterior ones being somewhat narrower than the anterior. Abdomen with a large ventral dull ochraceus patch bordered with green at the sides and behind. Cephalothoracic sterna whitish; coxæ pale olive-green below, whitish above; trochanters and all connecting membranes of the appendages also whitish; the whole of the cheliceræ, the terminal joint of the arms, and all four feet reddish; a crimson spot on the anterior surface of each leg on the connecting membrane between the femur and patella, these spots being most conspicuous on the last pair of legs. Eye-spots whitish, one on each side of the rostrum. Colour scarcely affected by spirit.

Length.—Up to three and a half millimetres.

This species is very closely allied to *S.* (*T.*) *modestus*, Hansen, from New Guinea and New Britain. It differs chiefly in having the anterior angle of the trochanter of the arms rounded and the anterior margin convex ; in having the foot of the antenniform legs proportionally shorter and stouter ; and in the greater stoutness of the tail, which is, moreover, always somewhat swollen at about the middle of its length.

The colour of *S.* (*T.*) *vittatus* is very constant even in young specimens, and quite distinct from that of *S.* (*T.*) *modestus*, resembling rather that of another allied species, *S.* (*T.*) *procerus*, Hansen, from Singapore. The sharply defined white and green segmental bands of the abdomen are always present, and are distinctly visible to the naked eye.

Sections show that the specimens here described include without doubt many mature females.

The chief interest of these two new species lies in the abundance in which they were obtained. Hansen had but a few specimens of each of the species he described, and can have had little direct evidence as to which points were likely to be constant and which were not. He found the proportions of different parts of the antenniform legs to be among the most useful characters by which to distinguish the species, especially in the female sex ; and the value of this selection is confirmed by the fact that in each of the long series of *Schizomus* (*s. str.*) *crassicaudatus*, *S.* (*Trithyreus*) *peradeniyensis*, and *S.* (*T.*) *vittatus* which I have examined these characters remain perfectly constant. Only in one instance have I noticed any abnormality, and as this occurred on one side of the specimen only, and affected the *number* of joints in the foot, it was presumably a malformation caused by some accident to the appendage in question.

The form of the lower anterior portion of the trochanter of the arm is another useful character ; but this is less fixed, and should not be relied upon unless a good series of specimens are available. Thus, Hansen states that in *Schizomus* (*s. str.*) *crassicaudatus* "the best distinguishing mark between this species and all other forms hitherto known is the presence of a process from the lower front angle of the trochanter of the palps"; this process, as they point out, is smaller in the female than in the male, and in the former I find it to be extremely variable in size, often minute, and sometimes entirely absent. The distinctive proportions of the parts of the foot of the antenniform legs being constant are of much greater systematic value, and it may not be out of place here to reiterate Hansen's emphatic statement that "measurement by the eye of such parts *is quite insufficient*"; the use of an eye-piece micrometer is absolutely necessary.

TARANTULIDÆ.

(= **Phrynichidæ.**)

Genus **Phrynichus,** Karsch.

P. pusillus, var. *gracillibrachiatus*, n.

♂ Resembles *P. pusillus* (*s. str.*) in all points, except the greater length and slenderness of the arms. In full-grown specimens the femur of these appendages varies from 19·5 to 29·5 mm. in length in the variety, and from 9·0 to 13·5 in the typical form, the "mode" in both cases being intermediate between the two extreme measurements.

♀ Body distinctly larger than in the male, arms proportionately somewhat shorter and stouter. Second abdominal sternum as in *P. pusillus* (*s. str.*), *i.e.*, with the pair of semi-lunar lobes small or absent.

As intimated in my previous paper, this appears to be chiefly a low-country form, but I am very anxious to obtain if possible further information as to its distribution in the Island before committing myself to any more precise statement than this.

LIST OF PAPERS REFERRED TO.

1899. *Kraepelin, K.*, "Scorpiones und Pedipalpi" in "Das Tierreich."

1900. *Pocock, R. I.*, "Arachnida" in "The Fauna of British India, including Ceylon and Burma."

1905. *Hansen, H. J., and Sörensen, W.*, "The Tartarides, a Tribe of the Order Pedipalpi." Arkiv för Zool., vol. II., No. 8.

1910. *Gravely, F. H.*, "Pedipalpi of Ceylon." "Spolia Zeylanica," vol. VII., pp. 43–47.

NEW HYMENOPTERA FROM CEYLON.

Mutillidæ and Scoliidæ.

By Rowland E. Turner, F.Z.S., F.E.S.

THE species described in this paper are mostly from the collection of Mr. O. S. Wickwar, who is generously depositing the types in the British Museum. Most of the Mutillidæ were collected by Mr. T. Bainbrigge Fletcher at Hambantota; from him the Museum has also received long series of some species. Most of the larger species are identical with those collected by Yerbury at Trincomalee and described by Cameron, but few of the smaller species are identical with those from Trincomalee. Most characteristic of the Ceylon Mutillidæ is the abundance of species in which the posterior margin of the thorax in the female is furnished with a row of rather long teeth; this group, though not confined to Ceylon, seems to be much richer in species there than elsewhere. The range of many of the species is probably extremely limited; for climatic conditions at Trincomalee and Hambantota are very similar, and the difference of the species in the two localities is not likely to be entirely due to insufficient collecting. The means of locomotion in the female are so limited that local forms are much more likely to be developed than in other families. In the genus *Tiphia* I have observed that the part most affected in local races is the median segment; and in the female Mutillidæ the shape of the thorax seems especially subject to local influence, the median segment in the female sex being combined with the thorax.

Mr. Wickwar has pointed out to me that the colour of the head and thorax, used as the main points of recognition in Bingham's Key, is not a reliable character; in this I fully agree with him and with other authorities.

Family *MUTILLIDÆ.*

Genus **Spilomutilla,** Ashm.

Spilomutilla eltola (Cam.).

Mutilla eltola, Cam. Mem. Manchester Lit. and Phil. Soc., XLII., p. 3, 1898. ♀.

Spilomutilla eltola, André. Deutsch. Ent. Zeitschr., p. 251 1907. ♂ ♀.

The male closely resembles *S. ocdipus*, Cam., but has no central spine on the posterior margin of the median segment. The ocelli are present though small, and are not absent as stated by M. André. The genus *Spilomutilla* is not rich in species, and seems to be confined to Southern Asia. While agreeing with Bingham that *M. ocdipus*, Cam., may well be regarded as the male of *M. rothneyi*, Cam., I consider that his suggestion that the wings have been accidentally lost is quite wild, as Cameron has pointed out. The name *ocdipus* has priority over *rothneyi*, and should be used for the species. *Mutilla cotesii*, Cam., which I have not seen, appears to belong to *Spilomutilla*, but there is no mention in the description of spines on the sides of the thorax. I consider that *consolidata*, Cam., is a synonym of *eltola*.

Hab.—Colombo (*Wickwar*); Hambantota (*Fletcher*).

Genus **Mutilla**, Linn.

Key to the Species of Mutilla *described here.*

I.—Posterior margin of the thorax with a row of acute spines:—

A. Second dorsal segment with a spot of white pubescence on each side; third and fourth segments with bands of white pubescence.

(*a*) The bands on the third and fourth segments partly interrupted in the middle; head red .. *M. ianthis*.

(*b*) The bands on the third and fourth segments continuous; head usually black .. .. *M. bainbriggei*.

B. Second dorsal segment immaculate .. *M. porcella*.

II.—Posterior margin of the thorax without spines:—

A. Second dorsal segment of the abdomen immaculate.

(*a*) Second dorsal segment longitudinally rugose-striate; thorax scarcely broadened posteriorly.

a^1. Second dorsal segment almost as broad in the middle as long .. *M. pinguicula*.

b^1. Second dorsal segment much narrower in the middle than long .. .. *M. fumigata*.

(*b*) Second dorsal segment punctured; thorax much broadened posteriorly .. .. *M. thermophila*.

B. Second dorsal segment with one spot or more of pubescence.
- (*a*) A spot at the base and a band of golden pubescence on the apex of the second dorsal segment.
  - a^1. Head and thorax red; sides of the thorax slightly concave .. *M. fletcheri.*
  - b^1. Head red, thorax black; sides of thorax slightly rounded .. *M. wickwari.*
- (*b*) Second dorsal segment marked with spots of white pubescence.
  - a^1. The spots not lateral.
    - a^2. A spot at the base and at the apex of the second dorsal segment.
      - a^3. Third dorsal segment covered with white pubescence .. *M. pondicherensis*, Rad.
      - b^3. Third dorsal segment without white pubescence .. *M. ocellata*, Sauss.
    - b^2. A spot at the apex only of the second dorsal segment .. *M. desiderata.*
  - b^1. The spots lateral; third and fourth segments also with lateral spots.
    - a^2. Thorax strongly narrowed anteriorly; a spot on each side on the apex as well as on the middle of the second dorsal segment .. .. *M. melanota.*
    - b^2. Thorax not much narrowed anteriorly; no spots on the apex of the second dorsal segment .. .. *M. hexaops*, Sauss.

Mutilla pondicherensis, Rad. and Sich.

Mutilla pondicherensis, Rad. and Sich. Hor. Soc. Ent. Ross., p. 204, 1869. ♀.

Mutilla rufitarsis, Sm. Descr. New Spec. Hym., p. 199, 1879. ♀.

Hab.—Colombo (*Wickwar*); Hambantota (*Fletcher*).

I have not seen the type of *pondicherensis*, but *rufitarsis* agrees well with the description, and I think there can be little doubt that both names refer to one species. Many Ceylon specimens have the head red, but I cannot see that the difference is specific. *M. blanda* Sm., is very closely related.

Mutilla ianthis, sp. nov.

♀. Ferruginea, abdomine nigro, secondo segmento maculis duabus albopilosis lateralibus, segmento tertio quartoque albopilosis in medio nigro-maculatis, area pygidiali longitudinaliter striata, thorace postice pectinato.

Head and thorax strongly longitudinally rugose, pleura smooth and shining, abdomen closely and rather finely punctured, the pygidial area finely longitudinally striated. Eyes oval, situated a little nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind them, no broader than the thorax. Mandibles acute at the apex, with one very small blunt tooth on the inner margin. Scape shining and almost smooth, the second joint of the flagellum distinctly longer than the third. Thorax about one-third longer than the breadth on the posterior margin, slightly rounded anteriorly and a little broadened posteriorly, the sides crenulate and slightly concave, the posterior truncation vertical, shining, and almost smooth, the margin above the base of the truncation with ten strong teeth increasing in length towards the middle, the row of teeth continued by two or three very small ones on the sides of the truncation. No scutellar ridge. First abdominal segment much narrower than the second, which is broadest in the middle.

Ferruginous, the abdomen black ; a large round spot of white pubescence on each side of the second abdominal segment before the middle, the third and fourth segments covered with white pubescence with a large black spot on the middle of each. Flagellum and the apex of the mandibles black.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*) ; November.

In some specimens the pile on the abdomen is golden instead of white.

Somewhat allied to *M. pectinospinata*, Magr., but is a much smaller species. In the serration of the posterior margin of the thorax it approaches the group of *serratula*, Cam., but the markings on the abdomen are very different.

Mutilla bainbriggei, sp. nov.

♀. Nigra, thorace pedibusque ferrugineis, abdominis segmento secundo maculis duabus lateralibus albopilosis, segmentis tertio quartoque apice albopilosis, thorace postice pectinato.

Head and thorax coarsely rugose, abdomen finely punctured, pygidial area elongate ovate, very finely longitudinally striated, pleura concave, smooth. Eyes oval, situated nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind them, the scape shining and finely punctured, the second joint of the flagellum distinctly longer than the third. Thorax as wide as the head, very feebly rounded on the anterior margin, broadened posteriorly, the sides slightly concave and crenulate, about one-third longer than the breadth on the posterior margin, vertically truncate posteriorly, the surface of the truncation shining, with a few indistinct longitudinal striæ, the margin above the truncation pectinate, the four teeth near the middle long, the others scarcely developed.

Black; the thorax ferruginous; legs, scape, and base of the flagellum fusco-ferruginous; second abdominal segment with a small round spot of white pubescence near the middle on each side, third and fourth segments with a transverse band of white pubescence at the apex; pygidium dark fusco-ferruginous. Ventral segments with a sparse apical fringe of long whitish hairs.

Length. 4 to 5 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November to February.

Very similar to *recondita*, Cam., but differs in the sculpture of the pygidium and in the presence of teeth on the posterior margin of the thorax.

Mutilla porcella, sp. nov.

♀. Ferruginea, rugosa, thorace arcuato, postice truncato, sex dentato, abdomine nigro, tertio segmento albopiloso.

Head and thorax rugose, the posterior truncation of the thorax coarsely longitudinally striated, abdomen finely punctured, the second ventral segment strongly punctured, the second dorsal segment longitudinally rugose-striate. Head scarcely broader than the thorax, not rounded behind the eyes, the posterior margin straight; eyes oval, as near to the base of the mandibles as to the posterior margin of the head. Scape finely punctured, the antennæ not very stout, the second joint of the flagellum twice as long as the third, which is as broad as long. Thorax arched from the base to the apex, moderately convex, the anterior and posterior margins both very broadly rounded, more than half as long again as broad, the sides nearly parallel, slightly broadened on the median segment, the scutellar tubercle distinct but small, the posterior margin with six well-defined teeth, the two median the longest, the posterior truncation almost vertical. Pleura smooth and shining, very slightly concave. Abdomen convex, the first segment much narrower than the second, the pygidial area much longer than broad, very narrowly truncate at the apex and finely punctured. Tibiæ with three or four well-developed spines on the outer margin.

Ferruginous; the abdomen black; the third segment and the ventral segments at the apex clothed with long whitish pubescence; calcaria white; flagellum fuscous.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Easily distinguished from *pinguicula*, which is very similar in size, colour, and sculpture, by the teeth on the apex of the median segment.

Mutilla pinguicula, sp. nov.

♀. Ferruginea, punctata, abdomine nigro, secundo segmento longitudinaliter rugose strigato, segmentis 3to, 4to, quintoque in medio sparse cinereo-pilosis.

Head and thorax punctured-rugose, more finely and closely on the head than on the thorax, abdomen punctured, the second dorsal segment longitudinally rugose-striate, pygidial area not defined. Head rounded behind the eyes, very little broader than the thorax; the eyes broadly oval, situated a little nearer to the posterior margin of the head than to the base of the mandibles. Antennæ stout, the scape very finely punctured, the second joint of the flagellum nearly half as long again as the third. Thorax almost twice as long as broad, the anterior margin straight, the sides parallel, obliquely sloped posteriorly, the surface of the posterior slope rugose, the scutellar tubercle absent, a faint longitudinal carina on the median segment; pleura shining and almost smooth, not concave, the dorsal surface of the thorax convex. Abdomen short and broad, strongly convex, the second segment less than half as long again as the breadth at the apex. Tibiæ with only two or three very feeble spines near the apex.

Ferruginous; the abdomen black; the third, fourth, and fifth segments sparsely clothed with gray pubescence in the middle; spines of the tibiæ white.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Mutilla thermophila, sp. nov.

♀. Ferruginea, tennessime punctata, abdomine nigro, subsessile.

Head, thorax, and abdomen finely and closely punctured, the punctures on the second dorsal segment of the abdomen often confluent longitudinally. Head not quite as broad as the thorax, rounded behind the eyes, which are a little nearer to the posterior margin of the head than to the base of the mandibles, oval and not very prominent. Antennæ moderately stout and rather short, the second joint of the flagellum short, equal in length to the third. Thorax convex, nearly half as broad again posteriorly as anteriorly, about one-third longer than the breadth on the posterior margin, the sides not emarginate or crenulate; the anterior margin straight, very slightly prominent at the angles. Pleura finely punctured, very slightly concave, the propleura almost smooth. Abdomen subsessile, strongly convex, the first segment depressed, the second very broad, nearly as broad in the middle as long, sixth segment without a pygidial area. Second ventral segment coarsely punctured, deeply depressed transversely at the base. Tibiæ almost smooth, with only one or two very slender spines near the apex.

Ferruginous; the abdomen black; the pubescence sparse and whitish; calcaria whitish.

Length, 4 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); January.

Mutilla fumigata, sp. nov.

♀. Ferruginea, abdomine nigro, segmento quinto in medio albopiloso.

Head finely punctured-rugose, a little broader than the thorax, the eyes separated from the posterior margin of the head by a distance equal to about half their breadth; antennal tubercles rather large, smooth, and shining, scape shining, finely and sparsely punctured, flagellum rather thick, the third joint as long as the second. Thorax coarsely rugose longitudinally, about twice as long as broad, the sides almost parallel, very slightly emarginate in the middle, obliquely sloped posteriorly, a low transverse carina a little before the apex. Pleura concave, shining, the metapleuræ finely punctured. Abdomen closely punctured, the second dorsal segment longitudinally rugose; pygidial area not very clearly defined, much longer than broad, shining, very finely and closely punctured. Ventral segments finely punctured, the second very coarsely and closely punctured. Ferruginous, the apical half of the flagellum more or less fuscous; the apex of the mandibles and the whole of the abdomen black; a spot of white pubescence on the fifth dorsal segment.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Mutilla fletcheri, sp. nov.

♀. Ferruginea, rugose punctata, abdomine nigro, segmento secundo basi macula magna aurea, apice aurea late fasciata.

Head and thorax coarsely rugose-punctate, more coarsely on the thorax than on the head, pro- and meso-pleuræ rather indistinctly, metapleuræ more distinctly punctured. Abdomen finely and closely punctured, the second dorsal segment coarsely longitudinally rugose. Pygidial area small, elongate, nearly twice as long as broad, shining, very minutely punctured at the base. Head no broader than the thorax, rounded behind the eyes, which are situated much nearer to the posterior margin of the head than to the base of the mandibles; the tubercles at the base of the antennæ rather large, scape shining, the second joint of the flagellum longer than the third. Thorax nearly twice as long as broad, slightly rounded anteriorly; the sides almost parallel, very feebly emarginate before the middle; the pleura slightly concave. The carina on the first ventral segment of the abdomen is rounded at the apex.

Ferruginous; the abdomen black; the flagellum (except the basal joint) fuscous; a large spot of golden pubescence at the base of the second dorsal abdominal segment, a broad band, broadest in the middle at the apex of the second segment, and a narrow band at the apex of the third and fifth segments.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November. Three specimens.

This seems to be nearer to *M. pulla*, André, than to any other species.

Mutilla wickwari, sp. nov.

♀. Nigra, capite ferrugineo, pedibus testaceis, abdominis segmento secondo basi macula magna, apice fascia lata transversa, segmentoque tertio toto aureopilosis, area pygidiali nulla.

Head closely punctured, thorax punctured rugose, pleura shining and almost smooth, abdomen finely and closely punctured, the punctures on the second segment more or less confluent longitudinally. Head no broader than the thorax, the eyes situated rather nearer to the posterior margin of the head than to the base of the mandibles, the head rounded behind the eyes. Antennal tubercles rather small, the scape finely punctured, the second joint of the flagellum half as long again as the third; an indistinct longitudinal carina on the front. Thorax half as long again as broad, a little narrower posteriorly than anteriorly, the sides very slightly convex, the pleura not concave. The carina on the first ventral segment is rather broad, with a small tubercle at the apex. No pygidial area.

Black; head and prosternum ferruginous; legs testaceous brown; a large spot at the base of the second segment, a transverse band, broadest in the middle, on the apical margin, the whole of the third segment and the fourth less densely convered with golden pubescence. The two anal segments with long pale hairs on the sides. The ventral segments narrowly fringed with golden hairs on the apical margin. An obscure ferruginous spot on each side near the angles of the median segment.

Length. 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November. Two specimens.

Easily distinguished from *M. fletcheri* by the absence of the pygidial area, the finer sculpture, especially on the second dorsal segment, and the shape of the thorax, the sides of which are slightly convex instead of concave.

Mutilla desiderata, sp. nov.

♀. Ferruginea, punctata, abdomine nigro, segmento 2do, 4to, quintoque macula albopilosa apice signatis, area pygidiali longitudinaliter striata.

Head and thorax punctured-rugose, second dorsal segment longitudinally rugose, pygidial area very finely longitudinally striated, rounded at the apex. Eyes nearer to the posterior margin of the head than to the base of the mandibles. Head orbicular, no broader than the thorax, the second joint of the flagellum a little longer than the third. Thorax nearly twice as long as broad, very slightly rounded posteriorly, a little more strongly anteriorly, the sides almost parallel, very feebly emarginate, the posterior truncation almost vertical and coarsely rugose. Pleura concave, almost smooth, with a few fine and shallow punctures. Ventral abdominal segments very finely punctured, the second coarsely and closely punctured. Tibiæ with two rows of spines.

Ferruginous; antennæ fuscous towards the apex; legs rufotes taceous; abdomen black, a spot of white pubescence on the apical margin of the second, fourth, and fifth segments; calcaria whitish. Pubescence white on the sides and ventral surface, black on the dorsal surface of the abdomen, pale ferruginous on the head and thorax.

Length, 6 mm.

Hab.—Hambantota, Ceylon (*Fletcher*).

This seems to be allied to *nigrigena*, André, and *rufiventris*, Sm., neither of which are known to me except by the descriptions.

Mutilla hexaops, Sauss.

Mutilla hexaops, Sauss. Ann. Soc. Ent. Fn., p. 356, 1867. ♀.
Mutilla ceylanensis, Rad. and Sich. Hor. Soc. Ent. Ross., VI., p. 247, 1869. ♀.

I cannot see that these forms are distinct. Bingham's distinctions between the two are not accurate; Saussure distinctly says of *hexaops* "pedes ferruginei," and this corresponds with a specimen named by him in the British Museum collection, but Bingham says "legs black, antennæ ferruginous." The antennæ in hexaops are fuscous, the scape fusco-ferruginous.

♂. Niger, abdomine rufo, segmento primo, apice excepto septimoque nigris; alis flavo-hyalinis, scutello tuberculato.

Black; the pubescence gray; segments 2 to 6 of the abdomen and the apex of the first ferruginous with light ferruginous pubescence. Wings hyaline, tinged with yellow, nervures pale testaceous.

Clypeus shining in the middle and sparsely punctured, with a median carina, the sides covered with long pubescence. Antennæ stout, the second joint of the flagellum scarcely longer than the third. Head closely punctured, thorax rugosely punctured, a shining median line on the anterior half of the mesonotum, the posterior half more coarsely sculptured, with a deep longitudinal sulcus on each side. Scutellum raised in the middle into a low shining tubercle, with a deep, shining transverse depression at the base. Pleura coarsely punctured, the metapleuræ and median segment coarsely reticulate, two narrowly separated longitudinal carinæ at the base of the median segment converging towards the middle. Abdomen shining and sparsely and finely punctured, more closely at the apex of the segments than at the base, and with a fringe of pubescence near the apex of the segments. The carina on the first basal segment is very shallowly emarginate beneath. Third abscissa of the radius equal in length to the first, the second half as long again; first recurrent nervure received before two-thirds from the base of the second cubital cell, second at three-quarters from the base of the third cubital cell.

Length, 14 mm.

Hab.—Colombo, Ceylon (*Wickwar*). ♂ ♀ in copulâ.

The male is near *foveata*, Cam., but differs in the distinct, though low, tubercle on the scutellum, the shape of the carina on the first ventral segment, the clypeus, and the proportions of the cubital cells. *M. acidalia*, Cam., is doubtfully distinct. In most specimens of *hexaops* the wings are fuscous at the apex.

Mutilla melanota, sp. nov.

♀. Nigra, rugosa, abdomina delicatissime punctato, segmentis 3–4 albo bimaculatis, secundo quadrimaculato, pedibus fusco-ferrugineis.

Head and thorax coarsely rugose, the mesopleuræ smooth and concave, abdomen finely punctured, the sixth segment closely punctured, flattened, the pygidial area not defined. Eyes large, situated nearer to the posterior margin of the head than to the base of the mandibles, separated from the posterior margin of the head by a distance less than their greatest breadth. Scape shining and almost smooth, the second joint of the flagellum more than half as long again as the third. Thorax scarcely as wide as the head, broadened posteriorly, the anterior margin rounded, almost vertically truncate posteriorly, the sides slightly crenulate, emarginate before the middle, the sides of the posterior truncation with small teeth, the thorax nearly twice as long as the breadth at the base of the truncation.

Black; the apex of the scape and the legs fusco-ferruginous; the second abdominal segment with an elongate ovate spot of dull white pubescence on each side before the middle, another smaller and transverse on each side on the apical margin, the third and fourth segments with a large spot on each side, the sides of the abdomen and the apex of the ventral segments with long whitish pubescence, the apex of the second segment fusco-ferruginous.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*); November.

Allied to *M. sexmaculata*, Swed., but the shape of the thorax is different.

Genus **Promecilla**, André.

Promecilla cyanosoma, sp. nov.

♀. Ferruginea, abdomine cyaneo, segmentis 2–5 apice macula parva albopilosa, thorace elongato, postice contracto.

Head and abdomen finely and closely punctured, thorax rather more coarsely punctured, the posterior slope reticulate, the pleuræ shining and sparsely punctured. Head scarcely broader than the thorax, narrowed behind the eyes and rounded posteriorly, the eyes nearer to the posterior margin of the head than to the base of the mandibles. Thorax more than twice as long as the head, rounded anteriorly, arched to the middle and strongly sloped posteriorly, nearly three times as long as the greatest breadth, narrowed posteriorly. Second abdominal segment long, twice as long as broad, apical segment shining, without a pygidial area.

Ferruginous, the abdomen dark shining blue. A small spot of white pubescence on the middle of the anterior margin of the thorax, and one in the middle of the apical margin of each dorsal abdominal segment from the second to the fifth inclusive ; the first ventral segment ferruginous.

As in most other species of the genus the second joint of the flagellum is much longer than the third. There are only one or two spines on the posterior tibiæ near the apex.

Length, 7 mm.

Hab.—Hambantota, Ceylon (*Fletcher*) ; February.

This species differs from *ariel*, Cam., in the colour of the legs and antennæ and the smaller size and different distribution of the spots of white pubescence. In the latter point it also differs from *regia*, Sm., and *metallica*, Cam. *P. hesitata*, Cam., has the head much broader posteriorly, and *P. præstabilis*, André, has no spots of white pupescence on the abdomen.

Genus **Stenomutilla**, André.

Stenomutilla egregia (Sauss.).

Mutilla egregia, Sauss. Ann. Soc. Ent. France (4), VII., p. 351, 1867. ♀. (nec Klug.)

Mutilla aureorubra, Sich. and Rad. Horae. Soc. Ent. Ross., VI., p. 304, 1869. ♀.

Mutilla placida, Sm. Descr. n. spec. Hym., p. 198, 1879. ♀.

Mutilla nobilis, Sm. (Cat. Hym. B. M., III., p. 33, 1855, ♂), is almost certainly the male of this species, but it is better to keep them separate for the present. I have not seen Saussure's type, but Smith's species, the type of which is from Bombay, answers well to his description and figure.

Sub-family METHOCINÆ.

Genus **Methoca,** Latr.

Methoca bicolor, Cam.

Methoca bicolor, Cam. Mem. Manch. Lit. & Phil. Soc., XLI., p. 52, 1897. ♀.

Hambantota, Ceylon (*T. B. Fletcher*). 1 ♀.

Not previously recorded from Ceylon. The specimen differs from Cameron's description in having the head finely and sparsely punctured; the tibiæ, as well as the tarsi, are testaceous, also the mandibles and the six basal joints of the antennæ. The thorax is distinctly more slender than in Cameron's figure, especially the median segment; but this may be an error in the figure. The size as in Cameron's description is 5 mm.

This seems to be the first authentic record of *Methoca* from Ceylon, for *M. rugosa*, Cam., does not belong to the genus.

Family *SCOLIIDÆ*.

Genus **Plesia,** Jur.

Plesia petiolata (Sm.).

Myzine petiolata, Sm. Cat. Hym. B. M., III., p. 72, 1855. ♂.

Myzine ceylonica, Cam. Ann. & Mag. Nat. Hist. (7). V., p. 18, 1900. ♀.

Male specimens from Colombo taken in June are rather smaller than the type, measuring only 9 mm. in length. The female varies much both in the closeness of the puncturation and the colour of the wings, and there is also much difference in the comparative length of the abscissæ of the radius. It is quite possible that two species are represented in the series, but I can find no constant distinguishing character. Some of the specimens are almost identical with *Myzine claripennis*, Bingh. The differences do not appear to be seasonal.

Genus **Tiphia,** Fabr.

Tiphia oswini, sp. nov.

♀. Nigra, nitida, alis subhyalinis, ubique sparse punctata, segmenti mediani carina mediali subobsoleta, pro- et metapleuris tenuiter oblique striatis.

♂. Niger, nitidus, alis subhyalinis, apice leviter violaceo micantibus, clypeo apice inciso, sparse punctatus.

♀. Clypeus transverse; head shining, sparsely punctured; scape and two basal joints of the flagellum shining, finely and closely punctured, the second joint of the flagellum twice as long as the first and about equal in length to the third, the flagellum from the third joint opaque and very finely pubescent. Posterior ocelli more than twice as far from the eyes as from each other. Pronotum coarsely, but rather sparsely, punctured, the posterior margin very broadly smooth; mesonotum very sparsely punctured; scutellum sparsely punctured, very broadly rounded at the apex. Propleura and metapleura finely and closely obliquely striated, mesopleura finely and very sparsely punctured. Median segment as long as the mesonotum and scutellum combined, subopaque, very minutely punctured, the three carinæ near together, the median one almost obsolete, the two lateral ones nearly parallel, a little nearer together at the apex than at the base, the apex distinctly margined, the posterior truncation almost vertical. Abdomen shining, very sparsely punctured, most sparsely on the second segment, the first segment rounded at the base, the second segment with a transverse longitudinally striated groove at the base; the sixth segment rounded at the apex, coarsely punctured, and with long sparse pubescence at the base, smooth at the apex. Second recurrent nervure received at about two-thirds from the base of the second cubital cell.

Black, with whitish pubescence; calcaria fusco-ferruginous; wings pale fusco-hyaline, nervures fuscous.

Length, 13 mm.

♂. Differs from the female by the usual sexual characters; more closely punctured, the clypeus incised at the apex; posterior ocelli only half as far again from the eyes as from each other; the second joint of the flagellum distinctly shorter than the third, median segment in the middle shorter than the mesonotum, very feebly and broadly emarginate posteriorly, the three carinæ distinct, the two outer ones a little nearer together at the apex than at the base. Radial cell narrowly rounded at apex, extending beyond the apex of the second cubital cell; stigma rather large, nearly three times as long as broad.

Black, wings subhyaline, tinged with fuscous on the apical half and with violet reflections.

Length, 8 mm.

Hab.—Pattipola, Ceylon (*Wickwar*). 1 ♂ 1 ♀; Matale (*Braine*). 1 ♂.

This is a larger and more sparsely punctured species than *consueta*, Sm., the sculpture of the propleura is different, and the first abdominal segment is more strongly rounded at the base. The three carinæ on the median segment are all clearly defined in *consueta*, and the colour of the wings is different, though somewhat variable.

Genus **Scolia**, Fabr.

Scolia (*Discolia*) *histrionica*, Fabr.

Scolia histrionica, Fabr. Ent. Syst. suppl., 256, 1798. ♀.

Hab.—Colombo.

Scolia vivida, Sm., is almost certainly the male of this species, as suggested by Saussure.

Genus **Dielis**, Sauss. and Sich.

Dielis rubromaculata (Sm.).

Scolia rubromaculata, Sm. Cat. Hym. B. M., III., p. 99, 1855. ♀.

Elis (*Dielis*) *rubromaculata*, Sauss. Spec. Gen. Scolia, p. 196, 1864. ♀.

Ceylon specimens, as far as I know, are without red markings on the abdomen, and very closely resemble *Scolia* (*Discolia*) *indica*, Sauss. The male of *indica* is almost certainly *eliformis*, Sauss. The male of *rubromaculata* is smaller, 20 to 25 mm. in length, is closely punctured, black, the abdomen strongly glossed with blue, the three apical segments with a fringe of long fulvous hairs. The wings are fuscous, slightly glossed with purple.

Hab.—Kandy (*Turner*) ; Maskeliya (*de Mowbray*).

A NEW MASON WASP.

Odynerus wickwari, n. sp.

By Geoffrey Meade-Waldo, B.A.

Description of Female.

BLACK; broadly at base and narrowly along the sides of clypeus, scape of antennæ beneath, narrow line running from between base of antennæ to the most anterior of the ocelli, sinus of the eyes, the inner orbits bordered with a line which branches off towards the ocelli above, the cheeks entirely, anterior margin of pronotum broadening laterally; two spots, the upper ovate, the lower elongate ovate, on mesopleuræ, base of tegulæ, a line on anterior margin of scutellum broader laterally, a narrow line interrupted medially on the post-scutellum, two triangular marks on medium segment yellow. Abdomen, apical margin of first abdominal segment above, second abdominal segment, both dorsally and ventrally, much enlarged on ventral surface, two small spots about the middle of first abdominal segment, four spots at even distances apart placed transversely on segment 2, a series of three spots on segments 3, 4, and 5, and the apical margin on ventral surface of segments 3 and 4, yellow. Anterior and intermediate legs, except the tarsi, posterior legs, with exception of femora, yellow. Apex of mandibles, entire median segment (except where yellow), first abdominal segment at base above and wholly on ventral surface, red. Posterior femora red above, the tarsi ferruginous-red. Wings hyaline, fuscous along the costa and in radial cell. Clypeus about as broad as long, truncate, and narrowed towards apex. Pronotum broad in front, median segment slightly depressed rounded at the apex; first abdominal segment not petiolate, rather narrower than the second. Head and thorax coarsely and evenly punctured, abdomen shining impunctate, clypeus and abdomen clothed with a sparse gray pile.

Length, 7½ mm.

Description of Male.

The male differs from female in several points in colouration. Clypeus yellow and slightly emarginate. Horseshoe mark on disc of mesonotum yellow. The following yellow markings present in female are not visible on the male, *i.e.*, the spots on the first and second abdominal segments, the lines bordering the inner orbits and branching in above the ocelli.

Length, $7\frac{1}{2}$ mm.

Habitat: *Female*, Oddichudan, Ceylon, N. P., Nov., 1908 (*O. S. Wickwar*). *Male*, Anuradhapura, Ceylon, N.C. P., Nov., 1908 (*O. S. Wickwar*).

This species would come next to *O. diffinis* in Bingham's Key ("Fauna of British India, Hymenoptera," Vol. I.).

I have pleasure in naming this species after Mr. O. S. Wickwar, who has done so much to further the study of Aculeate Hymenoptera in Ceylon.

THE EGG-TOOTH IN THE CEYLON KRAIT, OR KARAWELLA (BUNGARUS CEYLONICUS).

By Major F. Wall, I.M.S., C.M.Z.S.

In this Journal* some time ago Mr. E. E. Green recorded a most interesting discovery of Kraits (*Bungarus ceylonicus*) with eggs and hatching young. In January, 1907, visiting Peradeniya, I was able to examine the hatched young and three of the eggs, and suggested to Mr. Green opening the eggs with a view to investigating the egg-tooth. Accordingly the three eggs were incised, the embryos extracted, and we searched for the egg-tooth with the aid of a microscope, but were doomed to disappointment. I am fairly certain, however, that we did not examine the jaws of the two hatched young. At that time I had never seen the egg-tooth of any snake, but since have been able to do so in several species. It occurred to me the other day to re-examine these specimens in the hope of success, now that I know what to look for, and the exact site of this structure. Mr. Green very kindly presented me with the specimens, five in all, and the eggs which we had despoiled of their contents. I have re-examined these with the aid of a microscope, with the following results. In the three young extracted by us, which are (1) ♂ measuring $5\frac{3}{8}$ inches, (2) ♂ $6\frac{7}{8}$ inches, and (3) ♀ $6\frac{5}{8}$ inches. I failed to discover any rudiment of the fœtal-tooth, but in the smaller of the two hatchlings, which measures 9 inches, I was successful. I dislodged the structure from the præmaxilla, and viewed it under the microscope, and find it is exactly like the fœtal-tooth I recently alluded to in the "Bombay Natural History Journal," which I extracted from the fœtus of a pit viper. It bears a striking resemblance in form to a duck's head, the convexity of the head filling the aperture in the front of the mouth, through which the tongue in later life is exserted while the jaws remain closed. The beak-like process projects forward slightly beyond the snout and ends in a horizontal cutting edge, with which the embryo is able to effect its freedom.

I think it worth while drawing attention to the close resemblance in shape of this egg-tooth in an oviparous colubrine snake and the corresponding structure in the young of a viviparous viper. In the one case a tough membranous investment has to be opened by the

* Part III., October, 1905.

young snake, and in the other a delicate diaphanous membrane. I am puzzled to know the facts concerning the report given to Mr. Green that the parents were in the "nest" with the eggs and hatching young. There seems to be no doubt that there were two adult snakes in attendance, but were these ♂ and ♀, *i.e.*, the parents, as supposed ? It appears to me that there were undoubtedly in the "nest" two distinct broods of eggs. From one lot the young were hatching, and two of these measured 9 and $10\frac{3}{16}$ inches respectively, the other were far less advanced in incubation, the contained embryos being little more than half the length of hatchings. These measurements have been already given. Now, if we assume that the two adults were the parents as originally supposed, then the existence of two broods must point to superfœtation, a condition which I do not think has ever been established in the breeding of snakes. Unfortunately the adult snakes were never sent with the eggs, and the point cannot be cleared up, and there is no proof of superfœtation. Another solution presents itself, and that is that both the adults were females, in different stages of impregnation. This seems to me the more likely explanation of the two broods, though it appears to me remarkable that two snakes should select and retire within the same hole to deposit and incubate their eggs. I have had a considerable number of opportunities of investigating the incubation of snake's eggs in a state of nature, and only once have I known a ♂ in company with its mate after the deposition of eggs. In this case the species was Shaw's Wolfsnake (*Lycodon striatus*).

NOTES.

10. *Correction as regards the Ceylon Species of "Phlebotomus."*—In my account of the species of *Phlebotomus* that occur in Ceylon (*Spolia Zeylanica*, Vol. VII., Pt. XXVI.) I divided these species into two groups, distinguished by the relative positions of the tip of the first and the anterior fork of the second longitudinal vein of the wing. In my key on page 59 *P. argentipes* was placed by some error in the wrong group. The key may be amended as follows :—

(1) The tip of the first longitudinal vein of the wing but little in advance of the anterior fork of the second longitudinal vein.

(*a*) Colour silvery brown ; the area of the wing paler than the anterior border ; the coxæ yellowish ; the anterior branch of the second vein about twice as long as the distance between the two forks of the vein .. .. *P. marginatus.*

(*b*) Dorsal surface of the thorax dark brown, the sides yellow. The anterior branch of the second longitudinal vein less than twice as long as the distance between the two forks .. .. *P. argentipes.*

(2) The tip of the first longitudinal vein far in advance of the anterior fork of the second.

(*a*) Thorax brown ; coxæ yellowish ; the whole of the wings paler than the abdomen. The anterior branch of the second vein about five times as long as the distance between the two forks .. *P. zeylanicus.*

(*b*) Colour uniform, dull yellowish-gray. Wings very narrow ; the anterior branch of the second vein shorter than the distance between the two forks .. *P. babu.*

N. ANNANDALE.

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11. *The Ceylon Jungle Fowl in Captivity.*—During the experiments carried on by members of the Ceylon Poultry Club with the Ceylon jungle fowl several interesting incidents occurred which are worth recording. The following notes record some of these incidents.

They occurred mainly in the experimental run put up by Mr. Clement Johnson, who was the only experimenter who succeeded in producing some thirty hybrid chicks from a mating of a jungle cock with a domestic hen.

At one time he secured two jungle hens, which he placed in a large covered-in run with a jungle cock and two domestic hens. These hens tamed down wonderfully quickly, and were great friends with the cock. After a time one jungle hen developed gapes, so it was caught and set at liberty. Writing of this hen, Mr. Johnson says: "The jungle hen that I released interests me greatly. Its one object is to get back into the pen. It walks round and round outside or perches on the top Any sudden or unusual noise alarms it, and it flies or runs into cover. On the other hand, you can approach within a few yards' length of it, when it just calmly walks out of your path like a very tame domestic fowl, no hurry or flurry about it at all. It avoids fowls that cross its path. Since its release the jungle cock inside the run calls more or less all day long, and is undoubtedly distressed at seeing this hen at liberty outside his run. He gets frantic when she makes a run and disappears from view. I will give her a week or ten days' liberty, and then drive her back into the run again."

This hen after haunting the scene of her captivity for many days disappeared one night. It is presumed that she was destroyed by one of the jungle cats that patrol the neighbourhood.

A little later the second jungle hen developed chickenpox. Fearing that infection would spread, Mr. Johnson had this hen also caught and liberated, but she likewise refused to depart from the scene of her captivity. But as her removal was deemed necessary, she was caught and taken away across a ravine and liberated in the jungle some quarter of a mile away. Next day, however, she turned up again, trying to get into the run. She was caught a second time and taken further afield and liberated. After this, as she did not return, it was thought she had gone for good. However, some days later she was back again. She was now quite cured of the chickenpox, having evidently cured herself in the jungle, either by eating some herb or by living in surroundings natural to her. After this she continued to live in the garden outside the run, and used to walk about with some of the young hybrids which Mr. Johnson had bred, roosting at nights in the branches of a tree along with the hybrids. The fact of consorting with the wild hen rendered these hybrids a little less tame than usual. This hen eventually made a nest in the garden and laid three eggs and sat on them. As she was running with immature hybrid cockerels and had always rejected their advances, these eggs were not expected to be fertile. They were, however, removed from the nest and set under a domestic hen, and, as expected, all proved infertile. There is little doubt that, if Mr. Johnson had not left for England at this period, this jungle hen would shortly have produced fertile eggs by running with the more matured hybrid cockerel in the garden, and he would have produced the unique cross of hybrid cock and jungle hen.

When her own eggs were removed from the jungle hen's nest, they were replaced by three eggs laid by the domestic hen running with the jungle cock, and these she incubated. Just at the time of hatching one egg got broken in the nest; it was an addled one. This attracted thousands of ants to the nest, which not only drove off the sitting hen, but killed and partly devoured the two chicks just hatched from the other two eggs. It would have been a strange sight to have had a jungle hen strutting about the garden with some hybrid chicks.

Jungle hens have never bred in captivity. Mr. Johnson's opinion is that this hen would never have bred with the hybrid cock or any other cock if it had been confined within wire netting walls.

On the other hand, the late Mr. Young of Udabagie had two jungle hens in captivity for considerably more than one year, and they were mating up with a domestic cock, and Mr. Young was very hopeful of producing hybrids from this mating, when his tragic death by lightning put a stop to the experiment.

It was just at this period that Mr. Johnson left Ceylon for England. Before he left this jungle hen was enticed into the run and caught, and with the jungle cock was sent to Mr. G. C. Bliss at Atagalla. The cock did not take kindly to the close confinement necessary while his big run was being put up in the new locality, and began to sicken; when turned into the big run he did not recover, so he was let out and given his liberty. At night time, however, he returned to this run (in which the jungle hen had been also placed) and was allowed to go in. Next morning he was found dead. Thus, after captivity of sixteen months, ended the life of a most interesting bird—the progenitor of all the thirty hybrids that were produced during the experiments. This jungle cock only mated with the one domestic hen, and would have nothing to do with any other hen, in fact he drove them all away. Even when his own particular hen had been removed for a month owing to illness, he still would have nothing to do with any other. After the death of this cock the jungle hen became excited and wild, so she was given her liberty, and flew away to be heard of no more. The history of this hen is surely unique. She had lived either in the experimental run or in the garden just outside it for eighteen months.

J. LLEWELLYN THOMAS.

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12. *Pelenda Nuwara.*—" A rampart of forest-clad mountains encircle the great plain, which forms the adjacent villages of Morapitiya and Pelenda ; the earthworks which guarded the entrance can still

be easily traced, while a raised *Murapola* of stone commands the mountain path which leads across the Atweltota to Kukul korale. Crowning a gentle eminence, which is surrounded by several thousands of acres of *owita* lands, and close to the limpid waters of the Pelen-ganga, are the plain squared stone columns of the palace of Vidiye Bandara ; alongside them stands the house of the Colombo Arachchige family, the descendants of some faithful follower of the Prince. The position, intersected as it is by the numerous streams which fall into the river, is one of great natural strength, while the *owita* lands are capable of supporting a large population. Close by there are two villages of Porowakarayas of the Karawe caste and two of Chaliyas, no doubt the descendants of the Prince's camp followers ; while the Moorish villagers claim a similar ancestry. A stone cannon ball was discovered by me among some of the ruins during a recent visit, and there are numerous traces of ancient iron works. The road taken by the Prince must have been the ancient path through Badureliya, Boralugoda, Hewesse, and Hinidumkanda, into the Galle korale. At the Saman Dewale at Latpandura, 2 miles from Pelenda, is still preserved a cloth which is said to have been taken from a Portuguese elephant."

The above is a footnote from page 40 of the second edition of my translation of Ribeiro's Ceilão (printed 1909). On June 4 last Mr. G. F. Plant, the Assistant Agent at Kalutara, and I commenced excavating the low mound which marked the site of the palace of the brave father of "Don João, by the Grace of God, King of Ceilão, Perea Bandar." Ten pillars of stone, some large and some small, but only one in complete preservation, marked the outlines of the original building. The upper couple of feet of the mound consisted of broken flat tiles, nearly all ornamented or grooved. Below appeared the cinders of the stout beams which had once supported the roof. And under these lay the piles of earth, the walls which had filled the spaces between the stone supports. Iron nails, varying in length from 2 to 11 inches, were found in large numbers, but the results were disappointing. The chief find was a plain box of soft copper, 1½ inches square and fitted with a tight cover. Within, this was divided into 25 compartments, the central one containing a fragment of gold. In the others were recognized a pearl, still beautifully lustrous after 350 years underground, silver, a ruby, sapphire, topaz, coral, &c. In fact, this was a miniature *Yantragala*. One other object of interest there was, the quaint tile shown in the illustration. What its purpose was it is difficult to say. The circular hole in the forehead would seem to show that it was meant to be secured by a nail to the end of a wooden beam. With tender care the tile was carried under shelter in its bed of clay, and dried by a fire of coconut branches. But the transport to Kalutara in a hired Kalutara gharry proved too much for its enfeebled powers of resistance. The fragments, carefully backed

FIG. 3.

with cement, now repose in the dignified atmosphere of the Colombo Museum. That is the last relic of the refuge of "Tuttarayakandan Taniyanwallan Ekangaviran Madiyantramantran,"* from where he fled, leaving his standard and his book of war songs, before the victorious arms of the boy of twelve, the Lion King of the future.

One word more. Sixty-two villagers assisted us in the work of excavation. No one demanded payment. Their breakfast cost us Rs. 10·69, and we were enabled to show Government a saving of Rs. 39·31 on the sum which had been allowed us. (The photograph is by Mr. A. de Abrew, Proctor, of Kalutara.)

P. E. PIERIS.

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13. *Child's Play.*—Capt. F. R. Barton thus describes a children's game in British New Guinea [*vide* Journ. R. Anthrop. Inst. (Great Britain), 1908, p. 273]. "Four girls or more sit upon the ground in a circle facing inwards. They then place their hands, each girl nipping with forefingers and thumbs the skin on the back of the hand next to her. They then move their collected hands up and down in unison to the rhythm of the following song :—

Kinimala Kinimala
Lepa lepa maloa taitu
Kepa kepa anaurio
Melaule malare palaia.

The song finished they leave go of each other's hands and drop them limply in a heap."

Sinhalese children play an identical game, and sway their flexed hands up and down to the following jingle :—

Kaputu kák kák kák
Goraka dén dén dén
Umutu váv váv váv
Dorakada gahe puvák puvák
Batapanduré bulat bulat
Kaputage katé vela madulayi
Kaputige katé ran massayi
Magata kanta bat mallayi
Vekande kande udin yan yan
Peli doren usi kaputá usi.

ARTHUR A. PERERA.

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* The honorific assumed by the Prince while at Pelenda, according to an ancient *ola* copy of the *Rájáwaliya*.

14. *A convenient method of storing Butterflies in Paper Envelopes.**—Triangular paper envelopes have been employed by travelling entomologists for the temporary storage of butterflies, for many years. But it has been usual to lay these envelopes haphazard in plain boxes, in such a manner that it is impossible to find any particular specimen without turning over the whole contents of the box.

By the use of the special boxes here described the envelopes occupy very much less space, the contents are less liable to damage, and any individual specimen can be found and removed with the greatest ease without disturbing the remainder.

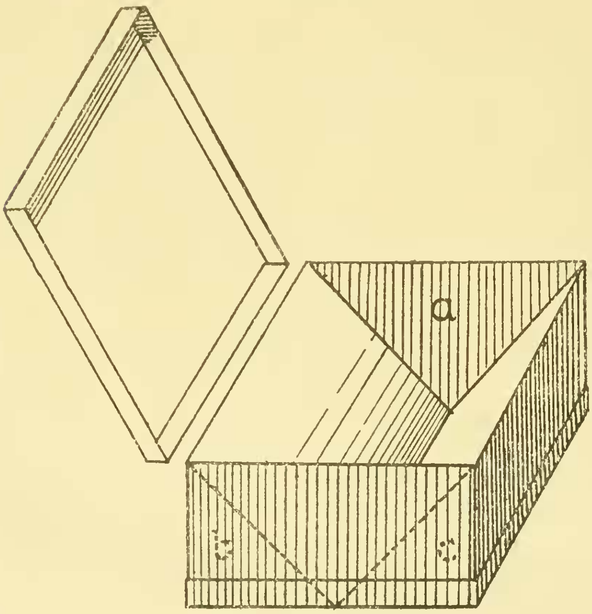

Fig. 4.

The boxes are made of tin plate, with partitions dividing them into trough-shaped spaces. The envelopes rest edgeways in the troughs. The boxes are fitted with two lids, above and below.

Fig. 4 shows a box with the upper lid removed and the lower one in place. The box measures 9 in. by 6 in. by 3 in. The upper space contains a single trough (*a*), and carries envelopes with a base of $5\frac{3}{4}$ inches.

* The above is abstracted, with some alterations, from the Proc. Ent. Soc., Feb., 1910, p. 3. The figures are reproduced through the kindness of the Entomological Society of London.—Ed.

Fig. 5 represents the reverse of the same box, with two smaller troughs (b, c) to contain envelopes of half the size.

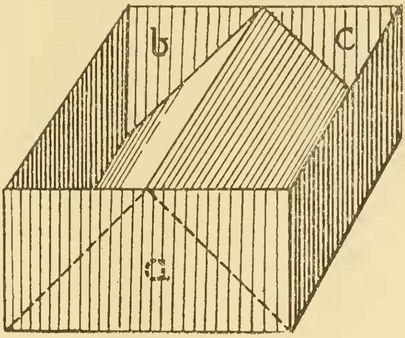

Fig. 5.

Fig. 6 shows a box of the same size, but designed for the smaller-sized envelopes alone, and containing four troughs (d, e, f, g).

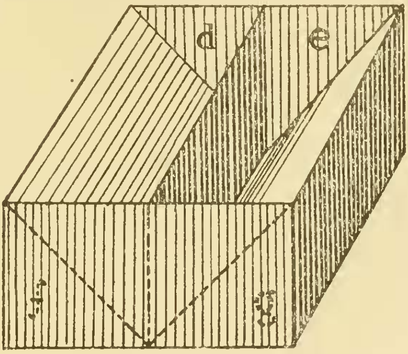

Fig. 6.

Fig. 7 is a larger box, of just double the depth of the others, measuring 9 in. by 6 in. by 6 in., with a diagonal partition forming

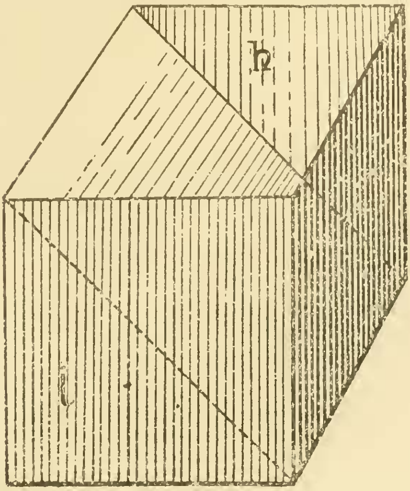

Fig. 7.

a single trough above and below (h, i), capable of carrying envelopes of a larger size.

(In figs. 5, 6, and 7 the two lids have been omitted for sake of clearness.)

These boxes are designed for three sizes of envelopes, which gives a sufficient range for butterflies of any size. Size 1 is made from a rectangle 8 in. by 5 in. Size 2 from a rectangle 6 in. by 4 in. Size 3 from a rectangle measuring 4 in. by 2¾ in.

It is found in practice that a box made according to fig. 4 will carry, without overcrowding, from 100 to 130 full envelopes in the larger trough, and from 175 to 200 in each of the two smaller spaces. Design 2 will hold in each of the four spaces 225 Lycænidæ, making a total of 900 insects. Design 3 will hold 75 or more filled envelopes in each of the two spaces.

For convenience of examination the insects should be arranged in families: the genera alphabetically in each family, and the species alphabetically in each genus. Subsequent additions can be slipped into their places without disturbing those already in position. To keep the envelopes in place when the troughs are only partly occupied, triangular blocks of cork about ¾ inch thick can be employed. For use as collecting boxes the troughs can be charged with empty envelopes, and the cork triangles will serve as markers to separate the unused envelopes as they are filled.

The boxes illustrated are of the simplest design, as made by a local tinsmith in Ceylon. They can be improved by a coating of black japan on the outside.

Messrs. Watkins & Doncaster have adopted this design, and are turning out boxes (to suit their special-sized envelopes) in stout japanned zinc, with perforated partitions at the end of each trough for the reception of naphthalene or camphor.

E. ERNEST GREEN.

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15. *On a curious Scolopendriform Caterpillar* ("*Homodes fulva*," *Hampson*).—Three species of *Homodes* (*crocea*, Guen.; *vivida*, Guen.; and *fulva*, Hampson) are recorded from the Indian region, but the larva of none of these species has been described.

A small dull-coloured larva was recently found wandering about in the verandah of my laboratory. Its form and movements were so peculiar that I had to examine it with a lens to assure myself that it was really the caterpillar of a Lepidopterous insect.

Fig. 8*a* shows a bird's-eye view of the larva (natural size). The lateral processes, which might at first sight be mistaken for the limbs of a myriopod, are stout spatulate hairs.

During the progression of the insect they are kept in constant movement, being raised and lowered consecutively, simulating the action of the legs of a Scolopendra, but at a much lower speed. While at rest both the head and the posterior extremity are elevated, and the latter is frequently jerked from side to side in a minatory manner. On closer examination it is seen that the posterior extremity simulates a second head. There is a pair of prominent black chitinous spots on the dorsum of the terminal segment which might readily be mistaken for eyes, and the spatulate hairs are suggestive of an arrangement of antennæ and palpi. Even the terminal claspers lend to the deception, for they occupy the position of a pair of mandibles, and are held distended, as though ready for action (see fig. 8*b*).

FIG. 8*a*.

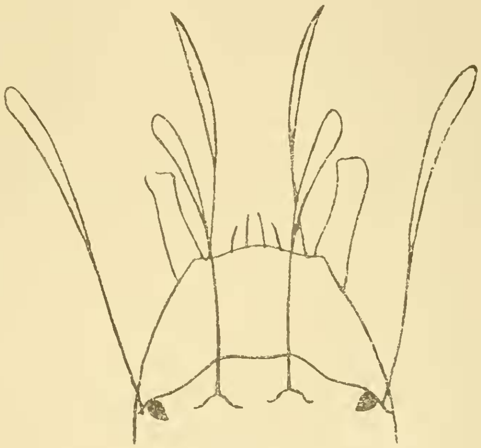


FIG. 8*b*.

This caterpillar pupated in a tightly rolled section of the leaf upon which it had been feeding. It had fed up on *Terminalia catappa*, which happened to be the first food plant with which it was presented.

The moth, which proved to be *Homodes fulva*, was disclosed on December 20.

The fully-grown caterpillar measures $1\frac{1}{4}$ inches in length. It is of a brownish-green colour, with inconspicuous maculations of a darker shade. Head reddish-brown. The first pair of abdominal claspers are small and practically obsolete, the others normal. The second segment carries ten long spatulate hairs directed forwards. There are two similar hairs on each side of the third and fourth segments. A single spatulate hair springs from each side of the fifth to the eleventh segments. The twelfth has a pair on each side, and the terminal segment has six of these hairs directed backwards, with a prominent black chitinous spot at the base of the outer hair on each side.

E. ERNEST GREEN.

16. *On the Larva of "Panilla albopunctata," Wlk.*—The larva of this Noctuid moth feeds commonly on the under surface of a large Polyporid fungus that vegetates on decaying stumps of trees. It is found more occasionally upon other woody fungi.

The caterpillar is of the normal form of Quadrifine larvæ, having only two pairs of abdominal claspers, and, when young, may easily be mistaken for that of a Geometrid moth.

Its colouration renders it very inconspicuous, being of a pale translucent ochreous tint, usually with an irregular blackish blotch on the dorsum of the fourth and fifth segments, and a similar mark on the seventh and eighth segments. It is of a rather slender cylindrical form, and carries a few colourless hairs.

Pupation takes place in a compact cocoon composed of pellets of the excreta of the caterpillar, which vary in colour with that of the fungus upon which it had been feeding. The cocoon is usually attached to the under surface of the fungus. It may be suspended by a short cord at one extremity, or may be attached at both extremities.

The caterpillars were feeding during January and February. The moths emerged during February and March.

E. ERNEST GREEN.

CEYLON CRUSTACEA.

Part 1.—Notes on the Alpheidæ.

By JOSEPH PEARSON.

(With three Plates.)

THE present report deals with a small collection of Alpheids from the Colombo Museum. The members of the genera *Alpheus* and *Synalpheus*, though numerous in individuals and species, are but little known to any but the specialist in marine carcinology. This is partly owing to their small size, but mainly due to the fact that they generally take up their abode in the deep recesses of some sponge or in the crevices of a fleshy alcyonarian, and even, for want of more favourable shelter, in some friendly hole in a coral. Thus the casual collector may be in the midst of a rich Alpheid fauna without being aware of the fact. Often, however, when sponges are brought up in the dredge and are emptied on deck, the Alpheids will emerge from their retreat.

These tiny creatures are characterized by having an asymmetrical pair of chelæ, one of them being extremely large, perhaps half as big as the body of the animal, while the other is of normal size. The large chela does not appear to be restricted to one side of the body in any particular species. It may be either on the left or on the right side. It is hard to say along what lines this single large chela has been evolved, and the exact meaning of its abnormal development. The Alpheids live in holes, and it is conceivable that, like the hermit crab, the single large claw may be used to block the entrance to the shrimp's retreat. But this does not afford a satisfactory explanation, especially in view of the fact that an Alpheid is much more independent of its place of shelter than is the hermit crab. Moreover, many active Macrurans, such as some of the *Palæmonidæ*, often have asymmetrical chelæ.

These small crustaceans are sometimes known as "snapping shrimps," on account of an interesting habit they have of snapping the fingers of their huge claw. When emptied on deck out of the dredge, or when put into a dish of water, they frequently betray their presence in this way, making a noise which may readily be heard at a distance of fifteen or twenty feet.

I give here an interesting note on the habit of Alpheids, contributed by my assistant, Mr. George Henry. He says :—

"On one occasion I watched two Alpheids, male and female, courting. They were in a pie-dish, full of sea water, with several other creatures, among which were some other Alpheids. The larger specimen, which I took to be a male, was following the smaller (female) slowly round the pie-dish, and evidently "showing off," feeling her with his antennæ, &c. The pair slowly crawled round and round the pie-dish, the female first, followed by the male. After a while a third Alpheid, presumably another male, became interested in the proceedings and approached the pair. When he was within a few inches of them, the first male discovered his presence and smartly whisked round, at the same time vigorously snapping his large chela. He did not attempt to attack the interloper, but merely snapped a number of times in succession, and this appeared to have the desired effect, because the intruder promptly fled. I was unable to make any further observation as a large cuttle-fish came scrambling round and crawled over the pair, much to the indignation of the male, who snapped his disapproval of this treatment."

The knowledge of colour characters that one is able to derive from specimens of Alpheids preserved in spirit is naturally not very reliable. When living these tiny crustaceans are very daintily and even brightly coloured, and the large chela is always most conspicuous by reason of its well-defined colour, generally of a uniform scarlet. Perhaps nowhere else in Nature are the colours so vivid and so varied as those possessed by the coral fishes and other creatures which frequent the brightly coloured sponge masses and branching corals of tropical seas. The Alpheids form no exception to this rule. Owing to the small size the colours are not very noticeable, but their brilliancy harmonizes with the general colour scheme of the coral reefs and sponge banks where the Alpheids abound.

Our present knowledge of Ceylon Alpheids cannot be regarded as being by any means extensive, as it is based upon two small collections—one made by Professor Herdman in 1902, and the other lying in the Colombo Museum and forming the subject of the present paper. As marine biological research in Ceylon has been mainly concerned with the Pearl Banks, most of the Alpheids hitherto described, and the majority of those dealt with in the present report, have come from that locality. It is true that Professor Herdman made collections all around the Ceylon coast, but those made on the Pearl Banks were much more intensive than those taken elsewhere. Consequently it is not surprising to find that of the eighteen species of Alpheids collected by him fourteen were obtained between Chilaw and Adam's Bridge.

In January last I made a very careful examination of the fauna of Trincomalee Harbour and I found it surprisingly rich in Alpheids. Only six species were represented, but the number of individuals was very large. The presence of so many Alpheids may be accounted for by the abundant sponge fauna of Trincomalee Bay.

The following is a list of the species described in the present report :—

Synalpheus neomeris, var. *streptodactylus*, Coutière.
Synalpheus gravieri, Coutière.
Synalpheus biunguiculatus, var. *exilipes*, Coutière.
Synalpheus tumido-manus, Paulson.
Alpheus ventrosus, H. M.-Edwards.
Alpheus phrygianus, Coutière.
Alpheus bucephalus, Coutière.
Alpheus aculeipes, Coutière.
Alpheus frontalis, H. M.-Edwards.
Alpheus rapax, Spence Bate.
Alpheus bis-incisus, de Haan.
Alpheus audouini, Coutière.
Alpheus strenuus, Dana.

The following table gives a list of Alpheids which have been described from Ceylon up to the present :—

	Herdman's Collection.	Colombo Museum.	General Distribution.
Synalpheus neomeris	×		Indo-Pacific, Australia
—— var. *streptodactylus*		×	Maldives, Ceylon
Syn. gravieri	×	×	Maldives, Ceylon
Syn. biunguiculatus	×		Indo-Pacific
—— var. *exilipes*		×	Maldives, Ceylon
Syn. laticeps	×		Maldives, Ceylon
Syn. tumido-manus		×	Red Sea, Indian Ocean
Syn. comatulorum	×		Indo-Pacific, Australia
Syn. carinatus	×		Indian Ocean
Alpheus ventrosus	×	×	Indo-Pacific, Australia
A. idiocheles	×		Maldives, Ceylon
A. phrygianus	×	×	Maldives, Ceylon
A. bucephalus		×	Indian Ocean
A. aculeipes		×	Maldives, Ceylon
A. paraculeipes	×		Maldives, Ceylon
A. paralcyone	×		Maldives, Ceylon
A. frontalis		×	Indian Ocean
A. miersi	×		Indo-Pacific
A. rapax		×	Indo-Pacific
A. pareuchirus	×		Maldives, Ceylon
A. bis-incisus	×	×	Indo-Pacific
A. audouini	×	×	Indo-Pacific
A. strenuus		×	Indo-Pacific
A. macrodactylus	×		Australia, Ceylon
A. spongiarum	×		Maldives, Ceylon

It is not surprising to find that of the twenty-five species and varieties of the Alpheidæ obtained from Ceylon, only three species have not also been found in the Maldives, as one naturally expects the Maldivian crustacean fauna to be similar to that of Ceylon. Coutière has described sixty-six species and varieties of Alpheids from the Maldives, and there is every reason to believe that when the Ceylon fauna has been thoroughly investigated a large number of species will be added to the present list of Ceylon Alpheids.

In giving the sizes of the various species I have used the following symbols :—

a = Total length of carapace along the mid-dorsal line, commencing at the base of the rostrum.

b^1 to b^6 = Lengths along the mid-dorsal line of abdominal segments 1 to 6 respectively.

b^7 = Total length of telson.

e = Greatest length of propodite of large claw.

e^1 = Greatest height of propodite of large claw.

e^2 = Greatest length of dactylopodite of large claw.

I shall not follow Coutière's terms for the parts of the antennules and antennæ.

For "stylocerite" I shall use *antennular scale ;* for "carpocerite," *antennal peduncle ;* instead of "scaphocerite," *antennal scale ;* and I shall use *basal scale* instead of Coutière's "basicérite."

The following is the literature which has been chiefly consulted in the compilation of the present lists :—

1. *Pearson.*—Herdman's Ceylon Pearl Oyster Report. Supplementary Report No. XXIV. The Macrura. 1905.
2. *Coutière.*—Gardiner's Fauna and Geography of the Maldive and Laccadive Archipelagoes. Les Alpheidæ. 1906.

Genus **Synalpheus,** Spence Bate, 1888.

Cephalothorax laterally compressed. Abdomen well developed. Rostrum small and extremely variable in shape and length. Eyes covered by carapace. The orbital arches well defined and separated from rostrum and antennal sulcus by more or less well-defined grooves. Orbital spines in front of orbital arch always present and well developed, often equal in length to rostrum. First antennular article longer than the others. The antennular scale well developed. Basal antennal scale well developed. Pereiopods without epipodites. First two pairs chelate. First pair extremely large and asymmetrical ; the propodite without upper and lower notches ; the dactylopodite short. Carpopodite of second pair subdivided into five parts ; the first part at least equal in length to the sum of the three following parts. Dactylopodite of last three pairs either bifid or trifid.

SYNALPHEUS NEOMERIS, var. STREPTODACTYLUS, Coutière.

Synalpheus neomeris, var. *streptodactylus*, Coutière. Fauna of Mald. and Lacc., 1906.

Two specimens, from Trincomalee ; January, 1911.

The rostrum and orbital spines are equal in length and about two-thirds the length of the first antennular article.

The first antennular article is twice as long as the third and one and a half times as long as the second. The antennular scale extends to the middle of the median article.

The antennal peduncle extends beyond the antennular peduncle by a distance equal to the third antennular article. The antennal scale is slightly longer than the antennular peduncle, but the leaf-like portion is considerably shorter. The basal scale bears two spines: a larger ventral one which nearly reaches the middle of the median antennular article, and a smaller dorsal spine which extends as far forward as the orbital spine.

This variety only differs from de Man's species *neomeris* in the form of the dactylopodites of the third and following pereiopods, The main spine of the dactylos is narrower than in de Man's species, and not so curved. The dorsal spine is longer than in *neomeris*, and is about two-thirds as long as the main spine.

The two specimens are very small, and are, moreover, in a very bad state of preservation, so that satisfactory measurements of the body cannot be given. Measurements of the first three pereiopods are appended, but I cannot say with any certainty that they all belong to the same individual. The only value of these measurements, therefore, is that they give the proportions of the parts of the legs.

Large chela.

$e = 5{\cdot}0$ mm.	$e^2 = 1{\cdot}1$ mm.
$e^1 = 1{\cdot}5$ mm.	

*Second pereiopod.**

i = 1683 ; 370†	c^4 = 165 ; 287
m = 2112 ; 363	c^5 = 429 ; 330
c^1 = 1501 ; 280	p = 1056 ; 363
c^2 = 231 ; 280	d = 676 ; 148
c^3 = 181 ; 277	

Third pereiopod.

m = 2310 ; 594	p = 2046 ; 363
c = 1122 ; 429	d = 660 ; 214

General Distribution.—Maldives, Ceylon.

SYNALPHEUS GRAVIERI, Coutière.

Synalpheus gravieri, Coutière. Fauna of Mald. and Lacc., 1906.

Ten specimens, from the Pearl Banks ; February, 1911.

This form is closely allied to *Synalpheus neomeris*, but differs from it in having a longer antennal scale and a slightly shorter basal scale.

* i = ischiopodite ; m = meropodite ; c^1 to c^5 = segments 1–5 of the carpopodite ; p = propodite ; d = dactylopodite.

† The first of these numbers refers to the length, and the second to the width, of the segment in terms of μ.

The dactylos of the third and following pereiopods is also different, the dorsal spine being extremely small. The propodite is proportionately shorter in this species than in *Syn. neomeris.*

Dimensions of the body.

a = 12·6 mm.	b^6 = 2·4 mm.
b^1 = 2·4 mm.	b^7 = 5·2 mm.
b^2 = 4·5 mm.	e = 11·5 mm.
b^3 = 3·2 mm.	e^1 = 4·9 mm.
b^4 = 3·2 mm.	e^2 = 3·65 mm.
b^5 = 2·4 mm.	

Second pereiopod.

i = 4356 ; 825	c^4 = 627 ; 627
m = 5181 ; 825	c^5 = 1254 ; 660
c^1 = 3762 ; 594	p = 2145 ; 693
c^2 = 792 ; 594	d = 1287 ; 244
c^3 = 627 ; 594	

Third pereiopod.

m = 4785 ; 1617	p = 3729 ; 825
c = 2310 ; 957	b = 1056

General Distribution.—Maldives, Ceylon.

SYNALPHEUS BIUNGUICULATUS, var. EXILIPES, Coutière.

Synalpheus biunguiculatus, var. *exilipes*, Coutière. Fauna of Mald. and Lacc., 1906.

Twelve specimens, from the Pearl Banks ; November, 1910.

The rostrum and the two orbital spines are about equal in length, and the rostrum is much narrower than the orbital spines. The rostrum extends beyond the middle of the first antennular article.

The first antennular article is one and a half times as long as the median article and two and a half times as long as the third. The scale reaches nearly to the middle of the median article.

The antennal peduncle is one-third longer than the antennular peduncle ; its scale is only slightly longer than the latter, and the leaf-like portion of the scale is poorly developed. The basal scale consists of two parts : a longer ventral portion which extends to the middle of the median antennular article, and a smaller dorsal piece which extends as far forward as the tip of the orbital spine.

The following are the dimensions of a typical specimen :—

a = 7·0 mm.	b^6 = 1·5 mm.
b^1 = 1·8 mm.	b^7 = 2·5 mm.
b^2 = 1·8 mm.	e = 9·5 mm.
b^3 = 1·6 mm.	e^1 = 4·0 mm.
b^4 = 1·6 mm.	e^2 = 3·0 mm.
b^5 = 1·25 mm.	

The large claw differs somewhat from that of *S. biunguiculatus* in having the spine at the distal end of upper palmar surface upturned so as to resemble the claw of *Synalpheus apioceros*.

The second pereiopod is richly clothed with setæ near its distal end. Its dimensions are as follows :—

$i = 2046$; 561	$c^4 = 297$; 379
$m = 2706$; 561	$c^5 = 627$; 412
$c^1 = 1617$; 396	$p = 1254$; 429
$c^2 = 363$; 396	$d = 759$; 198
$c^3 = 297$; 379	

The third pereiopod has a single spine at the distal end of the posterior border of the carpopodite, and eight spines on the posterior border of the propodite. The dactylopodite is biunguiculate, the two parts being almost equal. The dimensions are as follows :—

$i = 1089$; 825	$p = 2079$; 528
$m = 3399$; 1056	$d = 396$; 214
$c = 1551$; 627	

General Distribution.—Maldives and Ceylon.

SYNALPHEUS TUMIDO-MANUS, Paulson.

Synalpheus tumido-manus, Paulson. Red Sea Crustacea, 1875.

Synalpheus neptunus, Coutière. Bull. Soc. Ent., France, 1898.

Synalpheus tumido-manus, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from the Pearl Banks ; November, 1910.

Six specimens, from bottom of ss. "Violet," Colombo ; October, 1910.

Twelve specimens, from Colombo Harbour ; September, 1907.

This species resembles *Synalpheus biunguiculatus*, but differs from it in the antennal peduncle being comparatively shorter. There is also a slight difference in the dactylopodite of the third pereiopod. The chela is also slightly longer in proportion to the height.

The rostrum and orbital spines resemble those of *Synalpheus buinguiculatus*, var. *exilipes*, except that the rostrum is slightly longer.

The first antennular article is twice as long as the distal article and slightly longer than the median. The scale extends past the middle of the median article.

The antennal peduncle is only slightly longer than the antennal and about the same length as the antennal scale. The ventral part of the basal scale extends beyond the basal antennular article, and the dorsal part is but feebly developed.

The dimensions of the body are as follows :—

$a = 8 \cdot 0$ mm.	$b^6 = 2 \cdot 0$ mm.
$b^1 = 2 \cdot 6$ mm.	$b^7 = 3 \cdot 2$ mm.
$b^2 = 3 \cdot 4$ mm.	$e = 10 \cdot 6$ mm.
$b^3 = 2 \cdot 56$ mm.	$e^1 = 4 \cdot 5$ mm.
$b^4 = 2 \cdot 25$ mm.	$e^2 = 3 \cdot 2$ mm.
$b^5 = 1 \cdot 9$ mm.	

The dimensions of the second pereiopod are as follows :—

$i = 2442$; 660	$c^4 = 363$; 429
$m = 3217$; 660	$c^5 = 825$; 462
$c^1 = 1914$; 403	$p = 1485$; 495
$c^2 = 379$; 412	$d = 785$; 198
$c^3 = 396$; 429	

The dactylos of the third leg has the ventral part slightly shorter and broader than the dorsal part. There are eight spines on the propodite of the third leg. The distal end of the carpos bears a blunt process on the dorsal side and a sharp spine on the ventral. The dimensions are as follows :—

$i = 1369$; 891	$p = 3069$; 561
$m = 3679$; 1056	$d = 858$; 264
$c = 1914$; 693	

General Distribution.—Red Sea, Indian Ocean.

Genus **Alpheus,** *Fabricius*, 1798.

Cephalothorax laterally compressed. Abdomen well developed. Rostrum small, rarely extending beyond first antennular article. Eyes covered by carapace. The orbital arches well defined and separated from rostrum and antennal sulcus by more or less well-defined grooves. Orbital spines generally absent. First antennal article shorter than the second. Antennular scale much reduced. Basal antennal scale usually extremely small. Pereiopods with epipodites. First two pairs chelate. First pair of pereiopods extremely large and show well-marked asymmetry. Propodite with or without upper and lower notches. Carpus of second pair subdivided into five parts, the proximal part being less than the sum of the three following parts, the last three pairs of pereiopods ending in a simple dactylopodite.

Alpheus ventrosus, H. M.-Edwards.

(Plate V., Fig. 2.)

Alpheus ventrosus, H. M.-Edwards. H. Nat. Crust., t. 2, p. 352, 1837.

Alpheus lævis, Randall. J. Acad. Sci., Philadel., vol. VIII., 1839, and many others.

Alpheus ventrosus, Coutière. Fauna of Mald. and Lacc., 1906.

Six specimens, from Weligama.

Three specimens, from the Pearl Banks ; February, 1911.

According to Coutière this is the commonest species of Alpheus, and the most widely distributed.

I have followed Coutière in including Randall's species along with that of Milne-Edwards.

This is one of the few examples of an Alpheus possessing orbital spines.

The rostrum, which extends almost to the extremity of the first antennular article, is well developed, and is separated from the orbits by well-defined grooves.

The first and second antennular articles are almost equal and nearly twice as long as the distal article. The antennular scale reaches nearly to the middle of the second article.

The antennal peduncle and scale are about equal in length, and extend beyond the antennular peduncle by a distance nearly equal to the third antennular article. There is a basal scale present which is nearly as long as the first antennular article.

This species is characterized by having the cephalothorax laterally compressed to a marked degree. The carapace is very deep, and its greatest depth is equal to its mid-dorsal length. Instead of the lower edge of the carapace being rounded as in most species, there are several sharp angles which give this form a very characteristic appearance.

The following are the dimensions of a typical specimen :—

$a = 9{\cdot}0$ mm.	$b^4 = 3{\cdot}5$ mm.	$e = 14{\cdot}9$ mm.
$b^1 = 1{\cdot}7$ mm.	$b^5 = 2{\cdot}8$ mm.	$e^1 = 6{\cdot}0$ mm.
$b^2 = 4{\cdot}25$ mm.	$b^6 = 3{\cdot}0$ mm.	$e^2 = 5{\cdot}0$ mm.
$b^3 = 3{\cdot}6$ mm.	$b^7 = 5{\cdot}0$ mm.	

The large claw is laterally compressed, and possesses no upper and lower teeth on the palm. The hands of both the first pereiopods are coloured bright orange in the living specimen and have a mottled appearance. Some of the specimens have a setiferous ridge on the movable finger of the smaller hand. The presence of this setiferous ridge is doubtless a sexual difference, and is probably confined to males. I cannot, however, give any proof of this, as in every specimen the first pereiopods are detached and are lying loose at the bottom of the bottle.

The second pereiopod is not so slender as in most Alpheids. The hand is richly clothed with setæ.

The following are the measurements of the second pereiopod :—

$i = 2112$; 825	$c^2 = 1023$; 759	$c^5 = 1221$; 693
$m = 4290$; 990	$c^3 = 858$; 726	$p = 1551$; 693
$c^1 = 2310$; 792	$c^4 = 825$; 726	$d = 359$; 297

The third pereiopod is fairly strongly made. The dactylopodite is not nearly so slender as in most species of *Alpheus*. Dimensions of third pereiopod :—

m = 4290 ; 1551	p = 2706 ; 858
c = 2673 ; 1155	d = 1320 ; 660

Altogether this species is a very distinctive one, and in many ways is different from a typical member of the genus.

General Distribution.—Indo-Pacific.

Alpheus phrygianus, Coutière.

Alpheus phrygianus, Coutière. Fauna of Mald. and Lacc., 1906.

Three specimens, from the Pearl Banks ; February, 1911.

The rostrum is represented by an extremely small projection. It is continued back between the eyes as a well-defined ridge.

The antennular peduncle are comparatively long and slender. The proximal article is shorter than the distal and the median is twice as long as the distal. The antennular scale is rounded in front, and is half the length of the proximal article.

The antennary peduncle is short and only extends to the end of the median antennular article. Its scale is still shorter, and only reaches to the middle of the median article.

The following are the dimensions of the body :—

a = 7·6 mm.	b^6 = 2·1 mm.
b^1 = 1·9 mm.	b^7 = 2·69 mm.
b^2 = 2·0 mm.	e = 8·1 mm.
b^3 = 2·18 mm.	e^1 = 3·67 mm.
b^4 = 2·5 mm.	e^2 = 2·2 mm.
b^5 = 2·0 mm.	

The hand of the large claw is peculiar, and the dactylopodite has a process directed backward, which makes the dactylos hammer-shaped.

The second pereiopod is exceeding slender and has the following proportions :—

i = 5775 ; 693	c^4 = 792 ; 528
m = 7326 ; 5181	c^5 = 1221 ; 594
c^1 = 2772 ; 488	p = 2574 ; 693
c^2 = 2871 ; 528	d = 1154 ; 307
c^3 = 693 ; 528	

In the third and following legs the meros has a well-developed process near the distal end. At the distal end of the carpos there is a blunt process on the dorsal side and a spine on the ventral side, The propodite has six spines, and the dactylos is well curved and single. The dimensions of the third leg are as follows :—

$i = 1386$; 990	$p = 2508$; 581
$m = 3993$; 1221	$d = 792$; 198
$c = 3300$; 726	

This form undoubtedly belongs to the *obeso-manus* group.

General Distribution.—Maldives, Ceylon.

ALPHEUS BUCEPHALUS, Coutière.

Alpheus crinitus, Coutière. Bull. Soc. Entom., 1898.
Alpheus bucephalus, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from Trincomalee; January, 1911.

The rostrum is short and is not half as long as the first antennular article. The rostrum is continued with a median ridge which extends backwards between the orbits.

The first and third antennular articles are equal, and both are slightly shorter than the median article. The scale is small, and only half the length of the first article. The peduncle is only five-sixths the length of the antennal peduncle, and equal in length to the antennal scale.

The single specimen is small, and is too mutilated for accurate measurement.

The dimensions of the chelæ are as follows :—

$e = 7{\cdot}0$ mm.; $e^1 = 3{\cdot}15$ mm.; $e^2 = 2{\cdot}7$ mm.

The fingers are very short, and the palm is high in comparison to its length. Both upper and lower palmar borders are smooth.

The second pereiopod possesses a long second segment to the carpos. The dimensions are as follows :—

$i = 2277$; 462	$c^4 = 462$; 346
$m = 2970$; 330	$c^5 = 660$; 363
$c^1 = 643$; 297	$p = 1221$; 429
$c^2 = 1840$; 330	$d = 627$; 165
$c^3 = 462$; 330	

The third pereiopod is very broad. There is a well-developed spine on the ischium. The meros broadens out distally into a very prominent spine on the lower side. The carpos has a blunt spine at the distal end of its lower border. The propodus is short and has about eight spines irregularly arranged on the lower side. The upper side is richly clothed with setæ. The dactylos is strong and curved. Dimensions :—

$m = 2310$; 792	$p = 990$; 429
$c = 1155$; 495	$d = 528$; 165

General Distribution.—Indian Ocean.

Alpheus aculeipes, Coutière.

Alpheus aculeipes, Coutière. Fauna of Mald. and Lacc., 1906.

Two specimens, from the Pearl Banks ; February, 1911.

The rostrum is poorly developed.

The proximal antennular article is slightly shorter than the distal. The median article is nearly twice as long as the proximal. The scale is short, and does not reach to the end of the first article.

The antennal peduncle is one and a quarter times the length of the antennular peduncle. The spine of the scale is nearly as long as the antennal peduncle, but the leaf-like portion is shorter than the antennular peduncle.

The dimensions of the body are as follows :—

$a = 5 \cdot 0$ mm.	$b^4 = 1 \cdot 67$ mm.	$e = 7 \cdot 6$ mm.
$b^1 = 1 \cdot 0$ mm.	$b^5 = 1 \cdot 2$ mm.	$e = 3 \cdot 3$ mm.
$b^2 = 1 \cdot 2$ mm.	$b^6 = 1 \cdot 3$ mm.	$e^2 = 3 \cdot 0$ mm.
$b^3 = 1 \cdot 2$ mm.	$b^7 = 2 \cdot 0$ mm.	

The chela is exceedingly large in proportion to the body, and is probably about three-quarters as large as the rest of the body. The fingers are short.

The dimensions of the second pair of pereiopods are as follows :—

$i = 2277 ; 363$	$c^2 = 1534 ; 238$	$c^5 = 561 ; 264$
$m = 2442 ; 251$	$c^3 = 379 ; 247$	$p = 1105 ; 297$
$c^1 = 495 ; 231$	$c^4 = 379 ; 257$	$d = 627 ; 115$

The third pereiopod has a small spine on the ischium ; the meros has numerous short spines on its ventral border ; near this border is a longitudinal ridge which ends distally in a well-developed spine. The short carpos has a similar ridge and spine. The propodite has about a dozen spines more or less irregularly arranged. The dactylos is curved, and is characterized by the presence of a small process on its ventral surface. The carpos and propodos are richly clothed with setæ. Dimensions :—

$i = 792 ; 594$	$c = 1320 ; 462$	$d = 373 ; 99$
$m = 2475 ; 660$	$p = 1518 ; 363$	

General Distribution.—Maldives, Ceylon.

Alpheus frontalis, H. M.-Edwards.

(Plate VI., Fig. 3.)

Alpheus frontalis, H. M.-Edwards. H. Nat. des Crust., 1834.
Alpheus latifrons, H. M.-Edwards. J. Mus., Godefroy, 1874.
——— de Man., Arch. f. Naturg., 1887.
Alpheus frontalis, Coutière. Fauna of Mald. and Lacc., 1906.

One specimen, from the Pearl Banks; February, 1911.

The frontal region of carapace has a very characteristic appearance. There is no well-defined, sharply-pointed rostrum, but instead there is a broad lobe covering the bases of both antennules. This lobe is carinated in the mid-dorsal line. The region of the carapace covering the eyes is greatly arched and bulges out considerably. The proximal and distal antennular articles are subequal, and together are equal in length to the median article. From the anterior end of the proximal article there arises a well-defined bunch of long setæ which point anteriorly and extend beyond the end of the peduncle. The antennular scale is poorly developed and is merely a broad lobe about half as long as the proximal article.

The antennal peduncle is slightly longer than the antennular. The scale is short and does not reach much beyond the end of the median antennular article.

The dimensions of the specimen are as follows:—

a = 10·65 mm.	b^6 = 3·0 mm.
b^1 = 3·0 mm.	b^7 = 5·25 mm.
b^2 = 4·5 mm.	e = 10·5 mm.
b^3 = 3·6 mm.	e^1 = 4·4 mm.
b^4 = 3·95 mm.	e^2 = 3·5 mm.
b^5 = 3·0 mm.	

The first pereiopods have no teeth on the palmar borders.

Dimensions of second pereiopod:—

m = 3960; 561	c^4 = 528; 462
c^1 = 2409; 330	c^5 = 858; 495
c^2 = 759; 396	p = 1452; 528
c^3 = 561; 429	d = 639; 231

The third pereiopod has three spines on the posterior face of the carpopodite, and the distal end of this face also ends in a spine. There are seven spines on the propodite. The following are the dimensions:—

m = 5082; 1221	p = 3531; 359
c = 2640; 858	d = 990; 264

General Distribution.—Indian Ocean.

ALPHEUS RAPAX, Spence Bate.

(Plate VI., Fig. 4.)

Alpheus rapax, Spence Bate. "Challenger," Macrura, 1888.

One specimen, from Nachchikuda, Tamblegam.

The median antennular article is more than twice as long as the distal. The proximal and distal articles are equal. The scale is not so long as the first article.

The antennal peduncle and scale are about equal in length and slightly longer than the antennular peduncle. Spence Bate figures the antennal scale as being much longer than the peduncle, but this appearance is due to the long setæ on the front border of the scale.

The following are the dimensions of the body :—

$a = 10{\cdot}5$ mm.	$b^6 = 3{\cdot}5$ mm.
$b^1 = 2{\cdot}95$ mm.	$b^7 = 4{\cdot}4$ mm.
$b^2 = 4{\cdot}35$ mm.	$e = 11{\cdot}6$ mm.
$b^3 = 4{\cdot}0$ mm.	$e^1 = 3{\cdot}5$ mm.
$b^4 = 3{\cdot}7$ mm.	$e^2 = 4{\cdot}35$ mm.
$b^5 = 3{\cdot}25$ mm.	

The large claw is flattened laterally, and its length is two and a half times the height. Both upper and lower palmar surfaces are smooth.

There is nothing noteworthy about the second pereiopods. The measurements are as follows :—

$i = 4620$; 462	$c^4 = 792$; 297
$m = 3861$; 429	$c^5 = 924$; 330
$c^1 = 2310$; 297	$p = 1386$; 396
$c^2 = 1947$; 280	$d = 825$; 165
$c^3 = 792$; 297	

The third pair of pereiopods are characterized by having no regular row of spines on the propodite and by the lanceolate nature of the dactylopodite. The dimensions are as follows :—

$m = 5610$; 1023	$p = 3861$; 594
$c = 3135$; 759	$d = 2310$; 363

Distribution.—Indo-Pacific.

ALPHEUS BIS-INCISUS, de Haan.

Alpheus bis-incisus, de Haan. Fauna Japonica, 1839.

Six specimens, from the Pearl Banks ; February, 1911.

Three specimens, from Trincomalee ; January, 1911.

One specimen, from Colombo Harbour ; September, 1910.

I have had considerable difficulty in deciding whether to place some of the above specimens in Coutière's varieties *malensis* and *stylirostris*. Minute investigation, however, has revealed the fact that there appears to be no constancy in the proportions of the hands of the first pereiopods and in the carpopodite of the second pereiopods upon which Coutière established his new varieties.

I have, in fact, several specimens which show intermediate conditions between de Haan's species and the variety *malensis*, both regarding the proportions of the hands of the first pereiopods and the relative lengths of the first and second articles of the carpos of the second pereiopods.

With regard to the rostrum, I have found that it shows considerable variation in this species, and consequently I do not consider that Coutière was justified in creating the new variety *stylirostris* upon the form of the rostrum of a single specimen. A careful consideration of the whole question makes me unwilling to separate any of these specimens from de Haan's species. Coutière's knowledge of the Alpheidæ is unsurpassed, and gives him an authority which one hesitates to question. But one cannot help feeling that many of the characters upon which he has established new species appear to be unimportant, and in some cases the material at his disposal does not appear to have been sufficiently abundant to enable him to say with any justification that these characters are constant.

In establishing his two new varieties, Coutière makes use of certain characters, the chief of which are, (1) the relation between the total length of the propodite of the first leg (p) and the length of the dactylopodite (d); (2) the relation between the height of the fingers (h^1) and the height of the palm of the first pereiopod (h^2); (3) the relation between the lengths of the first (c^1) and second parts (c^2) of the carpopodite of the second pereiopod; and (4) the relation between the length of the triangular rostrum (l) and the base of the triangle (b).

The following table gives Coutière's measurements for the three species :—

	$\frac{p}{d}$	$\frac{h^1}{h^2}$	$\frac{c^1}{c^2}$	$\frac{l}{b}$
Synalpheus bis-incisus ..	2·75 ..	1·6 ..	1·7 ..	about 1·5
S. bis-incisus, var. *malensis* ..	2·50 ..	1·34 ..	1·33 ..	about 1·5
S. bis-incisus, var. *stylirostris* ..	Not given	..	1·53 ..	about 3·5

To illustrate how the Ceylon specimens differ from the above measurements I append the following table, giving the characters of six specimens belonging to the present collection :—

Specimen.	$\frac{p}{d}$	$\frac{h^2}{h^1}$	$\frac{c^1}{c^2}$	$\frac{l}{b}$
A ..	2·61 ..	1·40 ..	1·43 ..	1·83
B ..	2·41 ..	1·41 ..	1·51 ..	2·48
C ..	2·73 ..	1·59 ..	1·56 ..	2·72
D ..	2·63 ..	1·36 ..	1·32 ..	2·60
E ..	Chela absent	..	1·53 ..	2·77
F ..	2·82 ..	1·56 ..	1·60 ..	2·50

It will be seen that specimen C is the only one which approaches *A. bis-incisus* as diagnosed by Coutière, except that the rostrum is too long. Specimen E appears to be similar to *stylirostris*. None appear to correspond to the variety *malensis*.

I have no hesitation in identifying the specimens under discussion as *Alpheus bis-incisus*, and, as I have pointed out, my examination indicates a considerable amount of variation in all those characters upon which Coutière formed the new varieties.

The rostrum is triangular, and is separated from the orbits by deep depressions. The shape of the triangle is not constant, and varies between the type figured by Coutière as *malensis* and that of *stylirostris*. The rostrum does not reach the end of the first antennular article. The first antennular article is slightly longer than the second and twice as long as the third. The antennular scale reaches to the end of the first article. The antennal penduncle and scale are about equal, and are slightly longer than the antennular peduncle.

The dimensions of specimen A are as follows :—

a = 10·0 mm.	b^6 = 3·5 mm.
b^1 = 2·5 mm.	b^7 = 4·3 mm.
b^2 = 2·5 mm.	e = 17·0 mm.
b^3 = 3·2 mm.	e^1 = 7·0 mm.
b^4 = 3·25 mm.	e^2 = 6·5 mm.
b^5 = 2·6 mm.	

The large claw is of the "edwardsi" type, and this form undoubtedly belongs to that group of species.

The second pereiopod calls for no further comment. The following are the dimensions in specimen A :—

i = 4455 ; 643	c^4 = 693 ; 528
m = 4884 ; 561	c^5 = 1254 ; 544
c^1 = 2838 ; 528	p = 2376 ; 627
c^2 = 1848 ; 528	d = 1254 ; 247
c^3 = 726 ; 528	

The third pereiopod has about seven spines on the propodite. The propodite is richly clothed with setæ. The dactylopodite is long and curved. Dimensions :—

i = 1746 ; 653	p = 4092 ; 528
m = 5280 ; 726	d = 1518 ; 231
c = 3184 ; 627	

General Distribution.—Indo-Pacific.

Alpheus audouini, Coutière.

(Plate VII., Fig. 5.)

Alpheus edwardsi, Coutière (not *audouini*). Bull. Soc. Ent. France, 1898.

Alpheus audouini, Coutière. Fauna of Mald. and Lacc., 1906.

Five specimens, from the Pearl Banks; February, 1911.

This form is very similar to *A. edwardsi* (*audouini*), but differs from it in the form of the palmar projections of the large claw. In *A. edwardsi* they are spinous and in the present species rounded.

This species, although related to *A. strenuus*, differs from it by well-marked characters. The second antennular article is only one and a half times as long as the third.

In *A. strenuus* a line joining the two palmar ridges of the large claw divides the hand into two equal parts. In *A. audouini* the distal portion of the hand is comparatively shorter, and such a line divides the hand in the proportions of 6 : 5.

The second pereiopod shows a difference in the proportions of the first and second parts of the carpos in the two forms. In *A. strenuus* the first segment is only slightly longer than the second (1·12 : 1). In *A. audouini* the proportion is 1·6 : 1.

The third pereiopod of the present species is not so robust as in *A. strenuus*, and the propodite does not bear so many spines.

The following are the dimensions of this form :—

a = 6·6 mm.	b^6 = 2·0 mm.
b^1 = 1·7 mm.	b^7 = 2·62 mm.
b^2 = 2·51 mm.	e = 9·5 mm.
b^3 = 2·3 mm.	e^1 = 4·0 mm.
b^4 = 2·62 mm.	e^2 = 3·5 mm.
b^5 = 1·6 mm.	

Dimensions of second pereiopod :—

i = 2541 ; 462	c^4 = 396 ; 363
m = 2640 ; 462	c^5 = 693 ; 396
c^1 = 1584 ; 363	p = 1452 ; 429
c^2 = 990 ; 363	d = 825 ; 198
c^3 = 495 ; 363	

Dimensions of third pereiopod :—

m = 3300 ; 627	p = 2442 ; 363
c = 1914 ; 396	d = 1023 ; 165

General Distribution.—Indo-Pacific.

ALPHEUS STRENUUS, Dana.

(Plate VII., Fig. 6.)

A. strenuus, Dana. U. S. Expl. Exped., 1852.

A. strenuus, Coutière. Fauna of Mald. and Lacc., 1906.

Localities.—One specimen, from Weligama ; November, 1905.
One specimen, from the Pearl Banks ; February, 1911.
Five specimens, from Mandativu, Jaffna ; July, 1903.
One specimen, from Nachchikuda, Tamblegam ; September, 1908.
Six specimens, from Delft ; June, 1903.
Nine specimens, from Kapalturai, Tamblegam ; October, 1907.

This is a fairly common form, and is the largest of all the Ceylon Alpheids. It is closely related to *A. edwardsi* and *A. audouini*, but differs from them both in the relative lengths of the second and third antennular articles. The second article is twice as long as the third, and the first article is intermediate in size. The antennular scale reaches to the extremity of the first article. The antennal peduncle is longer than that of the antennule. The spine of the antennal scale does not reach the extremity of the peduncle, but is longer than the antennular peduncle. The rostrum does not reach to the extremity of the first antennular article.

The dimensions of the body are as follows :—

$a = 18 \cdot 25$ mm.	$b^4 = 6 \cdot 0$ mm.	$e = 24 \cdot 0$ mm.
$b^1 = 3 \cdot 6$ mm.	$b^5 = 4 \cdot 0$ mm.	$e^1 = 10 \cdot 5$ mm.
$b^2 = 5 \cdot 8$ mm.	$b^6 = 4 \cdot 8$ mm.	$e^2 = 10 \cdot 0$ mm.
$b^3 = 5 \cdot 2$ mm.	$b^7 = 6 \cdot 4$ mm.	

The large claw has been described and figured by Coutière.

The second pereiopod has the following proportions :—

i = 7920 ; 1089	c^2 = 3531 ; 825	c^5 = 2145 ; 858
m = 8151 ; 1056	c^3 = 1386 ; 825	p = 3465 ; 1023
c^1 = 3960 ; 858	c^4 = 1320 ; 825	d = 1848 ; 429

The third pereiopod has the propodite provided with seven or eight pairs of spines arranged more or less irregularly on the anterior side. The dactylos is a strong slightly curved hook. The following are the proportions of the parts :—

i = 2970 ; 1815	c = 6006 ; 1419	d = 2475 ; 495
m = 8580 ; 2442	p = 6105 ; 1320	

The above dimensions are taken from a typical form of this species.

The rostrum varies in length. In one specimen it passes well beyond the first antennular article, and in another it is as long as that article. Normally the rostrum is only about two-thirds as long as the first article.

General Distribution.—Pacific ; Maldives, Ceylon.

Explanation of the Plates.

Plate V.

Fig. 1.—*Synalpheus biunguiculatus*, var. *exilipes*.

Fig. 2.—*Alpheus ventrosus*. *2a*, frontal region of carapace, with antennæ and antennules × 8 ; *2b*, second pereiopod × 9 ; *2c*, third pereiopod × 9 ; *2d*, dactylopodite of third pereiopod × 21.

Plate VI.

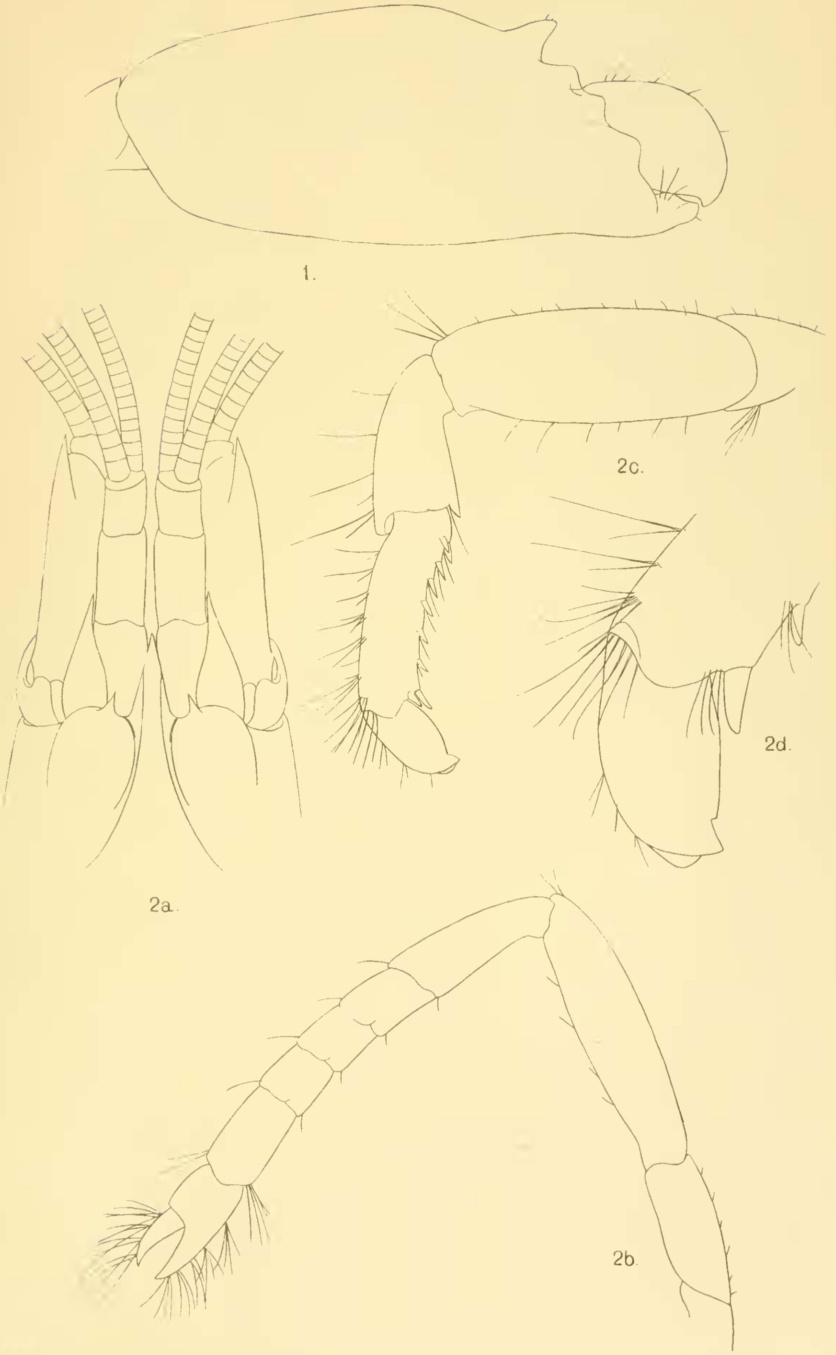
Fig. 3.—*Alpheus frontalis*. *3a*, frontal region of the carapace, the antennules, and antennæ × 6 ; *3b*, second pereiopod × 8 ; *3c*, third pereiopod × 8.

Fig. 4.—*Alpheus rapax*. *4a*, second pereiopod × 8 ; *4b*, third pereiopod × 8.

Plate VII.

Fig. 5.—*Alpheus audouini*. *5a*, frontal region of carapace, the antennules, and antennæ × 9 ; *5b*, second pereiopod × 10 ; *5c*, third pereiopod × 10.

Fig. 6.—*Alpheus strenuus*. *6a*, second pereiopod × 4 ; *6b*, third pereiopod × 4.



Henry, del. E Wilson, Cambridge

FIG 1 SYNALPHEUS BIUNGUICULATUS *var* EXILIPES.
FIG 2 ALPHEUS VENTROSUS

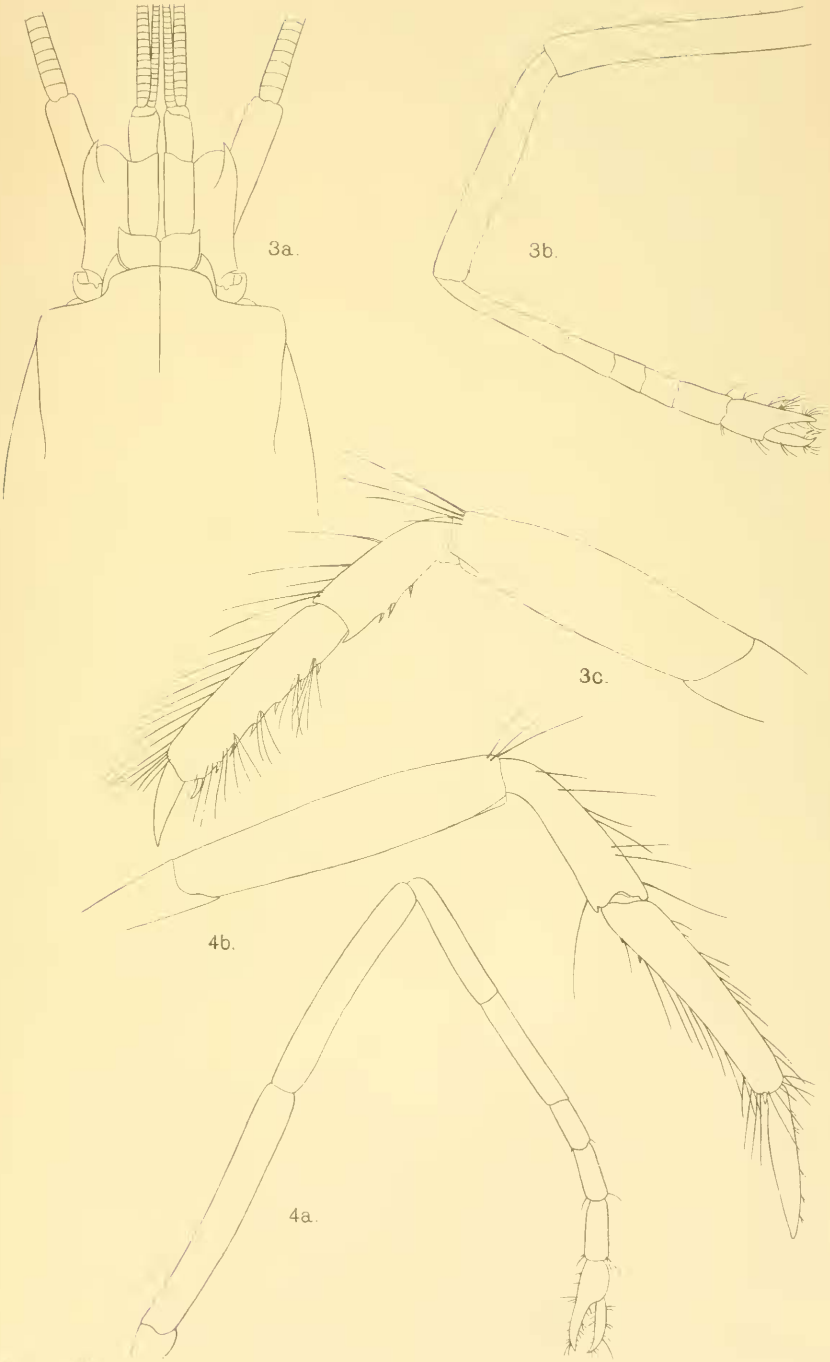


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Fig 3 ALPHEUS FRONTALIS
Fig 4 ALPHEUS FALAX

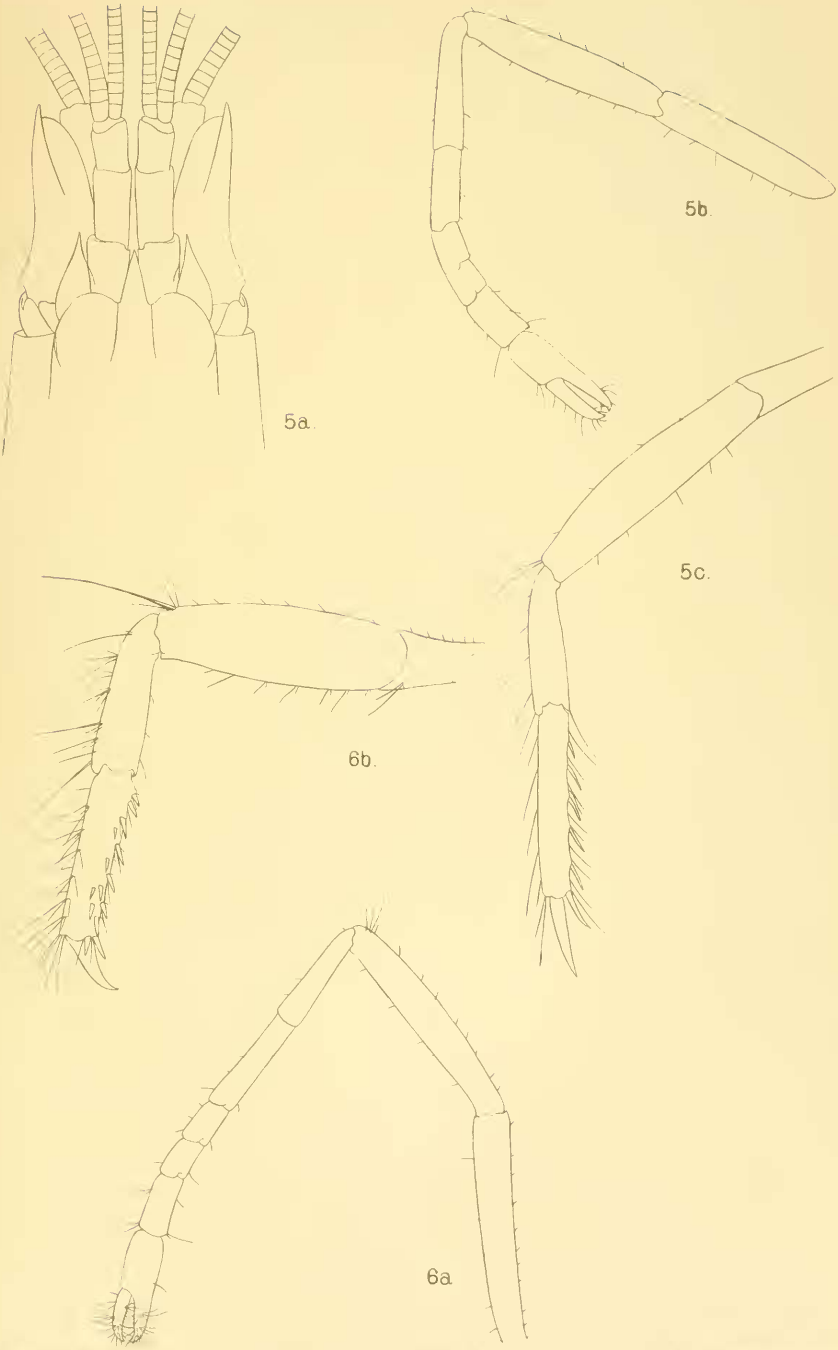


Fig 5. ALPHEUS AUDOUINI
Fig 6. ALPHEUS STRENUUS

A NEW GENUS OF SHORT-BEAKED GNATS FROM CEYLON.

By N. Annandale, D.Sc., F.A.S.B., Indian Museum.

(With one Plate and one Text-figure.)

THROUGH the kind offices of Mr. E. E. Green I have been entrusted with the examination of microscopic preparations of the larva, pupa, and imago of a peculiar little gnat taken by Major MacDougall, R.A.M.C., in a swamp at Diyatalawa in Ceylon (alt. *ca.* 4,300 feet). The specimens are mounted in Canada balsam, and unfortunately include only one imago, a male; but the structure of the fly and its immature stages is of such interest from a systematic point of view that I have ventured to describe the genus and species as new. In so doing I have, I may say, found it very much easier to give a description of the structure than if the specimen had been mounted dry in the ordinary way.

It is a point worth considering whether more fixed and definite standards of entomological classification might not be reached if dried specimens were to be treated as of less account than those carefully mounted in some liquid medium, which would prevent their more delicate organs from becoming shrivelled out of all recognition. Colour would, in some cases, have to go, but, if the preservation be properly carried out, there is no reason why even the finest scales or hairs should be lost in specimens kept in spirit or Canada balsam.

The main interest of the new genus here described as *Ramcia* lies in the fact that it affords a complete link between the "Culicidæ" of Theobald* and other recent authors, and the genera which these authors, intent on finding new pretexts for rending asunder what Nature has joined together, would separate as the family "Corethridæ." In this particular instance the excuse for dividing families resides partly in the structure of the larva and partly in the short proboscis of the imago and the absence of scales on the head, body, legs, and veins of the wings. The larvæ of different "Corethridæ," however, differ considerably more one from another than certain of them do from those of the "Culicidæ"; there is far more difference in structure, to take parallel instances, between the proboscis of *Stomoxys* or even *Philæmatomyia* and that of *Musca* than there is between that of *Culex* and that of *Corethra*, although even the most recent writers place *Stomoxys* and *Philæmatomyia* in the same family as *Musca*, while *Phlebotomus*, although it undoubtedly belongs to a family (Psychodidæ) of which some species have densely scaled wings, has actually fewer scales on the wing than *Chaoborus*.† Nobody denies the affinity of *Corethra* and

* Mon. Culicidæ, iv., p. 15 (1907).

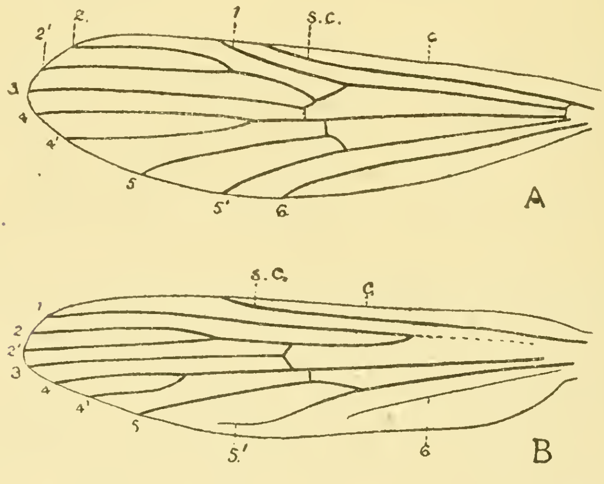
† As regards the synonymy of the genera allied to *Corethra*, see Brunetti, Rec. Ind. Mus., iv., p. 317 (1911).

Chaoborus, and even those authors who regard *Corethra* and its allies as constituting a separate family are forced to ignore the fact that *Pelorempis* has scales on its cross-veins, although they assign this genus also to the Corethridæ. *Ramcia* is eccentric enough to go further than *Pelorempis* in having at once a short proboscis, scales on the longitudinal veins (but not on the head or body), and a larva with several peculiar characters. I am not prepared to say whether those who have made a special study of the group would assign it to the Culicidæ (*sensu suo*) or the "Corethridæ." It differs from both groups in certain venation-characters, more especially as regards the position of the tip of the first longitudinal vein; but the larva on the whole resembles that of *Corethra*, and if the sub-family Corethrinæ is to be maintained, I would assign *Ramcia* to it.

I.—Description of the Adult Fly.

Ramcia,* gen. nov.

The venation is culiciform in general disposition, but is characterized by the fact that the first longitudinal vein, running almost parallel to the subcostal, reaches the costal border at some distance from the distal margin of the wing. The basal and marginal cells are elongate and narrow, and the cross-veins are situated near the centre of the wing.



Venation of the two Corethrinæ as yet known to occur in Ceylon:—A, *Ramcia inepta*, sp. nov. B, *Chaoborus asiaticus* (Giles), a species which occurs at Peradeniya.

c = costal border; *s. c.* = subcosta; 1 = first longitudinal; 2 = anterior branch of second longitudinal; 2′ = posterior branch of the same vein; 3 = third longitudinal or median vein; 4 = anterior branch of fourth longitudinal; 4′ = posterior branch of the same vein; 5 = anterior branch of fifth longitudinal; 5′ = posterior branch of the same vein; 6 = sixth longitudinal.

* Named, by special request of Major MacDougall, after the Royal Army Medical Corps.

The wing-margin (except the anterior proximal part) and the distal half of all the longitudinal veins are clothed with true scales, the proximal half of some of the longitudinal as well as the whole of the cross-veins bearing flattened hairs.

There are no scales on the head, body, or legs.

The eyes of the male as seen from the side consist of a transverse basal and a narrow vertical portion. The proboscis is short and feeble, much shorter than the palpi, which consist of four joints. The antennæ have fifteen joints, of which the first is minute, the second large and globular, and the remaining thirteen (the flagellum) almost cylindrical, but tapering slightly at the distal end, verticillate, and clothed with fine hairs.

The legs are moderately slender. They are clothed with stiff hairs and have simple, smooth-edged claws. The first tarsal joint is longer than the two succeeding joints together. The claws are smooth-edged and simple.

The male claspers are of simple structure.

The venation of this genus approaches that of the Psychodidæ as regards the position of the tip of the first longitudinal vein, but is of a less simple character.

Ramcia inepta, sp. nov.

The abdomen is dark in colour, the thorax paler but probably reticulated or mottled with some dark shade. The wings are pale, except for an interrupted dark crossbar which embraces the extremities of the subcostal and first longitudinal veins, includes the petioles of the first submarginal and the second posterior cells, and appears in the form of spots on the costal and posterior wing-fringes, the anterior branch of the fifth and the distal end of the sixth longitudinal vein, completely omitting the third longitudinal and the main stem of the fifth. The spot on the posterior margin is considerably in advance both of that on the anterior margin and of that on the sixth vein. The tips of all the tibiæ and the three distal joints of the tarsi of the first and second legs are dark.

The subcostal reaches the costal margin a little in front of the middle of the wing, and the tip of the first longitudinal is not much in advance of it. The second longitudinal vein is angulate at its junction with the third, and its fork is a little in advance of that of the fourth. The anterior cross-vein is extremely short. The anterior branch of the fifth longitudinal arises only a short distance behind the posterior cross-vein. There are no longitudinal incrassations or false veins, and the seventh longitudinal is entirely absent.

The wing is moderately narrow, bluntly rounded at the tip, its anterior border being nearly straight and its posterior border regularly and not very strongly curved.

Each joint of the flagellum of the antenna (of the male) bears a circle of very long stiff hairs at its base, and is clothed for the greater part of its length with shorter and softer hairs. The first joint of the flagellum bears also several additional circles of long stiff hairs. The first joint of the antenna is very small and inconspicuous, the second nearly half as large as the head. The third (*i.e.*, the first of the flagellum) is of moderate length and practically cylindrical. Joints 3 to 10 are subequal, joints 11 to 13 also subequal, but distinctly shorter than 3 to 10.

The fourth joint of the palpi (of the male) is the longest, the second the shortest, the first and third being subequal. The basal joint is clavate, the others cylindrical ; all are clothed somewhat sparsely with slender hairs.

The legs are not very long ; they are densely clothed with long straight hairs, among which shorter hairs are dispersed. The hind tibiæ are slightly incrassated at the tip. The femur and tibia of each leg are subequal, and in the first two pairs either joint is distinctly longer than the first tarsal joint, which in its turn is longer than the next three joints together. In the hind leg, however, which is longer than either of the other two, the tibia is only slightly longer than the first tarsal joint, which is shorter than the next three joints together. The claws are slender and strongly curved.

There is a small bunch of stiff slender hairs on the vertex just behind the eyes and another just in front of them. The thorax is sparsely clad with longer and stouter hairs, most of which curve backwards. The scutellum bears a very prominent bunch. The hairs on the abdomen, which are also scattered somewhat sparsely, are finer, more slender, and apparently softer.

The basal joint of the male claspers is cylindrical, about three times as long as broad and of about the same length as the distal joint, which is slender, not very strongly curved, narrowly blunt, and a little irregular at the tip. This joint is naked, but the basal joint is clothed in long hairs.

Length 2 mm. ; length of wing 1·3 mm.

II.—Description of the Larva and Pupa.

The larva differs considerably from any that has previously been described, but bears a certain purely superficial resemblance to that of *Stegomyia*. Its most conspicuous features are its broad triangular head, minute eyes, long jaw-like antennæ, which arise close together in front of the head, and the distinct segmentation of the thorax. There are no palmate chætæ on any part of the animal. When fully adult it measures about 2·5 mm. in total length, its head measuring 0·53 mm. by 0·72 mm.

The head is flattened as well as broad, triangular in outline, pointed in front, but with the posterior lateral angles broadly rounded. The antennæ arise close together at the anterior end, each on a small prominence. They are slender and somewhat depressed, each bearing at the tip three stout and rather lengthy chætæ. Pressed backwards in their natural attitude of repose their tips lie opposite the ocelli, which are dark, very minute, and circular in outline. They are situated on the dorsal surface near the lateral margin. There are no compound eyes. Fine sensory hairs are arranged as follows on the dorsal surface of the head: one on each side a short distance behind the base of each antenna, one just outside each eye, and a row of about five parallel to the lateral margin, a short distance in front of each eye. There is an S-shaped row of short, stout, simple chætæ on each side of the head, commencing on the dorsal surface a short distance behind the eye and curving down on to the ventral surface. Immediately posterior to the bases of the antennæ, on the middle line of the ventral surface, there is a bunch of slender pectinate chætæ which probably can be extended forwards, but in my specimens is folded backwards. The mandibles bear at the anterior end of their inner margin two stout rather blunt teeth, the outermost of which is the smaller of the two. Below these and on a different level six other teeth form an uninterrupted series, the first being the largest, the sixth the smallest, and the others subequal. Below the teeth there is a little T-shaped projection. The maxilla is rather slender and deeply notched on its free margin. The whole appendage is covered with minute chitinous projections. Two large chætæ are borne above the notch (the uppermost bearing a short subsidiary tooth on its upper margin) and two below it, the latter pair being very unequal in size. The lower lip is rather narrow, and the teeth on its anterior margin are slender, the central tooth being larger than any of the others, which are arranged approximately large and small alternately. There is a semi-circular row of stout simple bristles at the base of each maxilla, and at each side of the lower lip there are three sensory hairs, one situated near the end of the lip, the other two arising together some little distance posteriorly.

All the segments of the thorax are distinct and transverse. As seen from above, they have an irregularly hexagonal outline, and are produced to a point at each side, both the anterior and the posterior margins being sinuous, or (in the case of the posterior margin of the third segment) distinctly excavated in the middle. Each joint bears on the lateral point a bunch of long simple bristles.

The first segment of the abdomen, which consists of nine true segments, is broader than any of those of the thorax and more markedly produced at the sides, but otherwise resembles them. The succeeding joints are narrower and less distinctly hexagonal in dorsal profile. With the exception of the ninth, they bear a bunch of simple bristles at either side. The siphons are stout, of moderate length, and closely welded together; apparently they lie almost in the same line as the abdomen. They are provided round their free margin with several little organs, probably of a sensory nature and consisting of a minute chitinous structure shaped like a bird's mandible, from the base of which a slender chæta projects. A bunch of long simple bristles arises from the ventral surface of the tip of the abdomen below the base of the siphons. There are no "floats" or "fins."

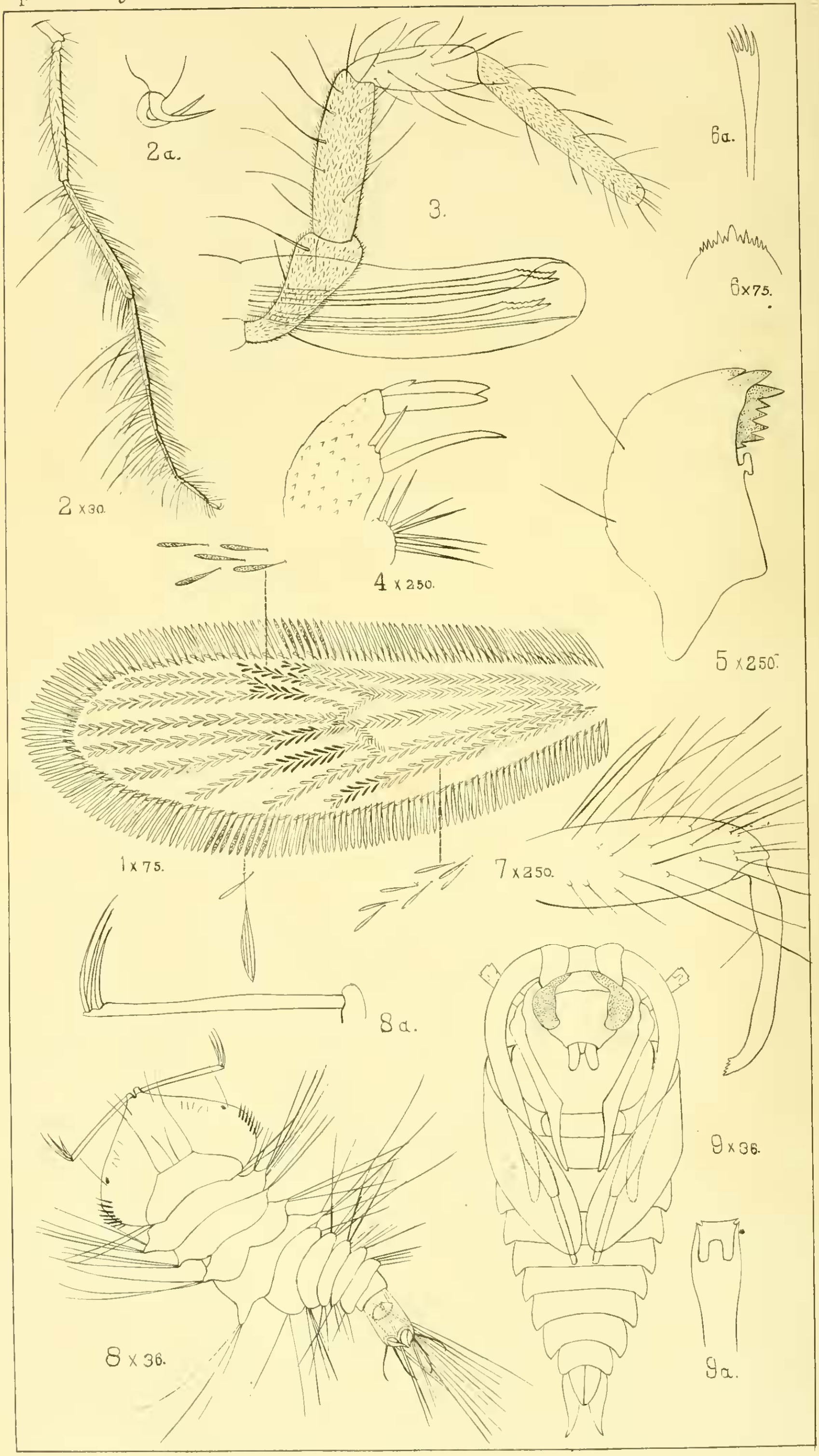
In general structure the larva is not unlike that of *Corethra* (*Mochlonyx*) *velutina*, but the position of the antennæ is different, the head is much broader, the thoracic segments are not welded together, the abdomen is shorter and broader, the siphons are much stouter, and there are other differences.

The pupa of *Ramcia* is not so peculiar as the larva. The general shape is an elongate ovoid, and there is no very clear distinction in the outline between the thorax and the abdomen. The length is about 2 mm. and the greatest breadth about 0·7 mm. The breathing trumpets are long and slender. Their distal margin is distinctly emarginate dorsally, and there is a minute projection in the centre of the emargination. The antennæ curve round entirely outside the eyes. The wings extend to the ventral surface of the abdomen and nearly meet in the mid-ventral line. The abdominal segments decrease gradually in width from before backwards. The tergites are produced laterally in a triangular form, and their free margins are minutely denticulated. The anal lamellæ are slender and pointed; they also are minutely denticulated round the edge.

This pupa differs from that of most Culicidæ in not having the cephalo-thoracic mass distinctly separated from the abdomen. The respiratory trumpets differ from those both of *Culex* and of *Corethra*, but resemble the latter more nearly.

Unfortunately direct information as to the habits of the larva is not forthcoming, but light on this subject may be obtained by a study of the structure. The structure of the thorax indicates great freedom of movement, while that of the antennæ suggests that these organs are employed in seizing prey. There can, I think, be little doubt, therefore, that the larva is actively predacious. The points in which it differs anatomically from the larva of *Corethra* (*Mochlonyx*) *velutina* are not so great as those which distinguish the latter from the larvæ of *Chaoborus plumicornis* and *Ch. pallida*, and it is not too much to assume that in each genus the larval peculiarities are adaptive and due to differences in habits and environment rather than genetic divergence.

The swamp in which the original larvæ were taken has been drained, and neither Mr. Green nor Major MacDougall, both of whom have been kind enough to search for further specimens, have been able to obtain more. It is, however, desirable that dry specimens of the imago should be examined, if only to satisfy those entomologists who regard the superficial character of colour as the most important.



D. Bagchi, del. et. lith.

Explanation of Plate.

Ramcia inepta, nov. gen., nov. sp.

1. Wing (× 75), with scales from different parts further enlarged.
2. Hind leg (× 30): 2a, claws further enlarged.
3. Proboscis and right palp of male (enlarged).
4. Right maxilla and bunch of bristles at its base (× 250).
5. Right mandible (× 250).
6. Lower lip (× 75): 6a, pectinate chæta from bunch in front of lower lip.
7. Clasper of male (× 250).
8. Larva from dorsal surface (× 36): 8a, antenna further enlarged.
9. Pupa from ventral surface (× 36): 9a, dorsal view of breathing trumpet further enlarged.

SOME REMARKS ON THE OCCURRENCE OF CESTODES IN CEYLON.*

By T. SOUTHWELL, A.R.C.Sc. (Lond.), F.L.S., F.Z.S.,

Scientific Adviser to the Ceylon Company of Pearl Fishers, Limited, and Inspector of Pearl Banks.

THERE are few groups of animals in Ceylon concerning which so little is known as the Cestoda. As far as I have been able to ascertain, prior to 1902 only the following Cestodes were recorded :—

Tænia solium, Rud., from man.

Tænia saginata (?), Goeze = *Tænia mediocancellata*, Kuch., from man.

Dipylidium caninum, L. = *Tænia elliptica*, Batsch. = *Tænia cucumerina*, Bloch., from dog.

Tænia saginata has since been definitely identified.

In consequence of the visit of Professor Herdman to the Pearl Banks in 1902, fifty-two new species were described by Shipley and Hornell in Herdman's "Ceylon Reports." Since that time nine other new species, also from marine fish, have been described in Part V., "Ceylon Marine Biological Reports," and a further seventeen new species from the same source are now being described by the writer.

Castellani and Chalmers ("Manual of Tropical Medicine," 1910) report the occurrence of a single case of *Echinococcus granulosus*, Batsch., but this was probably imported from South Africa.

Twelve other species (eleven new) were recorded by Von Linstow (*Spolia Zeylanica*, Vol. III., Part XI., 1906), and seven species (including one *Cysticercus*) were recorded by Shipley (*Spolia Zeylanica*, Vol. I., Part III., 1903).

The total number of Cestodes reported from Ceylon up to the present is therefore 100, described as under :—

Seventy-eight species from marine fish ("Ceylon Reports" and "Ceylon Marine Biological Reports"); two species from man; one species from dog; and the following list :—

Hymenolepis septarai, v. Lins., from *Upupa ceylonensis*.

———— *clausa*, v. Lins., from *Dendrocygna javanica*.

———— *spinosa*, v. Lins., from *Rostratula capensis*.

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* From the Ceylon Marine Biological Laboratory (Ceylon Company of Pearl Fishers, Limited).

Tænia spec. (?), from *Haliastur indus*.
Diorchis occlusa, v. Lins., from *Phœnicopterus roseus*.
Davainea polycolcaria, v. Lins., from *Corvus macrorhynchus*.
Diplochetes volvulus, v. Lins., from *Lobipluvia malabarica*.
Ophryocotyle ceylonica, v. Lins., from *Lophoceros gingalensis*.
Brochocephalus paradoxus, v. Lins., from *Ægialitis mongolica*.
Cittotænia bursaria, v. Lins., from *Lepus nigricollis*.
Ichthyotænia cryptobothrium, v. Lins., from *Chrysopelea ornata*.
Aphanobothrium catenatum, v. Lins., from *Phœnicopterus roseus*.
Cysticercus, from *Cervus axis*.
Duthiersia fimbriata, Dies., from *Varanus salvator* and *V. bengalensis*.
Bothridum pythonis, Blainv., from *Python molurus*.
Tetrabothrius erostris, Lonnbg., from *Sterna bergii*.
Tænia polycalcaria, v. Lins., from *Felis pardus*.
Tænia meander, v. Lins., from *Hipposideris speoris*.
Acanthotænia shipleyi, v. Lins., from *Varanus salvator*.

Of these 100 species, the life-history of four only is definitely known, viz. :—

Tænia solium, Rud.
Tænia saginata, Goeze.
Dipylidium caninum, L.
Tetrarhynchus unionifactor, Shipley and Hornell (the pearl-inducing worm).*

Through the kindness of Drs. Castellani and Chalmers I have had the opportunity of examining some parasites from the pathological laboratory of the Ceylon Medical College. The collection contained the following :—

(*a*) Two fragmented specimens of *Tænia solium*, Rud., from man. Heads and a considerable portion of the "anterior" end of the worms absent.

(*b*) Four specimens of *Tænia serrata* (?), Goeze, from dog. All without heads.

(*c*) Eight specimens of *Cysticercus cellulosæ*, Rud. (= *Cysticercus acanthotrias*, Wienl.) from man (described by Chalmers in *Spolia Zeylanica*, Vol. II., Part VIII., 1905).

(*d*) One part specimen without head of *Tænia saginata*, Goeze, from man. Only about the terminal half of the worm was obtained, and this comprised 170 proglottides and measured 250 cms. (over 8 feet). Each segment was approximately 12 mm. broad and from 18 mm. to 19 mm. long. The worm was markedly gelatinous in consistency, opalescent, and milky white in the fresh state.

* In addition to the foregoing, numerous Cysticercoids have been obtained from marine fishes, the adults of which are undetermined.

(*e*) Seven specimens of *Dipylidium caninum*, L., from a dog.

Average length of worm, 85 mm.
Length of largest segment, 6 mm.
Breadth of largest segment, 3 mm.
Total number of segments, 22.

(*f*) One specimen of *Ascaris lumbricoides*, Linn., from man. The specimen was a female of a grayish-brown colour.

Length 230 cm., greatest breadth 7 mm.

In addition to the foregoing, there were several fragments of a Cestode of the genus *Tænia*, said to have been obtained from a rat. No heads were present, and it was found impossible to identify the fragments further.

It will be obvious from the foregoing that our knowledge of the Cestodes found in the common Ceylon animals is very limited.

Literature cited.

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AN EXPLORATION OF THE BELIGAL-GE, NEAR BALANGODA.

By C. Hartley.

IN August, 1910, I undertook a partial exploration of the Beligal-ge, or Snail Cave, which is situated about twelve miles north of Balangoda and close to the tea estate of Dikmukalana, belonging to Mr. W. D. Holland.

On a preliminary survey I found the cave placed in a most advantageous position, scooped out of a solid and almost perpendicular cliff of gneiss and some 30 feet above a small rivulet, to which there slopes steeply a bank or talus of earth overgrown with trees. The front of the cave faces nearly due west; and at its southern extremity it plunges almost at right angles 79 feet into the rock. From this point it shallows rapidly, until after a considerable inward bend, forming a second recess in the rock, it grows even narrower, and finally tapers to nothing. The rock roof is lofty in the deeper parts, and the floor of dust strewn with boulders slopes gently downward to the northern end. Although no drip-ledge has been cut, the cave seems absolutely dry within; a small wall of rough stones and earth has been built from the southern end some little distance northward; and the drip from the cliff face falls entirely clear of the interior. In fact no more comfortable cave for inhabitation can well be imagined.

A considerable amount of water finds its way down the cliff face, since a small patch of paddy land is situated immediately over the cave; and the constant drip cutting on the loose soil of the slope at the mouth of the cave has laid bare and collected in pools an immense quantity of quartz chips once embedded in the soil. I carefully examined these fragments, and selected one or two which appeared to be implements. They are immediately distinguishable by their smooth waterworn faces from the sharply angular remains recovered beneath the soil.

I found that the floor of earth inside the cave had been greatly disturbed. Not only had the late Mr. Parsons carried out a small excavation near the southern end, in the course of which he found some human bones and other remains now in the Museum, but it has also been the custom among the neighbouring peasants to dig in the soil for the water-snail shells, from which the cave takes its name, and which they burn for chunam to accompany their betel.

During the whole time that I was engaged in digging a number of women and children were hard at work sifting the earth for shells. These consist principally of *Paludomus gardneri*, and more rarely of *Paludomus dilatata*, *Acavus phœnix*, *Bulimus albizonatus*, *Aulopoma hoffmeisteri*, and *Philopotamis globulosa*, which latter, my workers assured me, were not to be found within fifteen miles. I engaged six men, and started work on August 11 by digging a trench leading from Mr. Parsons's excavation northwards, and incidentally clearing out the hole which he had dug and which had become partially choked. Near the surface we found traces of recent civilization: fragments of pottery, at first stout and well made, later thin and fragile, quantities of charred wood and bones mingled with archaic chips of quartz and chert, buttons, and a short length of cheap brass chain. Under similar circumstances in Europe one might have reckoned confidently on unearthing a few coins; but it is certain that none reached my hands. Between 2 and 3 feet below the surface modern traces disappeared, and nothing came to light but fragments of quartz, chert, bone, and shells. At four o'clock we knocked off for the day, at a depth of 4 feet 6 inches.

As the earth was dug out, it was loaded into baskets, carried outside, and passed through a 1-inch sieve. I selected whatever struck my eye ; but it is likely that better work would have been done with a smaller sieve. One or two well-shaped bone implements were recovered by the women sifting the earth for snail shells.

Next day, August 12, we resumed digging at the same place, but in less than an hour we found large boulders which barred our way, and were forced to abandon the hole at a depth of 5 feet.

I thereupon selected a spot at the southern end of the recess in the rock wall already mentioned, and started a trench 8 feet long by 5 feet in breadth. The digging, I may say, is extremely easy work, the earth being light and dry, grayish-brown in colour, and largely composed of sand, ashes, and bats' droppings. We found pottery down to 3 feet, with rare quartz chips ; below 3 feet the latter became more numerous. Chert was comparatively scarce, which is all the more surprising, as a boulder occurs in a stream within half a mile of the cave. I examined this later, and found it much splintered, having no doubt been drawn upon for gun-flints and strike-a-lights. In this second excavation some bones were recovered showing knife-cuts and, at a considerable depth, a small waterworn fragment of plumbago. At a depth of 7 feet 6 inches we were again stopped by boulders ; but snail shells and quartz chips were withdrawn by hand from under these.

A thickness of 7 feet of cave-earth would in Europe lead us to assign a very remote antiquity to the bottom layer. Unless a cave is exposed to floods, such earth can only be composed of wind-borne dust and of particles adhering to the feet of beasts or men who made the cave their home; and it is unlikely that such fine matter could be deposited at a rate of more than 1 foot in a thousand years. In the tropics, however, another agent of accumulation must be reckoned with. All caves in Ceylon swarm with bats; and their droppings even in a single year would add appreciably to the earth, while in a century they might, if undisturbed, perhaps amount to over a foot in thickness.

On the morning of August 13 I opened a trench outside the cave in the sloping bank, heading at first uphill towards my second excavation. The soil here, being exposed to the action of rain, differed totally from the cave-earth from which it was derived. I excavated a considerable area, and found a uniform surface layer of black humus mixed with ashes, pottery, bones, shells, and chips to a depth of 2 feet. Below this we found stiff reddish-brown soil without ashes, but with quantities of quartz and chert chips, which grew ever rarer; until at a depth of 3 feet in the brown earth, or 5 feet from the surface, all traces of human work came to an end. In the brown earth I found neither pottery nor shells nor bones nor any sign of fire. Yet it was in the soil immediately below the layer of ashes that I found chips of quartz and chert most abundant. After carrying my trench 12 feet towards the cave, and meeting with more boulders, I dug another at right angles to the first for a distance of 6 feet and found precisely similar conditions.

The Doctors Sarasin in their "Ergebnisse naturwissenschaftlicher Forschungen auf Ceylon," published in 1908, describe on page 14 the excavation of a similar "talus" in the Bintenna; but they appear not to have found the same sharp dividing line between the black humus (which they do not record as containing ashes) and the brown earth rich in quartz fragments. It seems to me however that the brown deposit, which was evidently blown, kicked, or swept out of the cave above, must have required a lengthy period, perhaps some thousands of years, for its formation; that the underlying layer free from chips was accumulated previously to man's appearance; that the layer with chips and without ashes points to a period when man lived without fire; and that only the uppermost layer proves his acquaintance therewith. Too much stress must not be laid upon the results of a single excavation; but I look forward with interest to further researches.

This concluded my labours in the cave. I explored a few hill-tops in the neighbourhood, found a moderate number of quartz chips, and noted a large outcrop of good white quartz close to the cave. There is a considerable deposit of hard and heavy titanic iron ore within a few yards of the quartz; but I could not find that any use had been made of it by the cave-dwellers.

The harvest of implements which I reaped was a modest one. I brought away over five hundred specimens, of which a little over fifty have found their way into my collection. The best were a few bone needles or borers, two good hammers, and a certain number of blades, points, and scrapers. One waterworn pebble of micaceous gneiss has plainly been used as a rubber, both ends being much worn. But the conclusion is forced upon one, either that the cave-dwellers were very indifferent workmen, or that they were lacking in that quality so valuable to archæologists, of leaving their tools about.

On comparing the results of my digging with those achieved by the Doctors Sarasin, I find a general similarity, except in the case of the talus already mentioned. The identifiable animal remains were more numerous in their excavations in the Bintenna. It appeared to me that bones were surprisingly scarce in the Beligal-ge, those of the larger animals, such as deer and pig, being entirely wanting, while the enormous number of water-snail shells proved that my cave-dwellers were satisfied with the humblest fare. The implements of quartz, crystal, and chert were neither more nor less rude in the one case than in the other. A distinguished archæologist in England has favoured me with the following remarks: "The Veddas—if it be they who made them—must have been a very degraded people, worse than the most degraded we find about here of any period, except perhaps one lot who seem to have come for a short time in a short interglacial period." These scathing sentences are absolutely justified by the roughness of the specimens—good palæolithic work is as far superior to them as it is inferior to good neolithic work. The immense numbers of chips, cores, and refuse prove that the makers had abundant practice. The Doctors Sarasin note with justice the intractability of quartz as compared with flint. But the same plea cannot be admitted in the case of chert, and the chert implements recovered so far from caves are as rude as those of quartz and crystal. It is notable that a far higher level of workmanship and design is attained by implements found on hill-tops, and on the evidence before us I am inclined to believe that the cave-dwellers represent the oldest and rudest type, while their descendants, armed with improved weapons and disdaining the wretched fare of their ancestors, forsook the caves and led an ampler and freer life on the hills, following the game in their seasonal migrations.

Of animal remains discovered, the most important were the snails already mentioned, which seem to have formed their principal food supply. In addition, a fair number was found of the non-edible *Helia* (*Acavus*) *phœnix*, described by the Doctors Sarasin as the "Hobelschnecke," or Plane-snail, used for smoothing wood, of which specimens are to be seen in the Museum. Bones of the following animals have been identified by Dr. Pearson: Madras langur (*Semnopithecus priamus*) and mouse deer (*Tragulus meminna*).

On the other hand, the list of things which one would have liked to find, but did not, would fill several pages.

REVIEW.

THE VEDDAS: by C. G. Seligmann, M.D., and Brenda Z. Seligmann. Cambridge University Press. 1911.

THIS handsome volume of over four hundred pages, with seventy-one plates, thirty-four musical records, numerous songs, and a vocabulary, may be taken as summing up all that we know or are likely to discover of the history, the traditions, and the usages of the fast vanishing race whose purest representatives are estimated by Mr. Parker at less than one hundred persons. An average of over four pages to each individual of a semi-savage tribe may seem excessive to those who do not reflect that the lower the type, the greater the interest; and that, if a race could be discovered living under palæolithic conditions, an allowance of pages twice as generous as we have here would be eagerly demanded.

Dr. and Mrs. Seligmann have gone to the root of the matter. They forsook civilization for a time to live intimately with the Veddas. They have shared their meals and their primitive accommodation; they have been near them in sickness and in health, in festivity and in mourning; and we may well believe the handsome acknowledgment made in the preface to Mrs. Seligmann; "I feel convinced that the measure of success attained in gaining the confidence of these shy and extremely jealous people was entirely due to her presence and assistance."

A full but discriminating use has been made of previous writers on this subject. The works of Knox, Tennent, and Parker are widely known; but those of Virchow, Rutimeyer, and the Sarasins are mostly in German; while much important information is contained in stray articles by Bailey, Nevill, Hartshorne, and others, which is here conveniently summarized. The question of prehistoric stone implements is dismissed with one plate and five pages. We cannot but think that more use might have been made of the researches of the Sarasins and of the collections of Messrs. Pole and Green. For the matter as a whole we have nothing but praise. The authors expressly state that "this volume will scarcely touch on physical anthropology"; but a careful examination has been made of the Veddas' social and family life, religion, magic, ceremonies, music, language, and senses. There is very little in the book which will not be understood by any intelligent reader; but we think that the mode of testing for sight might have been explained at greater length for the benefit of the uninitiated.

Of the numerous illustrations, a few are partial failures owing to the forest gloom, but have been skilfully doctored, or, as Dr. Seligmann terms it, "faked." The greater part, however, are vivid presentments of wild life, and one, No. LV., "Nila holding bow while reciting invocation," rises to the level of fine art.

The "Conclusions" form the shortest chapter, and the authors agree in the main with Mr. Parker's theory that the upper ranks of the Veddas were absorbed by the conquering Sinhalese, who in their turn were influenced by the customs of the vanquished ; while the Veddas represent the untamed remnant who by accident or choice resisted or escaped absorption.

A useful warning is given to tourists not to accept the Danigala Veddas as the children of nature they pretend to be.

"These folk, who when we saw them wore their Vedda loin cloths and were smeared with ashes, are reported to wear ordinary Sinhalese cloths when not in their professional pose, and Mr. Bibile, who has himself seen one or more of them in sarongs, points out that the imposture is kept up for two main reasons : firstly, they fear that their cultivation might be stopped, or that they might be taxed if they did not appear to be poor fellows living on hardly-won jungle produce ; secondly, their pose of poverty interests strangers and procures them visitors, whose generosity is the greater, the more primitive their mode of life appears to be."

These gentlemen, under a more extended franchise, will vote solidly for converting Ceylon into a great winter resort for passengers.

C. HARTLEY.

NOTES.

17. *Further Note on Flies of the Genus "Phlebotomus."*—Recent additions to the collection in the India Museum, including a number of specimens received from Mr. E. E. Green, enable me to supplement, and in one or two points to correct, my former notes issued in Vol. VII. (pp. 57–62) of *Spolia Zeylanica*, while the publication of detailed descriptions of the species found in the Maltese islands by Mr. R. Newstead has made it possible to come to a decision as regards the identity of *P. minutus*, Rondani, and my own *P. babu*. In the first place, I may note that the examination of a large series of specimens of *P. argentipes* from different parts of India and from Peradeniya in Ceylon shows that the peculiarities in venation exhibited by the form I described as *P. marginatus*, great as they appeared to be, are not beyond the limitations of variation found in the former species. I have, moreover, taken specimens in Calcutta the colouration of which agrees closely with that of the form *marginatus*. I am therefore forced to the conclusion that this form must be regarded merely as a variety of *P. argentipes*. It should also be noted that the figure of *P. zeylanicus* printed in my former paper (p. 60, fig. 4) gives, because of the angle at which the wing was drawn, a somewhat incorrect idea of the venation in that species; fig. 5 on the same page is more exact in this respect.

As I suggested would prove to be the case, my *P. babu* is clearly identical with Rondani's *P. minutus*. Mr. Newstead's careful description and figures (Bull. Ent. Research, II., pp. 62, 69–70, 1911) leave no doubt as to this, differences in proportions noted by him being evidently due to nothing but the method of preparation and examination of specimens. I can confirm his statements in every particular from specimens of *P. babu* examined in a fresh condition or preserved in spirit without further treatment.

The changes proposed in this note therefore are—

(1) that *Phlebotomus marginatus* should be known as *P. argentipes*, var. *marginatus*; and

(2) that the name *Phlebotomus babu* should be sunk in favour of *P. minutus*.

As regards the former point, it is interesting to note that several, perhaps all, species of the genus exhibit a curious colour-dimorphism which is apparently not due to season or locality, and certainly is not sexual. Thus, *P. papatasi* exists in Malta, according to

Newstead, both in a "typical pale form" and in a "dark form," and the same is the case with *P. minutus* in Northern Bengal and with *P. major* in the outer Himalayas (see Rec. Ind. Mus., IV., p. 340, 1911).

N. ANNANDALE.

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18. *Contest between a Mynah* ("*Acridotheres tristis*") *and a Locust* ("*Acridium violascens*").—I was a witness a short time ago of a very good instance of the method of defence in a locust when attacked by a bird. The mynah in question was quite tame, and had the run of the house and garden ; the locust flew on to the verandah, and in its usual blundering flight hit against the wall and came to the ground. It was immediately pounced on by the mynah, but at the moment of seizure the insect rolled slowly on to its side, drawing up the long hind leg and exposing to view the gray and black ocellated spots surrounding the spiracles. They certainly gave the insect a bizarre appearance, which was not without effect, as the bird immediately drew back obviously disconcerted. After a moment of hesitation it cautiously approached its beak within two inches of the locust, when again the leg was slowly drawn back, evidently also with the intention as a last resource of striking the bird a smart blow with the sharply serrated ridge of the tarsus. This had the effect of again postponing an attack, and two or three times the same manœuvre was repeated on the approach of the bird's bill. It was very remarkable how the insect seemed to know that the startling effect was more pronounced the more slowly it moved over on to its side, and its apparent intelligence to be aware that it had, so to speak, only one shot in its locker which was to be used as a final resource. It was clear that once it had struck out, and possibly missed its object, the bird would have been immediately inside its guard, with disastrous consequences. Whether the above comes under the heading pseudaposematic defence (false warning colouration), *i.e.*, the assumption by a defenceless insect of a terrifying attitude, or aposematic, or warning character of an insect able to protect itself, is not quite certain, but probably the latter ; which ever it was, it was quite clear to my mind that the insect derived distinct advantage from its terrifying attitude, and displayed an almost human intelligence in its use.

I may add that the bird eventually gave up the contest, and the locust made good its escape.

N. MANDERS.

Note.—Since writing the above, it has occurred to me that an objection may be made to this interpretation ; the argument being that the bird's natural food was locusts and grasshoppers, which it caught in large numbers in the garden, and therefore it must have been well aware of these terrifying marks, and knew that as a practical defence they were useless, and further, that as it was acquainted with the formidable hind leg, it purposely put its beak within striking distance in order to draw its opponent's fire and render it for the moment harmless.

It is somewhat doubtful in my judgment that the above objections are correct ; in the first place, the bird quite likely may never have seen these startling spiracles, as they are normally hidden by the legs and wing covers and would not be visible under normal circumstances; and again, if the insect had not by some means been aware that a certain amount of protection was obtained by them it would not have rolled slowly on to its side, by which means a greater effect was produced, but as quickly as possible in order to draw up the hind leg, its only means of defence.

I mention these objections in order to show how two trained observers might well draw different conclusions from the same facts.

N. M.

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19. *The Effects of the Bite of "Ancistrodon hypnale."*—The other day I was bitten on the ball of the thumb by one of my *Ancistrodons* (I have been keeping a few in captivity). Although I had been previously bitten without any effect, I washed my thumb in a strong solution of permanganate of potash and applied a ligature of string above the bite, as the latter was a bad one, the fang having been broken off and left sticking in my thumb almost up to its base. My thumb then turned blue (due I think to the ligature, and not to the poison), and not wishing to take any chances I visited a native "Vedarala," who put on what he called a "caustic," though it did not burn at all, and only caused a slight smarting. Upon removal of the ligature my thumb returned to its normal colour and became very stiff and swollen, as if it was going to burst ; there was also a slight local tenderness and aching. About five hours afterwards the swelling began to subside and the stiffness to go, and the thumb became quite well in about twelve hours. Personally, I think that the effect of the poison on the blood was practically nil, and that all the symptoms were entirely local, resulting from the ligature, which I drew extremely tight. There was no sign of mortification about the place bitten.

A. F. ABERCROMBY.

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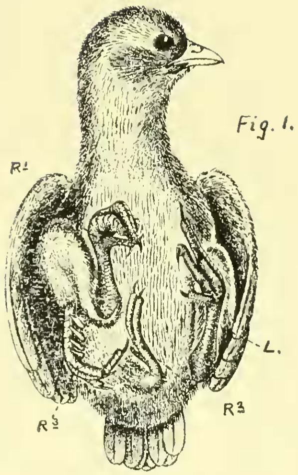
20. *Notes on Ceylon Snakes.*—The commonest of Ceylon snakes are perhaps the following : *Zamenis mucosus*, *Dryophis mycterizans*, *Naia tripudians*, *Lycodon aulicus*, *Dipsas ceylonensis*, *Dendrophis*

bifrenalis, *Oligodon sublineatus*, *Vipera russellii*, *Tropidonotus stolatus*, *Tropidonotus asperrimus*, and *Helicops schistosus*, though the list may vary greatly in different localities, *Ancistrodon hypnale* and *Python molurus* being both common in the northern jungles, while *Trimeresurus trigonocephalus*, so often met with in the Central Province, is rare in the north. I once encountered a young python at Yala, in the Southern Province, during the dry season, a most unlikely place to expect one, owing to the dry sandy condition of the district. It had probably worked its way down the river from the jungles further north.

Among the less common varieties I have found several specimens of *Dipsas forstenii* and *Dipsas barnesii* round Anuradhapura, though I have never come across these in the Central Province or round Kurunegala, though at the latter place are some colonies of *Tropidonotus plumbicolor*.

Snakes usually choose the type of country that suits their colouration, which country also suits their habits. Of all Ceylon snakes, the colour of *Python molurus* is the most inexplicable. It certainly blends with the sun and shadow effects of the jungle in a way which a uniform colouration would not do; but what is the reason for this protection. It is not hunted sufficiently to render protection from man necessary, and there are no other enemies to prey on it. When young, a python might be attacked by a mongoose, but when as small as all that a uniform colouration would not be conspicuous and would serve as a protection. Allowing that the python is "aggressively" coloured, it must be remembered that the latter is usually nocturnal in its habits, waylaying its prey after or about sunset, when its "sun and shadow" colour would be of no avail. The only conclusion is that the python is not as nocturnal as is commonly supposed, and probably waylays its prey at about six o'clock in the evening, when in the remote jungles the deer and small game go down to the tanks and water-holes to drink, though in more civilized and open country the game confine their drinking to after dusk.

Another common Ceylon snake, *Lycodon aulicus*, causes much needless alarm by its resemblance to *Bungarus ceylonicus*, and is much feared by the natives on that account, who mistake it for the deadly "krait," as the *Bungarus* is called in India. *Lycodon*, however, is very common, while *Bungarus* is rare in Ceylon; the former being distinguished by its pear-shaped head and regular scaling, and the latter by its enlarged hexagonal vertebræ. If the snake is over 26 inches long it is probably a *Bungarus*. Of the two species of *Bungarus* found in Ceylon, *Bungarus ceylonicus* is rare, while *B. cæruleus* is very rare indeed, and even of the former I have only obtained two specimens, both from Rangalla, in the Kandy District. Owing to their snake-eating propensities they probably keep to the mountainous districts, where there are many



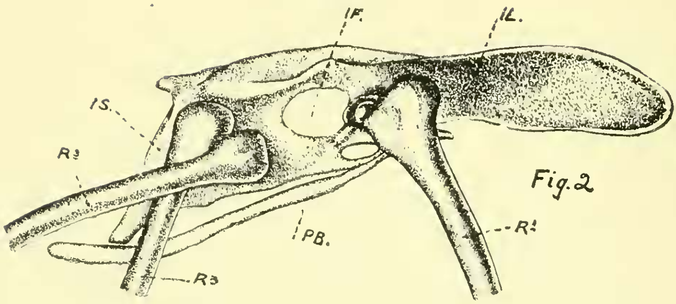


FIG. 1.—Abnormal chicken, ventral view. × ½.

R 1 Normal right leg.
R 2 and R 3 Abnormal right legs.
L. Left leg.

FIG. 2.—Skeleton of pelvic girdle, showing attachment of the three right legs.

R 1 Femur of normal right leg.
R 2 and R 3 Femurs of abnormal legs.
IL. Ilium.
IS. Ischium
PB. Pubis.
IF. Ilio-sciatic foramen.

earth-snakes. In fact, at the Zoological Gardens in Regents park it has been found impossible to make them eat anything but other snakes.

The pretty whip-snake, *Dryophis mycterizans*, has a peculiar habit, if caught and placed somewhere where it cannot escape, of raising itself up, opening its mouth, and expanding the lower jaw into the form of an oblong, which gives it a most ferocious appearance. Although I have repeatedly noticed this habit in low-country specimens, yet I have never seen one of the up-country snakes do it, though I have kept many of them.

Very much the same aggressive behaviour is to be seen in *Tropidonotus stolatus*, which puffs out its body in resemblance of a viper, while the rat-snake will often raise itself up and expand its neck with air, in emulation of the cobra.

Considering how closely allied *Trimeresurus trigonocephalus* is to the American *Crotali*, its custom of vibrating its tail rapidly when irritated is peculiar, but I do not think this habit is in any way due to its relationship to the rattle-snake, as I have noticed the same behaviour in *Dipsas ceylonensis*.

In view of the discussion which recently occurred as to the species of *Dendrophis* commonly found in Ceylon, it may be of interest to say that when last in England I asked Mr. G. Boulenger about it, and he gave it as his opinion that *D. bifrenalis* was the common variety, though there was very little distinction between it and *D. pictus*.

A. F. ABERCROMBY.

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21. *Abnormal Chicken with Four Legs.*—Some months ago a newly-hatched chick of the common domestic fowl was brought to me. The bird was peculiar in having two supernumerary legs—both on the right side of the body (see fig. 1). Such abnormalities in birds appear to be by no means uncommon. I was interested to see how the two additional legs were attached to the pelvic girdle, and for this purpose a skeleton of the specimen was prepared. Owing to the soft nature of the bones this process was by no means an easy one.

The heads of the two additional femurs did not appear to be fitted into sockets, but the two bones were plastered down flat on the side wall of the right ischium (see fig. 2). The heads of the two femurs lay quite close together, and the two bones crossed over each other. The interesting point about these two limbs was that there was no tibio-tarsus present. Each femur was directly connected with the tarso-metatarsus. The femur and tarso-metatarsus of each supernumerary leg was the same size as the similar parts in the normal legs. Each supernumerary leg had only three toes.

Measurements taken.

Total length of chick from beak to tip of tail 125 mm.

Lengths of normal legs (R^1 and L)—

Femur 21 mm.

Tibio-tarsus 33 mm.

Tarso-metatarsus 21 mm.

Foot with four toes, longest toe 24 mm.

Lengths of extra legs (R^2 and R^3)—

Femur 21 mm.

Tarso-metatarsus 21 mm.

JOSEPH PEARSON.

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22. *Sun-fish caught near Jaffna.*—In May last I received word from the Government Agent, Northern Province, of the capture of a peculiar fish in Kayts harbour, near Jaffna. A photograph of the fish was sent on to me, and is here reproduced. So far as I can make out it is a specimen of *Orthagoriscus truncatus*, a fish which has a very wide distribution throughout the Atlantic and Pacific. So far as I am able to determine this is the first time this species has been recorded from Ceylon waters. In 1885 a small sun-fish was caught off Colombo and created a small sensation. The fish was exhibited in the Pettah, and hundreds of natives paid a small fee to see it. It is unfortunate that the fish was not identified nor obtained for the Museum collections.

The present specimen agrees with *O. truncatus* in having small hexagonal markings on the skin. In the original photograph these markings were readily made out on the side of the body with the aid of a hand lens. The size of the specimen was—

Greatest length 26 inches.

Greatest height 13 inches.

Greatest thickness 4 inches.

The photograph which is reproduced was sent by the Government Agent, Northern Province.

JOSEPH PEARSON.

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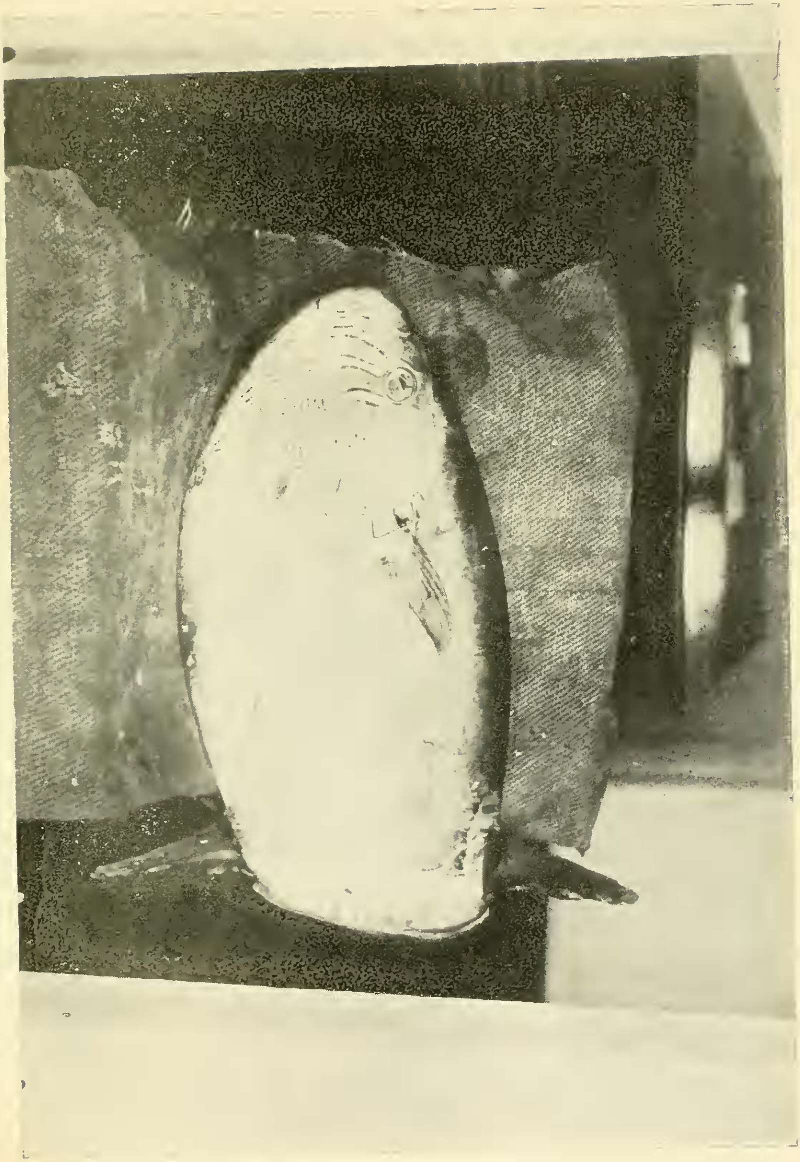
23. *The Giant Tortoise at Galle.*—Rambling about the grounds of Hirimbura, Garstin Hill, Galle, at present occupied by Mr. J. Black, is a fine old giant tortoise belonging to the same species as the old Colombo tortoise, viz., *Testudo gigantea*. This is undoubtedly the "Matara tortoise" to which I have already referred in *Spolia Zeylanica*, Vol. VII., Part XXVI., p. 109. The history of this tortoise



Sun-fish caught near Jaffna.

is by no means clear, and previous to the year 1843 nothing seems to be known about it. Mr. Black writes from Galle as follows: "He has been at the Hill as long as the oldest inhabitant can remember. Though quite active he is blind in one eye, and I do not think sees very well with the other...... I wrote to America to Mrs. Garstin, an old lady of ninety, the widow of the Rev. Norman Garstin, D.D., who lived many years at Hirimbura as far back as 1843. She could not remember how the tortoise came to the Hill. Her son, also in America, writes that he remembers riding the tortoise when a boy. He left Ceylon about 1860." Mr. Paul Pieris, C.C.S., writes as follows: "The Galle tortoise is at Garstin Hill, about three miles from the fort, a spot which is very prominent as one sails past Galle. This tortoise is said to be one of two brought to the spot by Dr. Norman Garstin, Colonial Chaplain of Galle, certainly before 1846. The animal is about four feet across, and is still in fairly good health. It roams about the Hill, eating leaves and the very tender coconuts which drop from trees, and any food that the servants at the house throw to it. Garstin Hill was purchased by Dr. Garstin in part from a clergyman who lives in local recollection as William and in part from the neighbouring villagers. Garstin, I understand, built the bungalow. His administrators sold the land to my kinsman, the late Frederick Dias Abeysinha, Mudaliyar, who in a fit of spleen has left it to the church. I remember the Mudaliyar had some papers which he once showed to me, from which he proved to his own satisfaction that the tortoise was over 120 years old. Where those papers are I cannot say. Perhaps the Bishop may have them among the title deeds. The Mudaliyar was also not unwilling to give the animal to the Museum. Perhaps if the Bishop were informed of this he might carry out his desire. I am sorry that I cannot give you any further information, but you ought to have no trouble about securing a photo of the animal from Galle."

In April last I paid a visit to Galle and saw the tortoise for myself. He is a specimen of *Testudo gigantea*, and is slightly larger than the Colombo tortoise. He seemed perfectly happy, roaming at will through the delightful grounds of Mr. Black's residence, and was quite active.

In addition to the Colombo and Galle giant tortoises, there was still another specimen, which was the property of Mr. A. A. Hankey, of Arncliffe, Colombo. This beast was brought from the Seychelles twelve years ago, and has now been sent to the Trevandrum Zoological Gardens in India.

JOSEPH PEARSON.

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24. *The Gourami.*—In his Administration Reports for 1908 and 1909 Dr. Willey describes the introduction of the gourami into Ceylon. Eventually three were placed in the small tank at the

back of the Museum, and twenty were placed in the large pond in Peradeniya Gardens. In a footnote to Dr. Willey's paper on the Fresh-water Fisheries of Ceylon (*Spolia Zeylanica*, Vol. VII., Part XXVI., p. 96) I wrote as follows: "On November 5, 1910, Mr. Green and I made an examination of the pond at Peradeniya and found no signs of the gourami. Two native fishermen were employed, and they used a vertical net somewhat like a seive net. After an exhaustive search they declared that there were no fish in the pond. The pond overflows into the Mahaweli-ganga, and it is probable that the fish have escaped to the river, although the ledge which guards the overflow would render this difficult but not impossible." Since the above was written, Mr. Pertwee of Colombo has seen some of the gourami in the Peradeniya pond, so that it is not true that all the gourami have escaped to the river. I had the small Museum tank emptied on May 16, 1911, and found the three gourami in a flourishing condition.

No figures are available regarding the exact sizes of the fish when first placed in the tank, but Dr. Willey, speaking in general terms of all the fish imported, said that they measured from six to eight inches in length. Those measurements refer to September, 1909. The following are the measurements of the three fish in the Museum tank taken in May, 1911:—

	(1).	(2).	(3).
Weight of fish ..	1 lb. 2 oz. ..	1 lb. 10 oz. ..	1 lb.
Total length ..	12 in. ..	$12\frac{1}{2}$ in. ..	$10\frac{1}{4}$ in.
Height of middle of body ..	6 in. ..	6 in. ..	5 in.

It is highly probable that a further stock of gourami will be imported, and after being suitably labelled they will be deposited in various tanks and ponds in different parts of the country. Here they will be protected to some extent from their natural enemies until they have become acclimatized and have fairly established themselves. If spawning is successful, as undoubtedly it ought to be, the young fry can be gradually transplanted either to other ponds where they will be preserved or directly to the rivers.

JOSEPH PEARSON.

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25. *Proposed further attempt to introduce the Gourami ("Osphromenus olfax") into Ceylon, with notes on a suitable locality.*—The gourami is so well known and so highly prized as an article of food throughout the Far East, that its absence from the rivers and tanks of Ceylon constitutes one of the many mysteries of our local domestic economy. True, several attempts to introduce gourami into Ceylon waters have been made in the past, the earliest of which

I have traced any authentic record being that by Mr. G. M. Fowler some ten or twelve years ago, but this, in common with other efforts since made by private individuals, came to nothing, chiefly for want of knowledge how to protect and propagate them and for lack of observation as to what actually happened after they were liberated in their new environment.

As many readers will remember, the most recent attempt to add this species to our meagre show of palatable fresh-water fish was made in September, 1909, when Mr. Kelway Bamber, at the instance of Dr. A. Willey, brought up a consignment of about forty from Java, most of which were landed in excellent condition. Unfortunately lack of experience on the part of their custodians, or want of time to give them adequate attention, has resulted in yet another failure. The writer had several opportunities of observing a few of the above specimens which were kept for a time in the cement tank at the rear of the Museum, and in spite of their cramped situation they appeared to be doing well, and certainly gained considerably in size and weight. After a few months, however, they developed a fungoid growth immediately above the eye, and this, although apparently no inconvenience to the fish, was thought by Dr. Willey to be a misfortune of sufficient gravity for special investigation. Whether or not the learned Doctor ever determined the cause I have been unable to learn. Probably the restricted space, high temperature of the water, or other local condition was accountable ; anyway the appearance of fungoid growths on the eyes of fish is no new thing, particularly in the tropics, and need not be taken into account when considering the advisability or otherwise of introducing a new species.

Dr. Willey's successor at the Museum, Dr. Joseph Pearson, has recently looked into this question of introducing gourami into Ceylon waters, and at his suggestion the writer recently made an examination (or rather inspection) of the Kandy waterworks reservoir with a view to determine its suitability or otherwise as a permanent nursery for the propogation of *Osphromenus olfax*, and possibly other tropical fresh-water fishes which are not at present represented in our inland waters.

For reasons set forth below, I am of opinion that the water in question is suitable in every way, and I strongly advocate the introduction of gourami therein. This fish thrives best in still or gently flowing water, a condition which is admirably filled in the above situation. It is also largely herbiverous, and the water indicated is well provided with subaquatic vegetation of a suitable nature. Marginal feeding grounds, which is an exceedingly important factor where breeding operations are to take place, could easily be provided ; at present the banks are kept strictly bare and free from vegetation of any sort. Essentially a tropical species, the temperature of this water is suitable in every way for the propagation of gourami, as I learn it seldom, if ever, drops below 70° F. At the date of my inspection (June 17, 1911), after an unusually long drought, there was 35 feet of water at the outlet, shelving up to a few inches at the intake—an admirable condition for breeding purposes.

There appear to be two natural enemies present, namely, the Indian otter and the fresh-water tortoise, but I do not consider either are sufficiently plentiful to constitute a serious menace, though unless checked they may become so.

I am further of opinion that gourami, if allowed to reach the age of 9 to 12 months, would thrive well in the large lake at Kandy, but the great number of tortoises there renders successful breeding problematical. At present the reservoir contains no fish beyond a few small carp, probably *Barbus mehecola* (black spot), *B. pinnauratus*, and *Rasbora daniconius.*

The fact that this water is close to Peradeniya is a further favourable circumstance, since any experiments that may be decided upon can be supervised by the Government Entomologist or other member of the Peradeniya staff. Further, the reservoir being enclosed and in charge of watchers night and day, the danger of poaching or other interference is reduced to a minimum.

A. H. PERTWEE.

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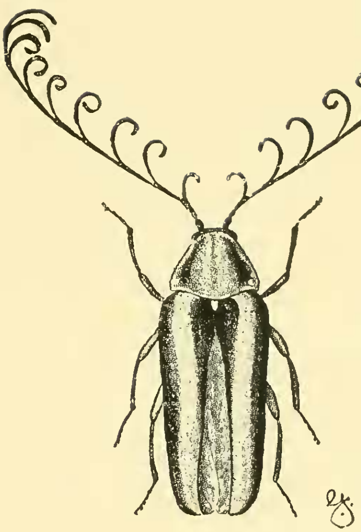
26. *On the Occasional Luminosity of the Beetle "Harmatelia bilinea."*—This small beetle (shown in the figure as magnified about 6 diameters) is extremely abundant, at certain times of the year, in many parts of Ceylon. It may be found resting upon the leaves of various shrubs in the jungle, and is often seen on the wing. It is noticeable on account of its remarkable pectinated antennæ, and may be further distinguished by two conspicuous longitudinal ochreous stripes (one on each elytron) on a black ground.

Although this beetle has been included by Olivier amongst the Lampyridæ (fireflies and glow worms), nothing appears to be known about its luminous properties. I have frequently examined living examples of *Harmatelia*, but have never observed the faintest trace of luminosity, nor does the abdomen show any conspicuous photogenic organ such as is noticeable on the under surface of all the typical fireflies. But that it can, on occasion, produce an appreciable light is proved by the following observation of Mr. John Pole, who, in sending me a specimen of the insect, asks if I am aware that it "gives light at night like a firefly." He reports that, one evening, at 7.30, in a mist and with a clouded moon, he "caught the animal, alight, on a tea bush, and boxed it as a small firefly." He adds that the light paled out before he reached home. The insect was kept



× 6

Harmatelia bilinea.

alive, and Mr. Pole tells me that on the following night the animal again became luminous, but that the light was rather more subdued, and that at no time was it as bright as that of the common firefly. Other examples of the same species, examined by Mr. Pole at the same time, did not exhibit this phenomenon.

Wishing to find out what had been recorded on the subject, I applied to Mr. C. J. Gahan, of the British Museum (Nat. Hist.), who replied as follows: " I believe nothing is known as to the luminous properties or otherwise of *Harmatelia*. The mere fact that Olivier included *Harmatelia* in Lampyridæ counts for little, as I believe the genus was unknown to him until he paid us a visit here a short time ago. Do you know the female of *Harmatelia?* All our specimens seem to be males .... They (the females) might incidentally throw some light upon the position of the genus. I suspect that the female *Harmatelia* is like the male, except that it has simple instead of pectinated antennæ; my reason for thinking so being that we have one (apparently) female of a species (undetermined) which seems referable to *Harmatelia*. Have you ever heard anything of a glow worm in Ceylon which has a series of emerald green lights along each side of the body? It is just possible that the female of *Harmatelia* may be luminous after this fashion; that it may, in fact, be larviform like the female of the *Phengodini*, of which the males have fine plumose antennæ and are not very different in structure from *Harmatelia*."

An examination of the series in my collection shows that these also are apparently all males—having elaborately pectinated antennæ. So the problem of the female of this insect still remains to be solved. If any readers of *Spolia* should meet with a multi-illuminated glow worm, as described in Mr. Gahan's letter, I would ask them to preserve it and send it to me, dead or alive, but preferably the latter.

Though Mr. Gahan speaks of the single species *Harmatelia bilinea*, Olivier (" Genara Insectorum," fasc. 53) records two species—*bilinea* and *discalis*—from Ceylon, both described by Walker in 1858. A study of my series, comprising specimens from Maskeliya (4,000 to 5,000 ft.) and from Peradeniya (approximately 1,600 ft.), convinces me that we really have two distinct species; but which is which I am not at present in a position to determine. The montane form (from Maskeliya) is the darker of the two, and has the prothorax proportionately smaller; the head black and almost glabrous, with strongly raised frontal ridges above the insertion of the antennæ; the median area of the prothorax uniformly black; the costal margin of the elytra ochreous, and the whole under surface of the body of the same pale tint. The Peradeniya form has the head and prothorax ferruginous red, the latter with a black fascia on each side, which in some examples tends to spread over the central area; the head is sulcate between the antennæ and densely clothed with fulvous hair, and has no markedly prominent frontal ridges ; costal margin of elytra black, and under surface of body distinctly fulvous. My figure represents the species (or form) common at Peradeniya. The luminous properties were observed in the up-country species ; but the two, if really distinct, are so closely allied that they are unlikely to differ in this respect.

Mr. J. Bourgeois, in a paper on " Malacodermes et Lymexylonides de Ceylan " (Ann. Soc. Ent. France, Vol. LXXVIII., 1909), has described and figured our Peradeniya insect under the name of *Haplogeusis ceylanica*, gen. et sp. nov. This is almost certainly a synonym of either *Harmatelia bilinea* or *H. discalis*.

E. ERNEST GREEN.

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27. *On the probable occurrence of Field Mice in Ceylon.*—Blanford, in his volume on Mammalia (" Fauna of British India "), describes nine distinct species of voles from the Indian region, but not a single one of these is recorded from Ceylon. At present, so far as zoological records are concerned, we have no voles in Ceylon. I am convinced that this omission is not really justified.

During a recent visit to the Horton Plains I saw an animal in the resthouse garden that could have been nothing but a vole. And my companion (Mr. J. C. F. Fryer) observed another (probably of a different species) in a swampy piece of ground near the jungle. The latter individual appeared to be of the nature of a water rat, as when disturbed it took to the water.*

The voles (or field mice and water rats) may be distinguished superficially from the true rats and mice by their comparatively short tails and blunt muzzles. The tail of a vole is never more than one-third the length of its body, while rats and mice have tails that are seldom less than half and sometimes equal in length to the body of the animal.

Will any of our sporting friends help us to establish the occurrence of voles in Ceylon ? The Horton Plains are the happy hunting grounds of sportsmen with rod, gun, and hounds, who must have unique opportunities of observing the wild life of the locality. A skin, accompanied by the skull, would settle the matter beyond dispute.

E. ERNEST GREEN.

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* Since sending in this note, I have had independent corroborative evidence of the existence of voles in the higher parts of Ceylon. Mr. W. Ormiston tells me that, while fishing at Ambawella, he has often seen small reddish mice on the banks of the streams. He describes them as having the appearance and attitudes of English field mice.—E. E. G.

28. *On some Butterflies of the Horton Plains.*—At the time of my visit (in the middle of May) butterflies were neither abundant in numbers or variety. The commonest species in the jungle paths were *Lethe daretis*, *Cyaniris lanka*, and *C. singalensis.* I was somewhat surprised to find at this elevation (between 6,000 and 7,000 ft.) two species that are usually associated with the low-country and the lower montane regions. I caught a single example of *Nepheronia ceylanica* in the resthouse garden, and found *Ypthima ceylonica* frequenting the edges of the jungle. *Ypthima singala*, which usually replaces *ceylonica* in the higher hills, was conspicuous by its absence. Similarly, the typical up-country forms of *Terias*, *venata*, and *libythea* were not seen, though *hecabe* was on the wing.

E. ERNEST GREEN.

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29. *On an interesting aberration of "Vanessa (Pyrameis) indica."* *—A curious aberration of this usually very constant butterfly has occurred amongst examples bred at Peradeniya, presumably consequent upon a stimulus induced by a sudden change of temperature. This butterfly is a distinctly montane species, seldom, if ever, occurring spontaneously below 3,000 ft. in Ceylon, but more frequent at still higher elevations. In India the species is said to range from 2,000 ft. upwards, but to be found more commonly at and above 4,000 ft.

The food plant of *Vanessa indica* is *Girardinia heterophylla* var. *palmata.* According to Trimen, typical *heterophylla* is common on waste land in the low-country up to 3,000 ft., above which elevation it is replaced by its variety *palmata*, which differs from the type form principally in having the leaves hirsute beneath. From its distribution *V. indica* appears to be restricted to the higher montane variety of *Girardinia heterophylla.*

In May last I received from Major A. J. MacDougall some pupæ of *V. indica* collected at Diyatalawa (4,300 ft.), together with a single full-fed larva. The pupæ all disclosed butterflies of the typical pattern, but the single larva, after pupating in the warmer climate of Peradeniya (1,500 ft.), appeared in a strikingly different form.

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* Since the preparation of my note on an aberration of *Vanessa indica*, I have seen a description and coloured figure of what must be a closely similar aberration from Southern India. This account is in a paper by Mr. P. J. Lathy, "On some aberrations of Lepidoptera from the collection of Herbert J. Adams" (Trans. Ent. Soc. London, 1904, p. 65). The locality quoted is merely "Travancore, S. India." The circumstances of the capture are not given, nor the altitude at which it was taken. It would be interesting to know whether this specimen was caught on the wing, or whether (like my examples) it had been bred from larvæ taken at a higher elevation.—E. E. G.

The main characters of the aberration are as follows. On the upper side the red area on the fore-wing is more widely extended, obliterating the usual black patch in the middle of interspace 1, and the submarginal red band on the hind-wing does not include the black spots that are found in typical examples. On the under side the differences are still more marked; the red area on the fore-wing is even more widely extended, and the subapical white streaks and spots in the black area have disappeared; the hind-wing is almost entirely suffused with pale gray scales, leaving only a few nebulous patches of brown. If this specimen had been captured on the wing it might have suggested a natural hybrid between *indica* and *cardui*.

From a subsequent batch of larvæ that pupated under similar conditions I obtained two normal examples of the butterfly and one aberration precisely similar to the first.

E. ERNEST GREEN.

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30. *On "Megaderma lyra," its Habits and Parasites.*—In a previous number of this Journal I have called attention to the carnivorous habits of bats of the genus *Megaderma*. I have found frequent signs of its depredations in the remains of birds and small bats dropped in my verandah. I have since seen the fragments of a mouse (consisting of the feet and part of the head, mingled with the characteristic excreta of a bat) that had evidently been captured and devoured by the same animal. But, until quite recently, I had never come to close quarters with the bat itself. Examination of a loft above the Royal Botanic Gardens Laboratory has, however, revealed a stronghold of *Megaderma lyra*. They were found to be swarming with a minute dipterous parasite, allied to the "tick-flies" (*Hippobosca*). The common bat parasite (*Nycteribia*) belongs to the same family (*Pupipara*), but is apterous. The parasite of *Megaderma* has small but fully developed wings and is capable of flight.

The destruction of small birds, due to these vampire bats, must be enormous. Day after day, for weeks together, I have found my verandah strewn with the wings and feathers of small birds, principally of the dainty little honey-sucker (*Cinnyris zeylonicus*). It would be interesting to know how the bat effects its capture. Though extremely agile on the wing, a bat is but a clumsy animal when it has to rely upon progress by means of its feet and claws alone. When the bat is abroad, the bird is snugly roosting in the recesses of a bush. How does the bat discover the presence of its prey? Does it enter and explore bush after bush on the chance of happening upon a sleeping bird, or does it scent them from a distance and then hunt them down in their retreat?

E. ERNEST GREEN.

31. *Capture of a Mouse by a large Spider.*—The huge spiders of South America, of the family *Aviculariinæ*, are known to capture and devour small birds and mammals. Our so-called "Tarantula" of Ceylon (*Pœcilotheria*) is nearly allied to these bird-eating spiders, and may, perhaps, occasionally indulge in a similar diet, though no such instance has been actually recorded. They are certainly strong enough to overpower a small bird. Their principal food appears to be cockroaches, grasshoppers, and large beetles, with perhaps an occasional lizard ; one has been observed with a gecko in its clutches. I am now able to record an instance of its capture of somewhat bigger game. Mr. G. Harbord, of the Cotton Experiment Station, found one of these spiders devouring a mouse on the wall of a room in his bungalow near Anuradhapura.

E. ERNEST GREEN.

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32. *On the Employment of a Snake-stone in a Case of Centipede-bite.*—Any first-hand records of the bites or stings of venomous insects are of interest. The following account was related by a friend who had recently been bitten on the naked foot by a large centipede (about 5 inches long). He describes the pain having been very severe at the time ; but after borrowing a "snake-stone" and applying it to the place he obtained immediate and complete relief. The stone adhered tightly to the wound, and remained attached for about an hour. There was no subsequent inconvenience from the bite, though the spot was tender for a few days.

There is a very prevalent idea that the mere passage of a centipede over the bare flesh is followed by severe inflammation. I have always felt rather sceptical about this matter ; but the following occurrence lends some support to the idea. My informant tells me that, while gardening a short time ago, a large centipede ran over his hand. He did not feel any bite and shook the animal off quickly ; but shortly afterwards the whole back of his hand swelled up. There were no marks of punctures.

E. ERNEST GREEN.

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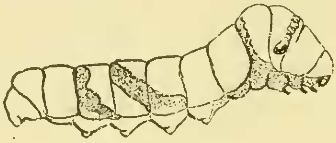
33. *Notes on the Larvæ of "Papilio polytes," "P. demoleus," "P. helenus" (race mooreanus), and "P. polymnestor" (race parinda).*—In an attempt to obtain statistics as to the relative abundance of the three forms of *Papilio polytes*, much trouble has been caused by a complete ignorance of any points of distinction between the larvæ of this species and those of *P. demoleus*. A search through the literature

available has yielded no satisfactory information, while, on the other hand, it has brought to light an apparent confusion between the larvæ of *P. parinda* and *P. mooreanus.* There appears to be, therefore, sufficient justification for a few notes on the four species, though it must be confessed that the material of *P. mooreanus* obtained up to the present has been very scanty.



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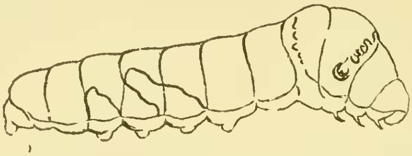

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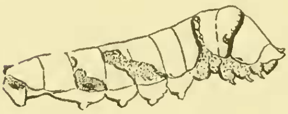

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FIG. 1.—Larva of *Papilio mooreanus* (?).
FIG. 2.—Larva of *Papilio parinda.*
FIG. 3.—Larva of *Papilio polytes.*
FIG. 4.—Larva of *Papilio demoleus.*

In habit the larvæ all feed on members of the natural order Rutaceæ, and are usually found on the cultivated species of *Citrus*. The adult larvæ, those in their fourth skin, may be easily distinguished by the following key :—

A. 4th and 5th segments markedly swollen ; much larger than succeeding segments .. .. *Section A.*

B. 4th and 5th segments not markedly swollen ; hardly larger than succeeding segments .. .. *Section B.*

Section A.	(i.)	Diagonal bands commencing on segments 8 and 10 mainly brown and meeting in the dorsal middle line. .	*P. mooreanus* (fig. 1).
	(ii.)	Diagonal bands commencing on segments 8 and 10 mainly white; not meeting in dorsal middle line . .	*P. parinda* (fig. 2).
Section B.	(i.)	Caudal tubercles white, much reduced . .	*P. polytes* (fig. 3).
	(ii.)	Caudal tubercles brown; size moderate . .	*P. demoleus* (fig. 4).

By "caudal tubercles" are meant the projecting points found in most Papilio larvæ on each side of the posterior portion of the terminal segment. When young the larva usually has two pairs of caudal tubercles; as it grows older the anterior pair are often lost, and even the terminal pair may become much reduced, as in *polytes*.

Young larvæ of *polytes* and *demoleus* are extremely hard to separate, and the following distinctions must not be too implicitly relied upon. When newly hatched, *polytes* is usually yellowish-brown, with an irregular yellow dorsal line; *demoleus* is blackish-brown, with a yellow "saddle" limited to segments 7, 8, 9. These differences, however, only apply when both larvæ are in their first skin; they soon change, and *polytes* then resembles *demoleus* in the characters enumerated above.

After the first moult the caudal tubercles show good distinctive characters; during the second skin there are two pairs of tubercles, of which the terminal pair are grayish-white, or white in *polytes* and brown in *demoleus;* in the third skin the anterior pair of tubercles degenerates, but the posterior remain, and are always white in *polytes* and brown in *demoleus*. After the third change of skin the larvæ attain their final scheme of colouration, and may then be easily known by the characters given in the key; in addition it may be mentioned that in *demoleus* the "ocellus" mark on segment 4 is connected by a brown line with the dark area surrounding the legs; in *polytes* there is no such connection.

The young stages of *parinda* and *helenus* have not been sufficiently studied to give distinctive characters; after the second moult, however, *parinda* is easily known by the absence of dark markings and the presence of minute blue spots, especially on segments 4 and 5. At all stages both species are larger than either *polytes* or *demoleus*, if the comparison is made when the larvæ are in the same skin.

Pupal distinctions, as well as general descriptions, of the larvæ can be found in various papers by Davidson, Bell, and Aitken in the

"Journal of the Bombay Natural History Society"; to avoid the necessity of reference, it may be mentioned that the pupa of *helenus* resembles that of *polytes*, but is slightly larger, and is bent back at an angle of almost 90 per cent. *Demoleus* differs from *polytes* in being comparatively narrow across the hind part of the thorax; *polytes* is very wide in this region, and as a rule is bent back at a greater angle than *demoleus*. *Parinda* is, of course, easily recognized by its superior size, as compared with any of the other species.

In conclusion it should be noted that the above distinctions apply in Ceylon only; in India, where other orange-feeding Papilios occur, considerable modification would probably be necessary.

My thanks are due to Mr. E. E. Green, who has most kindly figured the full-fed larva of each species. To avoid confusion, only the salient characteristics of each are represented, small unimportant markings being neglected.

J. C. F. FRYER.

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34. "*Filodes mirificalis*," *a good species.*—This pyrale was first described by Lederer in 1863 under the name *Auxomitia mirificalis* (Led., Wien. Ent. Mon., 1868, p. 391); subsequently it was re-described by Moore* as *Filodes patruelis* (Moore, Lep. Atk., p. 218), but in the "Fauna of British India" (Moths, Vol. IV., p. 297) it is reduced to the status of a variety of *Filodes fulvidorsalis*, Hubn. Mr. E. E. Green has always expressed the opinion that the two forms should rank as good species, and this view has now proved to be correct. Both species have been bred at Peradeniya, marked differences being found in the larvæ, while in every case the imagoes proved true to the maternal type. For a general description of *F. fulvidorsalis* the "Fauna of British India" must be consulted; the following table presents the essential differences between the two species:—

	Filodes fulvidorsalis.	*Filodes mirificalis.*
Wings ..	No dark band or fascia crossing fore- and hind-wings. General colour, black with a steely reflection.	A conspicuous dark band always present. Colour black, usually without metallic reflection, and often with slight fuscous suffusion.
Thorax and base of fore-wings	Bright orange ..	Usually reddish fuscous, but occasionally orange.
Build ..	Somewhat stout ..	Slender.

* Moore also referred to it under its correct name in Lep. Ceylon, p. 331.

As a whole the two species show a different fascies, the sum of the distinguishing characters having a greater effect than their consideration separately would suggest. No adequate description of the larva of *fulvidorsalis* has been found, and therefore a detailed description is necessary to allow a comparison with that of *mirificalis*.

When full fed the general ground colour of the larva is apple-green, with the exception of the head (the 1st segment), which is yellowish-brown, and the 2nd segment, which is green tinged with brown. The markings are as follows: The 2nd segment with six black tubercular spots, a pair being situate on each side of the middle line and a single spot over each leg (fig. 3); the 3rd and 4th segments similar to the second, but with an additional spot below the dorsal pair; the 5th–12th segments with three black spots on each side of the middle line, one pair being situate towards the anterior margin of the segment and the third behind, forming a triangle, the interior

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1.—Head and second segment of the larva of *Filodes mirificalis*.
Fig. 2.—Seventh segment of the same.
Fig. 3.—Head and second segment of the larva of *Filodes fulvidorsalis*.
Fig. 4.—Seventh segment of the same.

of which is occupied by a shining white plate, while there is a small white spot behind the apex of the triangle (fig. 4); in addition, on these segments a subspiracular black spot and a spot over base of prolegs on segments 7, 8, 9, 10; segment 12 with a pair of black spots united in the middle line, the white plates obsolescent; segment 13 much reduced, with a single dorsal spot and a pair on each side; terminal segment with a black spot above anus and a spot on the hinder part of each clasper. From each of the tubercular spots arises a hair, those from the lateral spots being longest. The general shape of the larva is short and stout. Length 2·5 cm.

The larva of *F. mirificalis* resembles that just described in the general system of markings, but may be easily distinguished by the following points: It is more slender; the ground colour is a blue-green (sage-green) instead of apple-green. The 2nd segment has a larger number of spots, there being three on each side of the middle line, and in addition an irregular composite lateral spot (fig. 1).

The white "plates," which give such a characteristic appearance to the larva of *fulvidorsalis*, are much smaller, and are usually reduced to small lobes near the inner angles of the triangles of black spots (fig. 2). No differences have been observed between the pupæ. The food plant in each case is *Thurbergia fragrans*, but the larvæ will also eat *T. allata* and *T. coccinea*. Finally, it may be pointed out that there is a further Ceylon species, *Filodes bilinealis*, Hampsn., about the larva of which nothing as yet is known, though it must be widely distributed, having been taken both at Peradeniya and Wellawaya.

J. C. F. FRYER.

H. C. COTTLE, GOVERNMENT PRINTER, COLOMBO, CEYLON.