

XXII NOTES ON STOMATOPODA

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Since the memoir on Indo-pacific Stomatopoda was published in 1913¹ a considerable number of specimens have been added to the collection of the Zoological Survey of India. The majority of these belong to species already known to be abundant on the Indian coasts and, as the records add nothing to our knowledge of their geographical range, we have not thought it necessary to mention them. There remain, however, a number of other specimens interesting from the point of view of their structural peculiarities, rarity, or distribution, together with examples of two species which have not hitherto been recognised. We have included a note on certain Californian specimens of *Gonodactylus*, which have kindly been lent to us for examination by Prof. Ch. Gravier of the Paris Museum. These specimens prove to belong to *G. oerstedii*, hitherto known only from the Atlantic, thus adding greatly to our knowledge of the geographical range of the species.

Calman² has recently drawn attention to the importance of the number of epipodites on the thoracic limbs as a specific criterion in the genus *Squilla* and has given a key to certain Atlantic species in which the primary divisions are based on this hitherto unnoticed character. We find that the epipodites vary in the Indo-pacific species also and we have thought it advisable to examine all the forms represented in the collection and note the number present in each. It is only in the genus *Squilla* that any variation in the number of epipodites is to be found; in all species of *Pseudosquilla*, *Hemisquilla*, *Lysiosquilla*, *Odontodactylus* and *Gonodactylus* that we have examined epipodites occur on all the first five thoracic limbs.³

Epipodites are to be found on the first five thoracic limbs in the following species of *Squilla* :—

¹ Kemp, *Mem. Ind. Mus.* IV (1913).

² Calman, *Brit. Antarctic Exped.* 1910, *Zool.* III, p. 141 (1917).

³ The species examined are *Pseudosquilla ciliata* (Fabr.), *P. cerisii* (Roux), *P. oculata* (Brullé), *P. ornata* Miers, *P. pilaensis* de Man, *Hemisquilla styliifera* (Milne-Edwards), *Lysiosquilla acanthocarpus* Miers, *L. eusebia* (Risso), *L. insignis* Kemp, *L. maculata* (Fabr.) and var. *sulcirostris* Kemp, *L. multifasciata* Wood-Mason, *L. spinosa* (Wood-Mason), *L. vicina* Nobili, *Odontodactylus brevirostris* (Miers), *O. cultrifer* White, *O. japonicus* (de Haan), *O. scyllarus* (Linn.), *O. southwelli* Kemp, *Gonodactylus acanthurus* Tattersall, *G. brevisquamatus* Paulson, *G. chiragra* (Fabr.) and var. *platysoma* Wood-Mason, *G. demani* Henderson, and var. *spinosa* Bigelow, *G. excavatus* Miers, *G. furcicaudatus* (Miers), *G. glaber* (Lenz), *G. glabrous* Brooks, *G. glyptocercus* Wood-Mason, *G. graphurus* Miers, *G. herdmanni* Tattersall, *G. nefandus* Kemp, *G. oerstedii* Hansen, *G. proximus* Kemp, *G. pulchellus* Miers and *G. spinosissimus* Pfeffer.

<i>S. annandalei</i> , Kemp.	† <i>S. laevis</i> , Hess.
<i>S. biformis</i> , Bigelow.	<i>S. mantis</i> , Latreille.
<i>S. braziliensis</i> , Calman.	<i>S. panamensis</i> , Bigelow.
<i>S. empusa</i> , Say.	<i>S. raphidea</i> , Fabr.
	<i>S. rugosa</i> , Bigelow.

On the first four thoracic limbs in the following species:—

<i>S. africana</i> , Calman.	† <i>S. leptosquilla</i> , Brooks.
† <i>S. armata</i> , Milne-Edwards.	† <i>S. lirata</i> , sp. nov.
<i>S. boops</i> , Kemp.	<i>S. massavensis</i> , Kossmann.
† <i>S. costata</i> , de Haan.	<i>S. microphthalma</i> , Milne-Edwards.
<i>S. decorata</i> (Wood-Mason).	<i>S. mikado</i> , sp. nov.
† <i>S. desmaresti</i> , Risso.	<i>S. multicarinata</i> , White.
<i>S. fasciata</i> , de Haan.	<i>S. nepa</i> , Latreille.
<i>S. foveolata</i> , Wood-Mason.	<i>S. oratoria</i> , de Haan.
<i>S. gilesi</i> , Kemp.	„ var. <i>perpensa</i> , Kemp.
<i>S. gonypetes</i> , Kemp.	† <i>S. polita</i> , Bigelow.
† <i>S. hieroglyphica</i> , Kemp.	<i>S. prasino-lineata</i> , Dana.
<i>S. holoschista</i> , Kemp.	<i>S. quinquedentata</i> , Brooks.
<i>S. interrupta</i> , Kemp.	<i>S. stridulans</i> , Wood Mason.
<i>S. investigatoris</i> , Lloyd.	† <i>S. tenuispinis</i> , Wood-Mason.
<i>S. lata</i> , Brooks.	<i>S. wood-masoni</i> , Kemp.
<i>S. latreillei</i> (Eyd. and Soul.).	

On the first three thoracic limbs in:—

S. dubia, Milne-Edwards.

And on the first two thoracic limbs only in:—

† <i>S. gibba</i> , Nobili.	† <i>S. scorpio</i> , Latreille.
<i>S. supplex</i> , Wood-Mason.	† „ var. <i>immaculata</i> , Kemp.

In the majority of Indo-pacific species epipods are found on the first four thoracic limbs, but there are certain notable exceptions. In *Squilla raphidea* and the closely allied *S. annandalei* they are present on all five limbs and this also occurs in the Australian *S. laevis*. *S. raphidea* and its ally on other structural characters form a well-defined group in the genus, but *S. laevis* is not related and appears to be rather an isolated form, allied perhaps to *S. hieroglyphica*. Apart from the possession of the full series of epipods none of these species possess characters which can be regarded as primitive.

We have not found any Indo-pacific species in which epipodites are found on the first three thoracic limbs only. Of those which possess them only on the first two thoracic limbs, *S. gibba* seems without doubt to be allied to the forms with reduced eyes (the *Chloridella* section), *S. supplex* is a species of uncertain affinities, while *S. scorpio* perhaps finds its nearest allies in *S. lata*, *S. gilesi* and *S. armata*. Classified on any other character than that of the

† In this species the mandibular palp is absent.

number of epipodites, these three species take up widely separate positions in the genus.

We are thus led to conclude that a reduction in the number of epipods has taken place in the genus *Squilla* on several different occasions and that the character, though possessing a definite specific value, cannot be used as a guide to the affinities of the different forms. In this it resembles the mandibular palp, which appears and disappears throughout the genus, apparently without any regard to the affinities of the species concerned. In the list given above the species in which the palp is suppressed are indicated by a dagger (†).

Squilla decorata (Wood-Mason).

1913. *Squilla decorata*, Kemp, *Mem. Ind. Mus.* IV, p. 27, pl. i, figs. 13-16.

C 301/1. Jack and Una Is., Mergui Archipelago. Investigator. 1 ♀ 65 mm. go.

Squilla microphthalma, Milne-Edwards.

1913. *Squilla microphthalma*, Kemp, *loc. cit.*, p. 31, pl. i, figs. 17-20.

Two additional examples of this species have recently been obtained, but the identification of one of them is open to doubt. This specimen, collected by the 'Investigator' in the Mergui Archipelago, differs from the others in the following particulars:—

(i) The rostrum is much narrower and is about one and a half times as long as wide.

(ii) The cornea is decidedly more expanded, its breadth being contained about two and a quarter times in the total length of the eye.

(iii) The eye reaches well beyond the end of the basal antennular segment and fully to the middle of the ultimate segment of the antennal peduncle. In typical *S. microphthalma* the eye does not nearly reach the end of the basal antennular segment and barely reaches the base of the ultimate segment of the antennal peduncle, much as in Brooks' figure of *S. chlorida*.¹

(iv) The lateral process of the fifth thoracic somite is short, stout and directed strongly forwards, whereas in typical *S. microphthalma* it is directed straight outwards.

(v) The raptorial dactylus bears five teeth (the terminal one included), all of which are well developed and evenly spaced. The proximal tooth is not greatly reduced and does not lie close against the next of the series as in those specimens of *S. microphthalma* which possess the same number of teeth.

(vi) There are clear indications of a pair of submedian carinae on the fifth abdominal somite.

The specimen is a male, with the carinae of the marginal teeth of the telson much swollen. It differs from Brooks' account

¹ Brooks, *Challenger Rep., Stomatop.*, pl. ii, figs. 1, 3 (1886).

of *S. chlorida* (i) in the form of the rostrum, (ii) in the length of the eye compared with that of the antennular and antennal peduncles, and (iii) in the direction of the lateral process of the fifth thoracic somite. It perhaps represents a species hitherto unknown, but the resemblances to *S. microphthalma* are so great that we hesitate to describe it as new.

C 303/1. Off Tondi, Madras Presidency, 6 fms. J. Hornell. 1 ♀ 20 mm.

C 302/1. 4 miles N.N.E. of Kabusa Is., Mergui Archipelago, 33 fms. 'Investigator.' 1 ♂, 40 mm.

It should be noted that, apart from a doubtful record from N. Australia (Miers), *S. microphthalma* has hitherto been found only at Zanzibar (Jurich) and from Karachi, Bombay, and the Madras Coast (Kemp). The specimen referred to above is the first that has been obtained on the eastern side of the Bay of Bengal.

Squilla fasciata, de Haan.

1913. *Squilla fasciata*, Kemp, *loc. cit.*, p. 34, pl. i, figs. 21-23.

Seven additional specimens, presented by Dr. T. Kawamura, were brought from Japan by Dr. Annandale. Under the name of *S. fallax*, Bouvier¹ has recently described a closely related species from Mauritius, which, apart from the number of teeth on the raptorial dactylus and other characters, differs from *S. fasciata* in the complete suppression of the mandibular palp. We have re-examined the Indian specimens in comparison with those brought back by Dr. Annandale and have no doubt that all belong to de Haan's *S. fasciata*.

C 298/1. Fomo, Bingo prov., Japan. T. Kawamura. 3 ♂ 4 ♀ 60-77 mm.

Squilla scorpio, Latreille.

1913. *Squilla scorpio*, Kemp, *loc. cit.*, p. 42, pl. ii, fig. 30.

1918. *Squilla scorpio*, Sunier, *Contrib. Faune Indes Neerland.* IV, p. 4.

1918. *Squilla scorpio*, Kemp, *Mem. Asiat. Soc. Bengal* VI, p. 297.

Sunier has examined a number of specimens from the Aru Is., Makassar and Batavia without finding any examples of the variety *immaculata*. The variety was, however, found—for the first time in company with typical examples—by Dr. Annandale in the Talé Sap in Peninsular Siam (*v.* Kemp, *loc. cit.*, 1918). We have seen additional specimens of the typical form from Singapore, collected by Capt. Hutcheson.

Squilla gonypetes, Kemp.

1913. *Squilla gonypetes*, Kemp, *loc. cit.*, p. 54, pl. iv, figs. 42-44.

1918. *Squilla gonypetes*, Sunier, *Contrib. Faune Indes Neerland.* IV, p. 5.

¹ Bouvier, *Bull. sci. France Belgique* XLVIII, p. 308, text-figs. 39-42 (1915).

Sunier is inclined to think that *S. gonypetes* is merely based on young individuals of *S. quinquedentata*, but we are unable to agree with this view. Apart from other characters the corneal and peduncular axes of the eye are more oblique in *S. gonypetes* than in the related species, and it appears to be a general rule that in those forms which possess oblique eyes, the cornea is more transversely placed in the young than in the adult.

The question cannot, however, be settled definitely with the material at present in existence. As Sunier has pointed out, the known specimens of *S. quinquedentata* all exceed 100 mm. in length, whereas the largest example of *S. gonypetes* is only 55 mm. in length.

C 320/1. Off Kabusa Is., Mergui Archipelago. 'Investigator.' 1 ♂, 2 ♀, 40-47 mm.

Sunier has examined specimens from the Java Sea.

Squilla holoschista, Kemp.

1913. *Squilla holoschista*, Kemp, *loc. cit.*, p. 64, pl. iv, figs. 50-53.

1918. *Squilla holoschista*, Sunier, *Contrib. Faune Indes Néerland.* IV, p. 8.

Sunier has recorded this species from Anjer in the Sunda Straits, thus greatly extending our knowledge of its geographical range. The only additional specimens we have seen are from the western side of the Bay of Bengal.

Squilla mikado, sp. nov.

1913. *Squilla stridulans*, Kemp, *loc. cit.*, IV, p. 78 (in part).

In 1913 one of us doubtfully attributed to Wood-Mason's *S. stridulans* a single specimen of *Squilla* found at Misaki in Japan. A second individual which Dr. Annandale obtained in 1915 from the Misaki laboratory proves that the Japanese form, though nearly related to that found in the Bay of Bengal, must be regarded as distinct.

The principal characters in which the two species differ are the following :—

S. stridulans, Wood-Mason.

Undivided portion of mid-dorsal carina of carapace, anterior to dorsal pit, less than one-third as long as bifurcated portion (text-fig. 1a).

Rostrum with an obscure mid-dorsal tubercle (text-fig. 1a).

Cornea much dilated and set very obliquely on eyestalk (text-fig. 1b).

Lateral processes of sixth and seventh thoracic somites shorter and broader (text-fig. 1c).

Surface of abdominal somites finely rugose.

S. mikado, sp. nov.

Undivided portion of mid-dorsal carina of carapace, anterior to dorsal pit about half as long as bifurcated portion (text-fig. 2a).

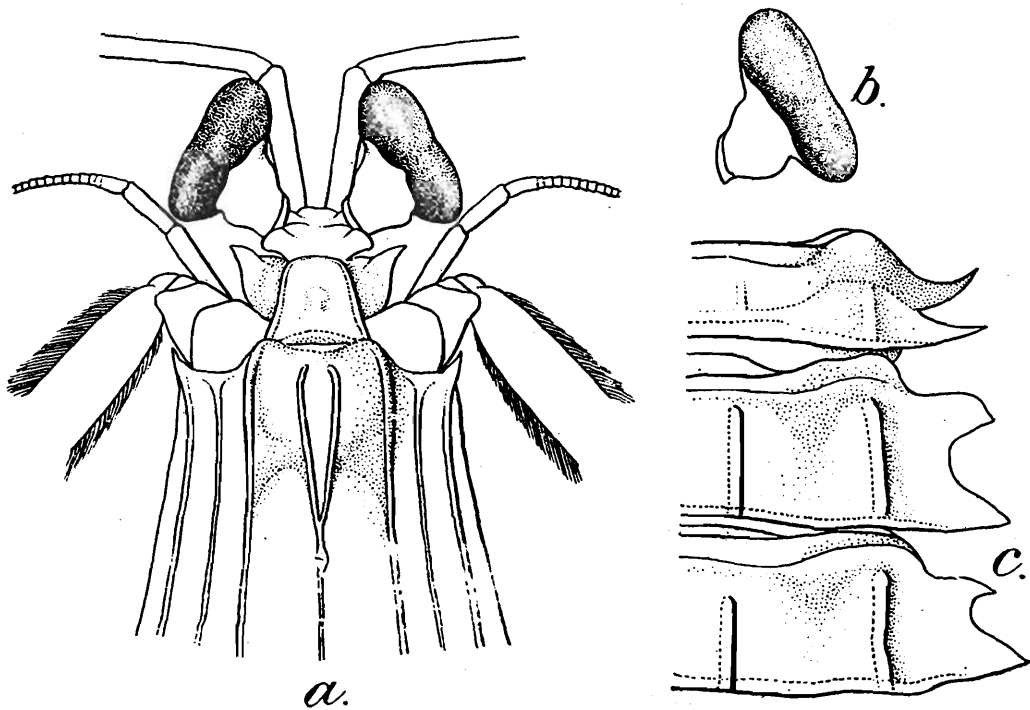
Rostrum with a well defined median carina (text-fig. 2a).

Cornea less dilated and set much less obliquely on eyestalk (text-fig. 2b).

Lateral processes of sixth and seventh thoracic somites longer and more slender (text-fig. 2c).

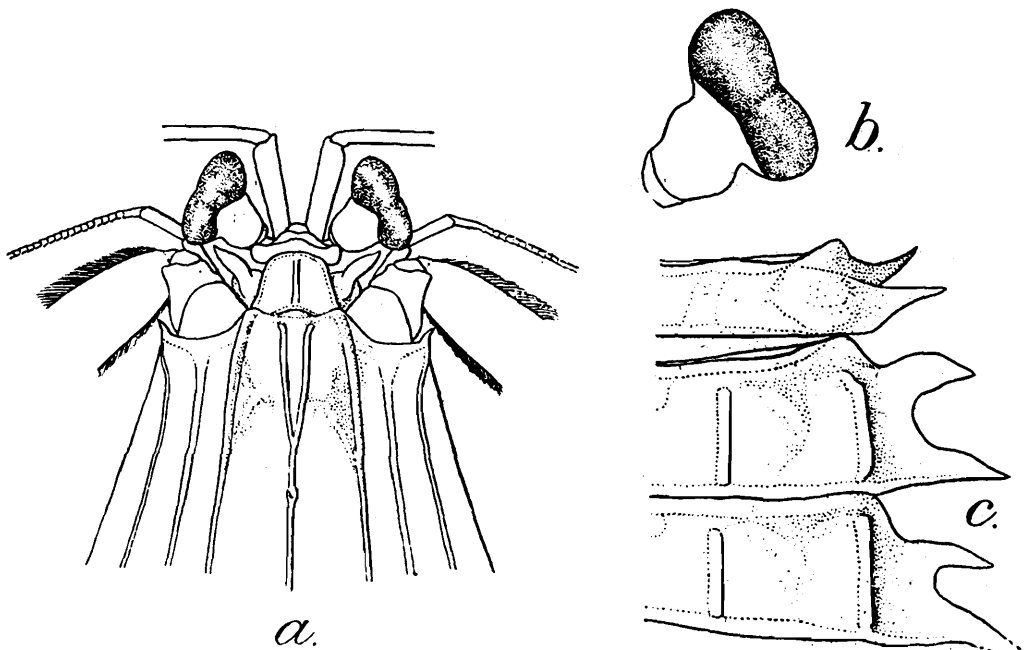
Surface of abdominal somites coarsely rugose.

S. mikado appears to be a larger species than *S. stridulans*. The two specimens examined are 122 and 144 mm. in length, whereas *S. stridulans* is not known to exceed 100 mm.



Text-fig. 1.—*Squilla stridulans*, Wood-Mason.

- a. Anterior part of carapace, rostrum, etc. b. Eye.
c. Lateral parts of 5th, 6th and 7th thoracic somites.



Text-fig. 2.—*Squilla mikado*, sp. nov.

- a. Anterior part of carapace, rostrum, etc. b. Eye.
c. Lateral parts of 5th, 6th, and 7th thoracic somites.

Both the specimens of *S. mikado* show traces of the large dark mid-dorsal patches on the second and fifth abdominal somites

which are found in *S. stridulans*, but they entirely lack the black pigmentation on the posterior margins of the abdominal and exposed thoracic somites which is characteristic of the latter species.

In *S. mikado*, as in *S. stridulans*, the two lobes found in many species of *Squilla* on either side of the fifth thoracic somite are replaced by two sharp spines and the lateral carinae of the first five abdominal somites are bicarinate. These two characters alone are sufficient to distinguish them from all other species of the genus.

7685/10. Misaki, Japan. A. Owston. 1 ♂ 144 mm., TYPE.
C 304/1. Misaki, Japan. N. Annandale (Kuma Aoki 1 ♂, 122 mm.
coll.).

Dr. Annandale informs us that the specimen he brought back was probably obtained in deep water.

? *Squilla costata*, de Haan.

1913. *Squilla costata*, Kemp, *loc. cit.*, p. 84, pl. vi, figs. 70-72.

In 1913 comparison was drawn between a specimen of this species from Japan and one obtained on the Burmese coast by Messrs. Simpson and Rudmose Brown and kindly lent by Mr. A. Patience. An additional specimen has since been found on the Burmese Coast by the 'Investigator,' but it is unfortunately in poor condition, having lost both raptorial claws.

We are unable to compare this individual with that previously recorded from Burma, as the latter has been returned to Mr. Patience, but it differs from the Japanese example in all the characters pointed out in 1913, except that (i) the submedian carinae of the last abdominal somite are tricarinate, the three keels meeting posteriorly, and that (ii) of the carinae which terminate in the submedian teeth of the telson edge only that on the right hand side is bifurcate. On close comparison with the Japanese specimen a number of minor distinctions in sculpture are to be found.

We think it probable that the Burmese form is distinct from that found in Japan, but we are unable to draw up a specific definition from a single imperfect specimen that shows signs of immaturity.

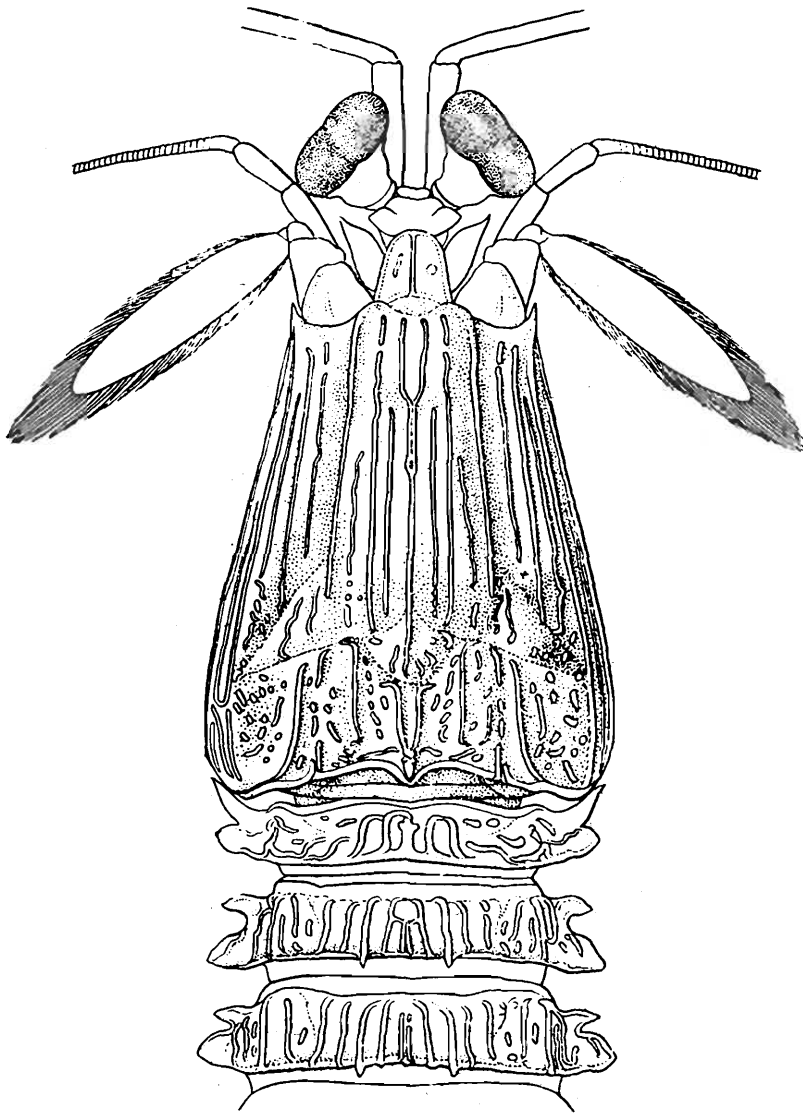
C 332/1. 4 miles N.N.E. of Kabusa Is., 'Investigator.' 1 ♀, 35 mm.
Mergui Archipelago.

Squilla lirata, sp. nov.

This species is closely allied to and easily confounded with White's *S. multicarinata* but is distinguished by a number of well-marked characters.

The carinae of the carapace (text-fig. 3) are less numerous than in the allied form and are frequently interrupted and broken up into series of short carinulae or tubercles. In the anterior

part of the carapace between the gastric grooves the carinae are for the most part not continuous as in *S. multicarinata*. Behind the cervical groove there are in the latter species from 26 to 30 well-defined longitudinal carinae, but in *S. lirata* less than half this number can be counted and most of these are irregular and broken up into small tubercles. The median carina in *S. multicarinata* is bifurcated for the whole of the distance in front of the mid-dorsal pit. In one of our specimens of *S. lirata* the arrangement



Text-fig. 3.—*Squilla lirata*, sp. nov.

Carapace and first three exposed thoracic somites.

is similar, but the carina is interrupted at the point where it divides. In the other specimen (text-fig 3) the carina is bifurcated for little more than half the distance between the mid-dorsal pit and the anterior margin.

The rostrum is less quadrate than in the allied species and is more rounded anteriorly. On either side of the median carina only a tubercle or short carinula can be seen. The cornea of the eye is less expanded.

The mandibular palp, which in *S. multicarinata* is composed of three segments, is entirely absent.

The oblique carina on the outer side of the merus of the raptorial claw in *S. multicarinata* is represented in *S. lirata* merely by a slight swelling. The dactylus has six teeth (including the terminal one), whereas in *S. multicarinata* there are only five.¹ As in the related species the first four thoracic limbs are provided with epipods.

The lateral processes of the exposed thoracic somites are closely similar in the two species, but the anterior process of the seventh somite is more produced in *S. lirata*. In the carination of these somites there are marked differences. In *S. multicarinata* there are clear cut continuous transverse carinae on either side of the fifth somite, whereas in *S. lirata* there are merely irregular tubercles. The longitudinal carinae on the three posterior thoracic somites are similar in the two species, but in *S. lirata* tend to be broken up into tubercles laterally and whereas in *S. multicarinata* practically all the carinae terminate posteriorly in spines, only one pair of spines, those terminating the submedian carinae, are to be found in *S. lirata*.

As in *S. multicarinata* there are numerous carinae on the abdominal somites, but at the sides, especially between the intermediate and lateral carinae they are frequently broken up into tubercles and short ridges which are often not strictly longitudinal in direction. Between the submedian carinae on the first two abdominal somites only three additional keels are to be found in place of the five which are constantly present in *S. multicarinata*.

The formula for the spines on the abdominal somites is as follows:—

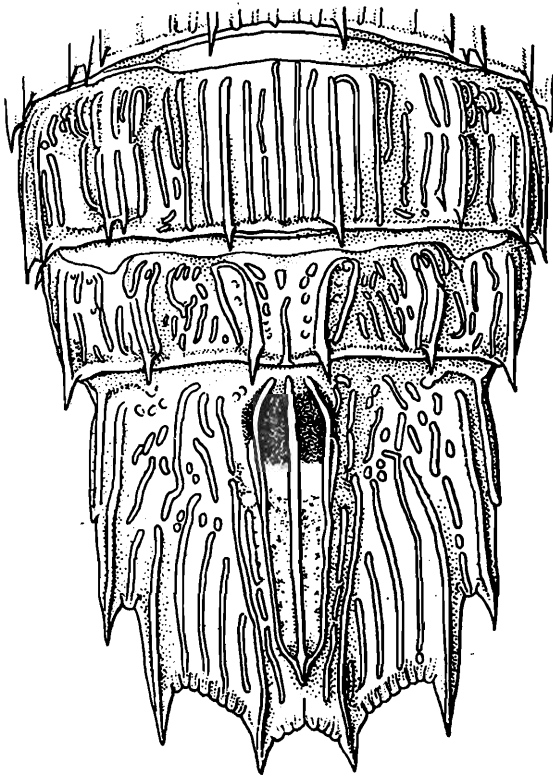
<i>Carinae.</i>		<i>Abdominal somites.</i>	
Submedian	..	..	1, 2, 3, 4, 5, 6.
Intermediate	..	..	1, 2, 3, 4, 5, 6.
Lateral	..	..	1, 2, 3, 4, 5, 6.
Marginal	..	..	1, 2, 3, 4, 5.

In *S. multicarinata* the lateral carinae of the first two somites and the marginal carinae of the first one, two, or three somites do not end in spines. In *S. multicarinata* all the subsidiary carinae between the intermediates end in spines; in *S. lirata* the only carina in addition to those mentioned in the above formula which ends in a spine is one situated immediately on the inner side of the intermediates of the fourth and fifth somites (text-fig. 4) and even this spine is not always well developed. On the last abdominal somite there are only a few obscure tubercles in place of a continuous carina between the median and submedian carinae,

¹ Miers found seven teeth on one dactylus of a specimen from the Philippine Is. The additional teeth in this individual were perhaps formed subsequent to an injury, for five are uniformly present in the ten specimens we have examined.

and irregular tubercles and ridges between the submedians and laterals.

The carinae on the telson (text-fig. 4), both on its upper and



Text-Fig. 4.—*Squilla lirata*, sp. nov.

Last two abdominal somites and telson.

under surfaces, are interrupted and few if any extend continuously throughout its length; the differences as regards the upper surface will be apparent on comparing text-fig. 4 with the figure of *S. multicarinata* published in 1913. The inner edge of the bifurcate process of the uropods bears only a series of small denticles in place of the sharp spines found in the allied species.

As regards colouration *S. lirata* is distinguished by the presence of a large round black spot at the base of the telson on the upper side. The dusky patch visible on the second abdominal

somite in *S. multicarinata* is also present in *S. lirata*, but of that on the fifth somite no trace can be found. Small dark chromatophores are more thickly scattered over the dorsal surface, particularly on the two ultimate segments of the antennular peduncle. The terminal segment of the outer uropod, which is jet black in *S. multicarinata*, is merely suffused with pigment on its inner side.

The larger of the two specimens is 69 mm. in length.

To summarize the characters which distinguish *S. lirata* from *S. multicarinata* :—

(i) The carinae are less numerous on both carapace and abdomen and tend, especially at the sides, to be broken up into tubercles and short ridges.

(ii) On the exposed thoracic somites only the submedian carinae end in spines; on the abdominal somites, between and including the intermediates, there are never more than six carinae which end in spines.

(iii) The mandibular palp is entirely absent.

(iv) The raptorial dactylus bears six teeth.

(v) There is a large black spot at the base of the upper surface of the telson.

In the number of teeth on the raptorial claw and in the absence of the mandibular palp *S. lirata* resembles *S. costata*. It is, however, readily distinguished from that species (i) by the

more numerous longitudinal carinae on the carapace, exposed thoracic somites and abdomen, (ii) by the spinous termination of the submedian carinae on all the somites from the sixth thoracic to the last abdominal and (iii) by the short carinae on the under surface of the telson.

C 306/1. Singapore.

Capt. Hutcheson.

1 ♂, 1 ♀, 60 and 69 mm. TYPES.

The two specimens formed part of a large collection of Stomatopods made by Capt. Hutcheson at Singapore. The collection included also a single specimen of *S. multicarinata*.

Squilla multicarinata, White.

1913. *Squilla multicarinata*, Kemp, *loc. cit.*, p. 86, pl. vi, figs. 73-76.

1918. *Squilla multicarinata*, Sunier, *Contrib. Faune Indes Neerland.* IV, p. 70.

C 305/1. Singapore.

Capt. Hutcheson.

1 ♂, 81 mm.

Squilla annandalei, Kemp.

1913. *Squilla annandalei*, Kemp, *loc. cit.*, p. 92, pl. vii, figs. 78-80.

1918. *Squilla annandalei*, Sunier, *Contrib. Faune Indes Neerland.* IV, p. 71.

C 297/1. 4 miles N.N.E. of Kabusa Is.,
Mergui Archipelago, 33 fms.

'Investigator.'

1 ♀, 43 mm.

The species, which was described from specimens obtained in the Gulf of Martaban, has recently been recorded by Sunier from 30-35 fathoms in the Java Sea.

Genus *Hemisquilla*, Hansen.

1895. *Hemisquilla*, Hansen, *Isop. Cumac. Stomatop. der Plankton-Exped.*, p. 72.

When the memoir on Indo-pacific Stomatopoda was being written the fact that Hansen had proposed *Hemisquilla* as a generic name for the species previously known as *Pseudosquilla stylifera* (M.-Edw.) unfortunately escaped notice. It was, however, pointed out that this species was an outstanding form without any near allies in the genus to which it was referred.

The adoption of Hansen's genus is we think to be recommended, for there can be little doubt that the species for which it was founded has had a phylogenetic origin distinct from all normal *Pseudosquilla*. The recognition of the genus is, moreover, attended with the practical advantage that we are able by admitting it to define the various genera of the family with greater precision.

Odontodactylus cultrifer (White).

1913. *Odontodactylus cultrifer*, Kemp, *loc. cit.*, p. 137.

? 1913. *Odontodactylus carinifer*, Kemp, *loc. cit.*, p. 138.

1918. *Odontodactylus cultrifer*, Sunier, *Contrib. Faune Indes Neerland.* IV, p. 72.

Through the kindness of Mr. J. Moulton, Curator of the Raffles Museum at Singapore, we have been able to examine a

specimen of this scarce species obtained at Pulo Adang, about 100 miles north-west of Penang.

The characters given in 1913 for separating this species from *O. scyllarus* were derived from the published figures and descriptions and were not based on actual comparison of specimens. They may be amended as follows:—

O. scyllarus (Linn.).

Rostrum broadly cordiform; apex pointed and lateral margins strongly convex.

Eyes small, reaching a little beyond base of penultimate segment of antennular peduncle and to base of ultimate segment of antennal peduncle; greatest breadth of cornea about one-fifth length of carapace.¹

Second segment of antennular peduncle about 3 times as long as wide.

Dactylus of raptorial claw strongly inflated at base.

A carina present on last abdominal somite between submedians and intermediates.

Median crest of telson not remarkably elevated, with two submedian carinae on either side; submedian spines of telson broadly expanded, with small movable tips.

Basal segment of outer uropod nearly twice as long as ultimate segment, with 11 or 12 movable spines on outer edge.

O. cultrifer (White).

Rostrum quadrangular with convergent sides; apex broadly rounded and lateral margins slightly concave.

Eyes larger, reaching beyond base of ultimate segment of antennular peduncle and to end of ultimate segment of antennal peduncle; greatest breadth of cornea about one-third length of carapace.

Second segment of antennular peduncle scarcely $1\frac{1}{2}$ times as long as wide.

Dactylus of raptorial claw slightly inflated at base.

No carina on last abdominal somite between submedians and intermediates.

Median crest of telson remarkably elevated, with only a single submedian carina on either side; submedian spines of telson not expanded, with large movable tips.

Basal segment of outer uropod shorter than ultimate segment with 8 or 9 movable spines on outer edge.

The specimen we have examined is a female, 55 mm. in length. The median crest of the telson is apparently less elevated than in the larger individual figured by White. Its height at the distal end is, however, nearly one quarter the basal breadth of the telson, whereas the proportion is less than one eighth in a much larger specimen of *O. scyllarus*.

In the specimens hitherto examined only two teeth have been found on the inner edge of the raptorial dactylus. In our specimen, however, three occur on each side. The knowledge that these teeth vary in number leads us to think that Pocock was perhaps right in suggesting that his *O. carinifer* was based on a young example of *O. cultrifer*. The single specimen that he described under the former name was only 24 mm. in length and all the characters that distinguish it from the related species, except the number of dactylar teeth, may be due to immaturity.

O. cultrifer has hitherto been known from only three specimens: from China (White), from Kelantan in the G. of Siam (Lanchester) and from 27 fms. in the western Java Sea (Sunier). Pocock's specimen of *O. carinifer* was obtained in 24 fms. on the Holothuria Bank, China Seas.

¹ This character probably varies somewhat with age, the eye being proportionately largest in young specimens.

Gonodactylus oerstedii, Hansen.

1895. *Gonodactylus oerstedii*, Hansen, *Isop. Cumac. Stomatop. der Plankton-Exped.* p. 65 (footnote).
 1902. *Gonodactylus oerstedii*, Bigelow, *Bull. U. S. Fish Comm. for 1900*, XX, ii, p. 152, figs. 1, 2.
 1920. *Gonodactylus oerstedii*, Rathbun., *Rapp. Vissch. en Industr. Zee-product. in Curacao, uitg. d. Prof. J. Boeke II*, p. 32 (of reprint).

Through the kindness of Prof. Ch. Gravier we have been able to examine a series of specimens of this species obtained by M. Diguët in the Gulf of California and belonging to the Paris Museum. The sample we have examined, which is only part of a much larger collection of specimens belonging to the same species, is labelled "Espiritu Sancto, Chalut, 15-25 m."

That these specimens from the Pacific Coast should prove to belong to *G. oerstedii* is very remarkable, but except for very young individuals less than 20 mm. in length, all exhibit the additional keel on the inner side of the intermediate teeth of the telson which is the sole discriminating character between *G. oerstedii* and *G. chiragra*. We have made a close comparison between the Californian specimens and others from Fernando Noronha and St. Thomas in the W Indies and are unable to find any appreciable difference between them.

So far as we are aware the only previous records of a *Gonodactylus* belonging to the *G. chiragra* group from the Pacific Coast of America are those of Miers¹ from Panama and of Nobili² from the Gulf of St. Miguel in Darien. Both authors referred their specimens to *G. chiragra*, but Miers record was made long before the distinctive characters of *G. oerstedii* were known and Nobili's so soon after the publication of Hansen's paper that it is probable that he had not consulted the work.

Gonodactylus oerstedii has hitherto been found only in the Atlantic and, so far as is known, does not live in the southern parts of that ocean; Miss Rathbun in a recent paper gives its distribution as "North Carolina to Brazil, Bermudas." The occurrence of the species in the Gulf of California is thus most unexpected and points to the conclusion that its distribution is discontinuous. The species of *Gonodactylus* inhabit the warmer waters of the globe and, apart from the absence of any records, it is extremely improbable that *G. oerstedii* extends along both east and west coasts of S. America and round Cape Horn.

Gonodactylus demani, Henderson.

1913. *Gonodactylus demani*, Kemp, *loc. cit.*, pp. 164, 198, pl. ix, figs. 108-III.
 1921. *Gonodactylus demani*, Tattersall, *Fourn. Linn. Soc., Zool.*, XXXIV p. 359.

In 1913 (*loc. cit.*, p. 198) it was pointed out that in specimens of this species from the northern end of the Gulf of Manaar and

¹ Miers, *Ann. Mag. Nat. Hist.* (5), V, p. 119 (1880).

² Nobili, *Boll. Mus. Zool. Torino* XII, No. 280, p. 6 (1897).

in one from the Persian Gulf the inner margin of the inner uropod was devoid of setae, in this resembling Henderson's original figure, whereas in all the other specimens the inner margin was invested with setae.

Tattersall has recently remarked that it is "just possible" that Bigelow's *spinosus* may be constantly differentiated from the typical form by the presence of setae on this margin and, on re-examining all the material at our disposal, we are inclined to agree with him. We find, however, that no precise correlation exists between the degree of spinulation of the telson, the size of its lateral teeth and the presence or absence of the fringe of setae. All that can be said is that in specimens which possess the fringe of setae, the telson has a moderate to large number of spinules, which are usually small, while the lateral teeth of the margin are frequently reduced and sometimes absent. In specimens in which the fringe is absent the spinules are usually larger and few to moderate in number, while the lateral teeth are nearly always well developed.

In the material we have examined the setae on the inner margin of the inner uropod are either present or absent: intermediate forms do not occur. The character thus appears to be more useful for the distinction of a varietal form than the shape of the telson and the extent to which it is covered by spinules, for in both these respects there is a very great range of variation. Bigelow, however, does not refer to the inner uropod in his description of *G. spinosus* and until we are certain that the inner edge bears setae in his type specimens, it is impossible to say whether the new character can legitimately be employed for the separation of a variety under that name.

We consider that a variety, which may at present be termed var. *spinosus*?, should be separated from the typical form on the basis of the character of the inner uropod and, if this be done, a number of the specimens recorded in 1913 as typical *G. demani* must be referred to the variety. Including the additional examples listed below, the distribution of the two forms as represented in the collection, is as follows:—

Typical form,—with inner margin of inner uropod devoid of setae,—Gulf of Suez, Persian Gulf, northern end of Gulf of Manaar Madras Harbour.

Var. *spinosus*?,—with inner margin of inner uropod provided with setae,—Portuguese E. Africa, Persian Gulf, Karachi, Bombay, Gulf of Manaar (Pearl banks).

It will be noticed that both forms occur in the Persian Gulf and Gulf of Manaar and Tattersall has shown that both also occur in the Red sea.

Additional specimens are from the following localities:—

C 337/1.	Tor, Gulf of Suez, Red Sea.	R. B. S. Sewell.	1 ♂, 8 ♀, 21-43 mm.
C 338/1.	Ain Musa, Gulf of Suez, Red Sea.	"	1 ♂, 29 mm.
C 339/1.	Madras Harbour, 4-5 fms.	S. Kemp.	2 ♂ 1 ♀ 18-27 mm.

var. *spinosus* ? Bigelow.

- C 336/1. Pearl Banks, Persian Gulf. Comm. Willcox. 1 ♀ 22 mm.
5-7 fms.

***Gonodactylus brevisquamatus*, Paulson.**

1913. *Gonodactylus brevisquamatus* and *fimbriatus*, Kemp, *loc. cit.*, pp. 174, 175, pl. x, figs. 115, 116.
1921. *Gonodactylus brevisquamatus*, Tattersall, *Journ. Linn. Soc., Zool.*, XXXIV, p. 362, pl. xxvii, figs. 5, 6.

Tattersall has shown that *G. fimbriatus* is synonymous with *G. brevisquamatus*.

***Gonodactylus pulchellus*, Miers.**

1913. *Gonodactylus pulchellus*, Kemp, *loc. cit.*, p. 177, pl. x, figs. 117, 118.
C 340/1. Madras Harbour, 4-5 fms. S. Kemp. 3 ♂ 3 ♀ 18-28 mm.

***Gonodactylus nefandus*, Kemp.**

1913. *Gonodactylus nefandus*, Kemp, *loc. cit.*, p. 179, pl. x, figs. 119, 120.
C 351/1. Sorsogon, S. Luzon, Philippines. A. L. Day. 2 ♀ 35, 40 mm,

***Gonodactylus tuberculatus* (Borradaile).**

1907. *Protosquilla tuberculata*, Borradaile, *Trans. Linn. Soc. (2), Zool.*, XII, p. 209, pl. xxii, fig. 1.

This species, which is known only from a single specimen dredged in 39 fathoms at Providence I., N. of Madagascar, was unfortunately omitted from the account of the Indo-pacific forms published in 1913. It appears to belong to the *excavatus* section of the genus and is easily distinguished by the form of the rostrum and telson.

***Gonodactylus glyptocercus*, Wood-Mason.**

1913. *Gonodactylus glyptocercus*, Kemp, *loc. cit.*, p. 186.
C 466/1. Port Blair, Andamans. S. Kemp. 2 ♂ 5 ♀ 19-25 mm.

***Gonodactylus spinosissimus*, Pfeffer.**

1913. *Gonodactylus spinosissimus*, Kemp, *loc. cit.*, p. 191, pl. x, figs. 124, 125.
C 341/1. Port Blair, Andamans. R. P. Mullins. 1 ♀, 24 mm.

XXIII THE FAUNA OF AN ISLAND IN CHILKA LAKE.

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INTRODUCTION.

By N. ANNANDALE, D.Sc., F.A.S.B., Director, Zoological
Survey of India.

I have recently published in the *Memoirs of the Asiatic Society of Bengal* ¹ a paper entitled "Introduction to the study of the Fauna of an Island in the Chilka Lake." From this paper I purposely excluded all but casual references to the fauna, although, as I explained, its main object was to prepare the way for an account of the animal life. In these *Records* I propose to issue, so far as circumstances permit, a report on the fauna of the island. In so doing my intention is not to increase the number of species known to science (though of course this must occur), or even to make the taxonomic limits of those already known more precise. The question I have striven, perhaps in vain, to answer, is this: What animals are to be found in a small and somewhat isolated area with the physical characters and vegetation of Barkuda Island and situated within the geographical limits of Peninsular India? That the reply to this enquiry is far from complete is due largely to the fact that our knowledge of the Indian fauna is still in its infancy so far as many invertebrate groups are concerned, and that the services of few specialists able and willing to study the various elements in a fauna so unpromising from a taxonomic point of view are available in India or elsewhere. To accomplish my task successfully it would have been necessary to have had the help of a large staff of zoologists who were at once good field-naturalists and good taxonomists. Some say that no such persons exist. This the history of zoology in India proves to be untrue, but the number of zoologists whose help I have been able to obtain has been small.

¹ *Mem. Asiat. Soc. Bengal*. VII, No. 4 (in the Press.)

My thanks are all the more due to those who have helped me. I have received much assistance from other members of the Zoological Survey of India and may mention in particular Dr. F. H. Gravely, now Superintendent of the Madras Museum, who has worked on the fauna of Barkuda as a collector, a field naturalist and a taxonomist. Mons. L. Chopard has kindly offered a report on the Orthoptera and Professor Silvestri one on the termites and the *incolae* of their nests. Lt.-Col. H. H. Godwin Austen¹ has already published notes on the land molluscs and Lt.-Col. J. Stephenson² on the Oligochaete worms, while the late Mr. C. A. Paiva³ described the Rhynchota. Most of the identifications of Cicindelid beetles I owe to Dr. W. Horn, and of butterflies to Lt.-Col. W. H. Evans, R.E.; Lt.-Col. F. Wall, I.M.S., has kindly examined most of the snakes, Mr. E. Brunetti of the Diptera and Major F. C. Fraser, I.M.S., and Dr. F. F. Laidlaw of the dragonflies.

A few reports on separate groups are issued with this introduction and others will, I hope, be published later. I propose to preface the series with a short general account of the fauna, indicating so far as possible at present its main peculiarities and deficiencies. This account should of course be read with the paper to which I have referred in the first sentence on the preceding page.

MAMMALIAN FAUNA.

The Mammalian Fauna of the island is, like that of most other groups, chiefly remarkable for its deficiencies. There are no carnivores except mongooses (which have perhaps disappeared lately), no ungulates except an introduced herd of Chital, no monkeys, no squirrels, no porcupines or hedgehogs and now very few bats. The only abundant terrestrial species, indeed, are a shrew of the genus *Pachyura* and a race of *Rattus rattus*. The only common bat is now the Indian Flying Fox.

AVIFAUNA.

The Fauna of Land Birds is even more scanty, relatively, than that of mammals, only three species being abundant at all seasons, namely the two common Indian crows (*Corvus macrorhynchus* and *C. splendens*) and the Mynah (*Acridotheres tristis*). A green pigeon visits the island in large flocks in the rainy season, but all other land birds are mere casual visitors or nest in solitary pairs. Even shore birds are less abundant than at many other spots in the Chilka Lake, but several egrets and herons and a cormorant often roost upon the trees in considerable numbers.

FAUNA OF REPTILES AND BATRACHIA.

The Fauna of Reptiles and Batrachia, comprising 17 or 18 species, is comparatively rich. There are six lizards, ten snakes,

¹ *Rec. Ind. Mus.*, XIII, pp. 349-351 (1917).

² *Mem. Ind. Mus.* V, pp. 139-146; 483-490 (1915).

³ *Rec. Ind. Mus.* XV pp. 1-16 (1917).

probably two Crocodilia, and two Batrachia; but all of these, except the house-lizard *Hemidactylus frenatus* and the frog *Rana cyanophlyctis*, are scarce or rather scarce. The most remarkable form is a completely limbless skink (*Barkudia insularis*) belonging to a genus at present only known from the island, but that it does not occur also on the mainland of the Ganjam district or Orissa is most improbable. All the other species of Reptiles and Batrachia are widely distributed forms.

FISH FAUNA.

Strictly speaking the island has no Fish Fauna as both the pond and the two wells are fish-less, but I may mention the fact that when the waters of the lake (which of course has an extensive fish-fauna¹) have been higher and are retreating, the small Cyprinodont *Panchax panchax*, one of the most useful of indigenous Indian mosquito-eating fish, is often left in large numbers in pools isolated on the foreshore. As these dry up, however, it perishes.

MOLLUSCAN FAUNA.

A peculiar feature of the Chilka Lake, in which it differs notably from the creeks of the Gangetic Delta, is the complete absence of amphibious molluscs from its shores. This fact greatly limits the molluscan fauna of Barkuda, which consists of five land and three aquatic species, the latter found in a small pond. It is noteworthy that each of these eight species belongs to a distinct genus, the genera being *Ennea*, *Ariophanta*, *Rachisellus*, *Opeas*, *Glessula*, *Limnaea*, *Indoplanorbis*, and *Gyraulus*, all Pulmonata. The land-snails belong to three biological categories. The *Ennea* is a terrestrial carnivorous form, preying on the *Opeas*, which is also terrestrial but feeds on algae and mosses. The *Glessula* is similar in habits to the *Opeas*, while the *Ariophanta* and the *Rachisellus* are phytophagous, the latter distinctly arboreal. Most of the species have a wide range in Peninsular India or beyond, but the *Ennea*, the *Opeas* and the *Glessula* are slightly modified insular races or species of widely distributed snails.²

INSECT FAUNA.

Comparatively poor as is the Insect Fauna of Barkuda, it actually includes a large number of species and must be discussed in its separate orders.

APTERA.—Both Collembola and Thysanura are fairly common and include species interesting as habitual incolae of the nests of termites and ants. A small bluish-black collembole often occurs in such numbers on the surface of small pools of water among

¹ Chaudhuri, *Mem. Ind. Mus.* V pp. 405, 443, 493.

² See Godwin-Austen, *Rec. Ind. Mus.* XIII, pp. 349-351 (1917) and Annandale and Prashad, *ibid.*, XIX, p. 189 (1920).

rocks on the shore as to form a regular scum upon them, just as *Anurida maritima* does on the English coasts. Others are abundant in dead wood. "Fish Insects" (Thysanura) of at least two species are found in the bungalow, but have probably been introduced. Representatives of this group are not very common in the jungle except in ants' and termites' nests.

NEUROPTEROID INSECTS.—Under this convenient title I propose to deal with the various groups other than dragonflies and termites at one time included in the order Neuroptera. They are not well represented on Barkuda except perhaps by the Ant-lions. In the drier parts of the island the soil is often pitted with the excavations of the larvae of the smaller species of this family and adults of two of the larger and more conspicuous kinds (*Palpares pardus* and *Acanthoclis horridus*), which probably have different larval habits, are taken occasionally. The Hemerobiidae are represented by a species of *Sisyra* the larva of which is parasitic in the sponge *Spongilla alba* in the pond.

ODONATA.—Most of the dragonflies found on the island are common and widely distributed species, but Major Fraser has recently described a new Agrionid (*Enallagma insula*)¹ from Barkuda. The three most abundant species are *Pantala flavescens*, clouds of which hover in the air in the rainy season, *Diplacodes trivialis*, which flies close to the ground throughout the year, and *Pseudagrion microcephalum*, which breeds in large numbers in the lake.

ISOPTERA.—Termites are abundant, the commonest species being *Termes* (*Odontotermes*) *obesus*. Several species find their food in the dead trunks of *Ficus bengalensis*, of which there are many on some parts of the island, but it is curious that no species of *Kaloterme*s has been found in this situation. A *Capriterme*s occurs under bricks and stones. Some large termite-mounds have been observed, but they are not very numerous, the only mound-building species being *T. obesus*. The distribution of the various species on the island seems to be largely dependent on the nature of the soil in different areas. The fungi cultivated by certain forms are being studied by Prof. Bose of the Carmichael Medical College, Calcutta, while Prof. Silvestri of Portici promises a report on both the termites themselves and the other arthropods found with them.

ORTHOPTERA.—The Orthoptera are fairly well represented, the most abundant of the families (or superfamilies) being the Acridiidae and the Gryllidae. Among the former it is noteworthy that only one wingless form (a species of *Chrotogonus*) has been obtained. Among the crickets at least three myrmecophilous species have been taken, each inhabiting the nest of a different genus of ant. Tridactylinae are abundant in damp places. Cockroaches and earwigs are relatively scarce so far as species are concerned but individuals are sometimes common. Stick-insects have not

¹ *Rec. Ind. Mus.* XIX, pp. 32-33 (1920).

been observed, and mantids are not so common as they often are in India. The commonest of the Phasgonuridae are arboreal grasshoppers of the group Pseudophyllides. One of these lays its eggs in little pockets on the edge of the leaves of *Glycosmis pentaphylla*, the most abundant shrub on the island. A remarkable ant-like form of the same family, but a different tribe, was taken on one occasion. It is probably the young of a larger, wingless species captured several times.

COLEOPTERA.—The beetles of Barkuda are mostly small and of dull and inconspicuous colouration. Highly modified forms are scarce, except minute termitophilous species. This is due mainly to the absence or scarcity of phytophagous beetles, and this again to the sclerophytic nature of the vegetation, which depends on the physical structure and climate of the island. The few Chrysomelids that occur are small and for the most part rare, while such groups as the Cetoniinae and the Rutelinae are represented mainly by occasional stragglers. The absence of many wood-boring genera is more surprising, as dead wood is abundant. Perhaps it is due partly to the fact that the wood is derived almost exclusively from the genus *Ficus*, and partly because certain families and genera of Coleoptera (e.g. the Lucanidae, Passalidae and many of the larger longicorns) although they are abundant in the hill-jungles of both Northern and Southern India, avoid the tropical plains of the Peninsula. On Barkuda no trace of Lucanidae or Passalidae has been found, and the few longicorns observed have been mostly small and scarce. Another class of beetles in which the fauna is deficient is the larger dung-beetles. Several of the smaller Scarabinae are common, feeding on the dung of deer (*Cervus axis*), but the absence of other ungulates doubtless accounts for that of the beetles that eat their excrement. The dominant types of Coleoptera are strictly terrestrial forms, either actively predaceous such as the Carabidae and Cicindelidae, both of which are well represented, or of vegetarian habits such as the Tenebrionidae. The only really conspicuous form at all common, however, is the Meloid *Mylabris pustulata*, which is frequently seen in flight and also on the flowers of the Sword-Bean (*Canavalia*), which are a favourite food. Some peculiar termitophilous Coleoptera have been collected, including *Termitodiscus heimi*, Wasm., a minute flattened and expanded Staphylinid which inhabits the fungus-gardens of *Termes* (*Odontotermes*) *obesus*, often in large numbers.

HYMENOPTERA.—Less care was expended on the collection of the Hymenoptera than on that of the majority of the larger groups of insects as there was very little prospect of getting them worked out. The parasitic and phytophagous families are, as might be expected, poorly represented. Ants are very abundant and belong to many species, but are almost exclusively terrestrial, the arboreal forms usually common in Indian woods being apparently absent. This is certainly so in respect to the Leaf-sewing Ant (*Oecophylla smaragdina*), which never succeeds in establishing

a colony, though I have seen solitary females attempting to do so on more than one occasion. A race of *Camponotus compressus* is abundant and cherishes in its nest a minute myrmecophilous cricket, which it apparently transports with its larvae and pupae to any convenient spot (in an instance that came under my notice a box of books) that it may find on its foraging expeditions. A curious habit was observed on the part of a small black ant (*Phidole rhombinoda*) also very common. This ant constructs burrows beneath stones or flower-pots and stores up various kinds of animal food, amongst others the remains of beetles, which the workers hurriedly remove when disturbed. A small Tenebrionid beetle is extremely abundant about the bungalow in the rainy season and crawls into any crevice. It evidently does so, to its own destruction, into the ants' nests under flower-pots, where its remains can often be found, but the curious point is that the ants store it alive by biting off its legs. When disturbed they carry off the crippled, but still living beetles, as they do the rest of their stores. The same ant has a small myrmecophilous cricket in its nest which it carries off when disturbed but apparently does not injure.

Mutillids are scarce, Pompilidae, Sphegidae, and Eumenidae common but in little variety. Apidae are fairly abundant on the flowers of *Crotolaria striata*. A solitary species (*Megachile lanata*) caused us considerable inconvenience in April by building its cartridge-like mud nests full of honey and pollen in the backs of our books. When the book was opened the nests were crushed and the sticky mass extruded. Several species of *Xylocopa* occur and I once took a specimen of *X. rufescens*, which does not appear to have been recorded previously from the plains of India. *Apis florea* is common, *A. dorsata* scarce. The social wasps are represented by the Indian Hornet (*Vespa cincta*) and by *Polistes stigma*, etc.

RHYNCHOTA.—The late Mr. Paiva enumerated 37 species as occurring on Barkuda, including 6 aquatic forms from the pond. The number of small Fulgoridae and Jassidae has increased considerably since he wrote, probably with an increase of the herbaceous Leguminosae (*Crotolaria striata* and *Taphrosia purpurea*). On the evenings of October 7th to 12th, 1920, the "Green-Fly" (*Nephotettix bipunctatus* and *N. apicalis*) was very troublesome on account of its vast abundance. To Mr. Paiva's list of Heteropterous species I may add the name of *Chrysocoris marginellus*, the nymphs and adults of which were found in abundance feeding on the Tree Euphorbia (*E. neriiifolia*) in April, 1920. Coccidae, Aleurodidae and Aphidae are not common. The females of a species of *Monophlebus*, belonging to the first family, occur sparingly on the aerial roots of *Ficus bengalensis*, *F. obtusa* and *F. gibbosa* and I have taken an Aleurodid on leaves of the var. *parasitica* of the last species. Woolly Coccidae are by no means scarce on the young shoots of *Taphrosia purpurea* and *Ficus obtusa* and on the fruit of the Custard-Apple (*Anona squamosa*). A yellow Aphid is abundant in the cold season on the creeper *Leptodenia*

reticulata, and a small colourless species is kept in its nests in rotten wood and deserted termite mounds by the ant *Acropyga acutiventris*, Roger.

DIPTERA.—The two-winged flies are poorly represented and the only large or conspicuous species that occur belong to the Bombyliidae (including the magnificent *Exoprosopa flammea*), of which several are common from April till June. They disappear for the most part, however, with the onset of the rainy season. Many of the common species of such families as the Syrphidae are absent or very scarce. The Trypaneids and other frugivorous forms are rare, while parasitic and semi-parasitic species are rarer than might be expected. Mr. Brunetti identifies a fly that lives on *Cervus axis* with the European *Lipoptena cervi*. A termitophilous Phorid of the genus *Termitoxenia* has been found in the fungus-combs of *Termes* (*Odontotermes*) *obesus*, Ramb.

The Nemocera are in some cases very abundant in individuals, but most families are poor in species. The Chironomidae seem to be less so than others and some minute forms are sufficiently abundant to be troublesome, among others the blood-sucking *Culicoides peregrinus*, Keiffer, which, however, is more troublesome on account of its vast numbers than its bite. At the end of the rainy season in disturbed weather it swarms with other forms round lamps in the verandah of the bungalow and especially on the ceiling above. *Calyptopogon albitarsis*, Kieff. is the only larger species of the family identified. Some of the smaller Chironomidae breed in damp rotten wood. A small species of *Phlebotomus* (Psychodidae) also occurs, but is rather scarce. Mosquitos are sometimes abundant, especially at the end of the rainy season, but very few species were observed. The commonest is *Anopheles rossii* (or, or as it is now called *A. subpictus*, Grassi), which breeds in the lake. Tipulidae are scarce and small. The largest and also the least scarce is the widely distributed *Conosia irrorata*. Cecidomyid galls are very abundant on certain trees, particularly on the leaves of *Salvadora persica* and *Pongamia glabra*, both of which are found almost exclusively on the shore of the island, and several species of the flies come to light occasionally.

TRICHOPTERA.—Are rare, but a few small species breed in the pond.

LEPIDOPTERA.—The butterflies are discussed in this installment of the report. Some species are abundant, and practically without exception the Diurna belong to widespread and common species. The moths have not been diligently collected. They seem, however, to be better represented than many groups of insects, perhaps because their caterpillars often feed on unpromising materials. Species of the largest size, such as those of *Attacus*, do not occur, and the Saturniidae generally are poorly represented. I do not remember to have seen any Sphingid except *Cephanodes hylas*. The largest moth observed was probably *Nyctipao macrops*, which flies about rapidly in a circumscribed area at night in open

spaces such as jungle paths, making a curious creaking sound. The most brilliantly coloured species of moth I have seen on the island is the Cossid *Duomitus mineus*, the cylindrical form, orange colour and bold greenish metallic markings of which give it a close superficial resemblance when the wings are closed to a large Buprestid beetle.¹ A large yellow underwing (*Ophuisa coronata*) was sometimes abundant in the rains and developed the curious habit of coming to drink out of our glasses at dinner. It was by no means teetotal in its tastes and we found that it could imbibe quite an appreciable amount of brandy without apparent confusion. One of the commonest moths in herbage is the cosmopolitan *Deiopeia pulchella*. On the whole the moths of Barkuda are inconspicuously coloured, and the exceptions I have mentioned stand out as exceptions, to which but few names could be added.

ARACHNID FAUNA.

Dr. Gravely has discussed the spiders and scorpions of the island in this instalment of my report. The latter are scarce and only two species have been taken. Among the spiders perhaps the most remarkable are the burrowing forms of the group Mygalomorphae, several of which construct elaborate trap-door nests in the earth at the base of fig-trees. Among the web-spinners the absence of the large and conspicuous species of the genus *Nephila* is a noteworthy feature. No Pedipalpi have been found on Barkuda, notwithstanding diligent search on Dr. Gravely's part.

FAUNA OF MYRIAPODA.

Myriapoda are not very abundant, but representatives of most of the Indian families of both centipedes and millipedes occur. Among the former a large species of *Scolopendra* is not uncommon, while specimens of *Pseudocryptops agharkari*, a small species of the same family, described by Dr. Gravely from the Bombay Ghats, have been taken. Dr. Gravely² tells me that they belong to the race *singbhumensis* which he described from Chota Nagpur. Geophilidae are not uncommon among dead leaves and under stones. Among the millipedes much the most abundant is a Polydesmid, a species that wanders in the open in fairly large numbers throughout the rainy season. Minute forms of the family Polyxenidae are fairly common under stones and in the galleries of ants and termites, from the nests of which other small millipedes have also been taken.

CRUSTACEAN FAUNA.

The only strictly terrestrial Crustacea observed on Barkuda are land Isopods, and no freshwater species except small Ento-

¹ I first observed the resemblance between this moth and certain Buprestids in the Malay Peninsula, where suitable "models" occur in this group of beetles. See *Fasic. Malay., Zool.* I, p. 58 (1903).

² Gravely, *Rec. Ind. Mus.* VII, p. 417 (1912).

mostraca have been found in the pond or wells. Several species of wood-louse occur under stones and one is not uncommon in spiders' nests on the leaves of *Glycosmis pentaphylla*. Prof. Chas. Chilton¹ has given a detailed account of the common littoral species, *Ligia exotica*. This Isopod is seasonal in its occurrence, disappearing annually at the end of the rains. In the littoral zone of the shore two sand-hoppers occur in large numbers, but neither ever makes its way into the interior of the island. This is noteworthy, as the more abundant of the two (*Orchestia platensis*) has been found among the mountains of Hawaii as well as at the edge of many seas and lakes. The less abundant but bigger species is *Talorchestia martensii*.

ANNELID FAUNA.

There are no land-leeches on Barkuda, the soil of which is much too dry for them. In the pond I have seen species of *Glossosiphonia*, doubtless parasitic on *Limnaea*, and a *Piscicola* which must live on frogs (*Rana cyanophlyctis*), the only aquatic vertebrate.

Several Oligochaetes have been described by Col. Stephenson from below water-level on the shore of the island, but the only terrestrial species is apparently his *Octochaetus barkudensis*, which is common in the earth between the roots of fig-trees.

POLYZOA AND SPONGES.

One species of freshwater Polyzoa and one of freshwater sponge are found on the island. The latter is the widely distributed *Spongilla alba*, which occurs both in the pond and in one of the wells, while the Polyzoan, representing the subgenus *Hyalinella*,² Jullien, of the genus *Plumatella*, was until recently known only from the pond on Barkuda, but has been found within the last few months in great abundance in the Colombo water-works in Ceylon. I have called it *Plumatella longigemmis*.³

The general characters of the fauna thus briefly summarized will, I hope, be discussed later, when the reports on the various groups have been considered in detail. It will be sufficient to say at present that it is in some respects almost an essence of that of the central part of Peninsular India, after most of the more highly specialized species had been eliminated in the struggle for existence, intensified by the peculiar nature of the soil, climate and vegetation.

¹ Chilton, *Mem. Ind. Mus.* V, p. 462 (1916).

² Annandale, *Rec. Ind. Mus.* XVIII, p. 93 (1919).

³ Annandale, *Rec. Ind. Mus.* XI, p. 168 (1915); *ibid.*, XVIII, p. 94 (1919).

THE BIRDS OF BARKUDA ISLAND

By N. ANNANDALE, *D.Sc.*, *F.A.S.B.*

In the annotated list of birds that follows I have not attempted to discuss the races to which they belong, or even to bring their nomenclature "up to date." The names given them are those used by Blanford and Oates in the *Fauna of British India*. My purpose has not been taxonomic, and though there may be differences of opinion as to the proper names of some of the birds, there can be no doubt as to their specific identity, for all belong to widely distributed and well-known species.

The island provides comparatively little food for any but indiscriminate feeders and is too far from the regular feeding-grounds of many birds to be utilized by them as a nesting-place. Its freedom from arboreal carnivores, and possibly the scarcity of tree-snakes, however, with its high and spreading trees, renders it an excellent roosting-place and large flocks of crows, mynas, egrets, pigeons and (at certain seasons) cormorants, may be seen every evening wending their way towards it at sunset.

I have included in my list the names only of those birds seen alighted on the island. There are many other species (land-birds, waders and swimmers) that are common in the surrounding districts and in other parts of the Chilka Lake and must fly across the island occasionally, for example, to cite species occasionally seen, at least one of swift among the land-birds, the Open-bill and a flamingo among the waders, the Cotton-teal, the Pintail and other ducks among the swimmers.

ANNOTATED LIST.

Corvus macrorhynchus, Wagler and *C. splendens*, Vieill.

Both species of crow are common on Barkuda, where they resemble one another closely in habits. A few reside on the island and even breed there, and the number which do so seems to have increased since I have habitually visited it and lived in the bungalow. The great majority, however, gain their livelihood on the mainland and fly over at dusk to roost. The crows come from both sides of the lake and some of them must fly six or seven miles every evening. The two species arrive together in flocks. The food of residents is very mixed and is obtained both from land and water. It includes fruit of the Custard-apple (*Anona squamosa*) and of the Prickly Pear (*Opuntia* sp.). The latter they do not attack until it has fallen to the ground. Snails (*Ariophanta infausta* and *Rachisellus Praetermissus*) are also eaten, as well as an occasional

dead Chital (*Cervus axis*), or other dead bird or mammal. When large masses of dead weed are washed ashore, as is often the case, they are carefully examined by both crows, which capture the small Isopod and Amphipod Crustacea with which they swarm. Sandhoppers (*Orchestia platensis* and *Talorchestia martensii*) also form their prey and I have seen a *C. splendens* hovering over the water and finally picking a dead fish from a mass of weeds with its beak. The strangest method they have, however, of obtaining food is that of robbing young Fishing Eagles, a procedure that they have developed into a regular conspiracy, in which both House Crows and Jungle Crows are implicated. Not only do they mob the old eagles whenever they see them and frequently chase them out over the lake, but when there are young birds in the eyrie, they collect in large numbers on the branches round it every evening towards dusk. When the old birds return, carrying fish, crabs or snakes for the young, the crows allow them to deposit the food in the nest and then chase them away. I have seen a single *C. splendens* chasing an eagle, which fled before it. The crows then share the provender with the young eagles, and it is not until they begin to grow sleepy, which they do rather early, and retire to roost, that the parent eagles can return to the nest, bringing more food for their despoiled young.

Acridotheres tristis (Linn.).

Except the two crows, the Myna is the only land bird common on the island, on which it lives in small flocks and breeds, chiefly in holes in the trunks and branches of dead Banyan trees (*Ficus bengalensis*). Like the crows, it obtains a good deal of its food from the lake, as it accompanies them in the search for small Crustacea among dead weeds on the shore. Flocks also fly across the lake from the mainland to roost on the island every evening.

Copsychus saularis (Linn.).

Stray individuals of the Dyal bird are occasionally seen in thickets in the rainy season.

Arachnecthra asiatica (Latham.).

At least one pair bred on the island in the season of 1920.

Ceryle varia, Strickland.

The Pied Kingfisher is often seen fishing off the island when the water is low and occasionally perches on the shore.

Merops viridis (Linn.).

This bee-eater is not resident on the island but small flocks of it occasionally fly over from the mainland and establish themselves for the day on some large tree with spreading branches, usually a *Ficus bengalensis* or *F. infectoria*. Their object, to judge from the scattered wings under their perch, is to feed on butterflies, particularly on *Papilio polytes*, which is very abund-

ant on the island. On the headland, Ganta Sila, across the lake from Barkuda, the bee-eaters live in large numbers. There they are fond of perching on some spray of creeper or shrub overhanging the water and of darting out on butterflies that have just flown across the lake.

Lophoceros birostris (Scopoli).

Small flocks and single individuals of the Grey Hornbill visit Barkuda not infrequently in the rainy season.

Eudynamis honorata (Linn.).

The voice of the Koel is often heard on Barkuda in June and July but the bird seems very shy and keeps mainly to the thickets.

Athene brama (Temm.).

The Spotted Owlet is fairly common on Barkuda and is very tame. I have seen four individuals issuing together from a hollow branch of *Ficus bengalensis*.

Pandion haliaëtus (Linn.).

The Osprey is an occasional visitor to the shore of the island.

Haliaëtus leucogaster (Gmelin).

Two pairs of the White-Bellied Sea-Eagle breed regularly on Barkuda. Each has its nest, to which it remains faithful throughout the year, in a large Banyan that overtops the surrounding forest. The breeding-season is prolonged and two broods are sometimes raised in the year. At the beginning of April, 1920, the inhabitants of one nest consisted of a pair in adult plumage and a nearly fledged young one. In the middle of June there was one adult in full plumage, one in immature plumage and two half-fledged young. The other nest I could not see so clearly, on account of the branches and foliage, but the parent birds were both in adult plumage in April, while in June the nest contained young and one of the adults was in immature plumage. It would, therefore, seem, either that one of each pair had died and that a young bird of the first brood of the year had assumed its place, or else that the young one had driven off one of its parents and taken on itself the responsibilities of parenthood, even if it was only as a step-parent. Both parents of both pairs were in full plumage in October.

This eagle is very cowardly in spite of its size. I have already mentioned the fact that a single House-Crow can put it to flight. On Cherriakuda, another island in the Chilka Lake close to Barkuda, I once saw an even more ignominious escapade. An eagle was soaring over a tree on which a large flock of flying foxes were roosting. Its appearance caused great agitation and the bats scurried about along the branches and squealed incessantly. This attracted the eagle's attention and it alighted just

above one of them and looked down at it. The bat turned up its muzzle and bit the eagle on the leg, and the eagle flew away.

The food of the Fishing Eagle consists on Barkuda largely of the fish *Triacanthus brevirostris*, the harmless sea-snake *Chersydrus granulatus* and the swimming-crabs *Scylla serrata* and *Nephtunus pelagicus*. To judge from remains at the base of the trees on which the nests are built and on other parts of the island, *Triacanthus* is the most important item, but this fish has a very solid skeleton and only part of it is as a rule eaten by the birds, while the snakes are as a rule swallowed whole and their skeletons can rarely be distinguished. *T. brevirostris* is, perhaps, the most abundant fish in the lake. It is a laterally compressed active fish of the suborder Sclerodermi and goes about in shoals which often swim near the surface. It possesses powerful and poisonous spines both on its back and at the sides of its body. The snake is a very sluggish species. It never leaves the water and is found only in the open lake. Doubtless the eagle catches it as it rises to the surface and protrudes its head and neck, as it often does. The two crabs are both powerful swimmers, but the *Nephtunus* is more frequently seen on the surface than the *Scylla*, which is actually the more abundant of the two in the lake. Its remains are also more abundant, in spite of its more retiring habits, among those of the eagle's victims. Siluroid fish of the genera *Arius*, *Macrones* and *Plotosus* are also captured occasionally, and these are essentially bottom-haunting fish. As the water of the lake is usually turbid, it is rather strange that the eagle can catch them. How it does so I do not know.

As I have pointed out elsewhere, the remains of the food of this bird may provide interesting material for the palaeontologists of some future epoch. They are congregated not only round the trees on which they nest but also lie scattered over the whole island, the prey being not infrequently dropped intact, perhaps when its captor is chased by a crow.

Haliastur indus (Bodd.).

Frequently observed fishing round the island, on which at least one pair bred in 1919 and 1920.

Astur badius (Gmel.).

A pair of Shikra bred on the island in a Banyan tree in 1919. I saw one of them sitting among the foliage of another Banyan besides a dove's nest and darting out at the parent bird as it returned. The dove, however, escaped.

Crocopus phoenicopterus (Lath.).

Large flocks of this pigeon visit the island during the rainy season to feed on the figs of *Ficus bengalensis*, *F. infectoria*, *F. obtusa* and *F. globosa*. They do not come, however, until the rains are well established (in July) even though the figs are often ripe in April. Specimens seem to agree with the northern rather than the southern species of the genus.

Columba intermedia, Strickl.

The Indian Rock pigeon is abundant, at any rate at night, on the more rocky islands of the Chilka Lake, but is only an occasional visitor on Barkuda. Small flocks do, however, roost on the island sometimes.

Turtur orientalis (Lath.).

Fairly common on the island, on which it breeds regularly.

Turtur risorius (Linn.).

Apparently no more than a casual visitor on Barkuda. A pair were observed on the shore in June, 1920, feeding on the halophytic plant *Suaeda multiflora*.

Esacus recurvirostris (Cuvier).

A common bird on the foreshore except when it is covered by the floods. When the water reaches the base of the trees at the head of the beach, the birds desert the island, but they return as soon as the floods abate. I have seen a half-fledged nestling on the island, in April. Four or five adult individuals are often seen together and once I saw twelve standing on a sand-bank. This was at the end of October.

Sarcogrammus indicus (Bodd.).

The Did-he-do-it is one of the most familiar birds on the shore of Barkuda, on which it breeds. It is present throughout the year.

Charadrius fulvus (Gmelin).

Flocks of the Eastern Golden Plover frequent the shore of Barkuda in the cold weather, arriving about the middle of September and not departing until May.

Aegialitis alexandrina (Linn.).

The Kentish Plover is common on the shore of Barkuda in the hot weather. I have seen individuals in full breeding plumage in June.

Numenius arquata (Linn.).

The Curlew is by no means uncommon on the shore of Barkuda in the cold weather and the latter part of the rains. I have seen individuals as early as the end of September.

Limosa belgica (Linn.).

Large flocks feed on the shore, just below the water-level, in the cold weather.

Totanus glareola (Gmelin).

A common bird on the shore throughout its stay in the south.

Totanus calidris (Linn.).

The Redshank is common on the shore in the cold weather and the latter part of the rains. It arrives at least as early as the beginning of October.

Totanus glottis (Linn.).

The Greenshank is common on the shore in winter and autumn, arriving before the end of October.

Tringa subarquata (Güldenstorp).

Yet another common shore-bird in its season. I think I have seen it as early as the end of July.

Himantopus candidus (Bonn.).

Several pairs frequent the shores of the island in the winter and hot weather, but leave them when the floods rise. I found a nest in June, 1920. It contained three eggs arranged with the pointed ends inwards and was constructed as described in the "Fauna." It was situated on gravel amidst masses of dead weed. The old birds were very bold in its vicinity, dashing close down and almost touching one's head, screaming all the time.

Larus ichthyæetus, Pallas.

I think this is the large black-headed gull sometimes seen resting on the shore.

Larus ridibundus, Linn.

Occasionally seen on the shore in the cold weather.

Sterna melanogaster (Temm.).

Not uncommon round the island in the hot weather.

Sterna minuta, Linn.

Also fairly common. I have seen the species in the breeding season on the shore, but am sure that it does not nest on the island.

Other species of terns probably visit Barkuda, but I have not been able to identify them with certainty.

Phalacrocorax carbo (Linn.) and *P. javanicus* (Horsf.).

These two cormorants visit the island occasionally.

Phalacrocorax fuscicollis (Steph.).

Very large numbers of this cormorant visit the island nightly in the hot weather and the early part of the rains to roost. After sitting for some time on rocks on the shore, they fly to certain trees near the middle of the island, leaving at dawn. The places stink of them. About the beginning of September they begin to disappear, and have done so completely by the end of the month.

The last to go are young birds in immature plumage. The species breeds in enormous numbers, with the Common Herons and the Open-bill on Kalidai, the sacred island of the Chilka Lake, some ten miles north-east of Barkuda. By the end of October the young birds are nearly fledged.

Plotus melanogaster (Pennant).

Not uncommon on the rocky parts of the shore of the island.

Ibis melanocephala (Lath.).

I have seen several birds of this species roosting on trees with the egrets in the hot weather and early part of the rains, but it does not breed on the island.

Dissura episcopus (Bodd.).

An occasional visitor to the shore.

Xenorhynchus asiaticus (Lath.)

Also an occasional visitor to the shore.

Ardea cinerea, Linn.

A common visitor. It breeds both on Kalidai and on Cherriakuda, which lies just across the bay from Barkuda. Eggs were taken on the latter island in September.

Herodias alba (Linn.), *H. intermedia* (Wagler), and *H. garzetta* (Linn.).

These three egrets roost on trees of *Pongamia glabra* and *Azadirachta indica* near the south shore of the island, but do not breed there.

Ardeola grayi, (Sykes).

Common on the shore but I do not think it breeds on the island. I have seen it accompanying a herd of deer (*Cervus axis*) grazing on the scanty herbage of a cleared area on Barkuda, for the sake of the grass-hoppers disturbed by them. It does not, however, feed on the backs of the deer or even approach them very closely.

Nycticorax griseus (Linn.).

Several birds breed on trees near the south side of the island, but their main nesting place in the vicinity is on Cherriakuda.

Anser indicus (Lath.).

An occasional visitor to the shore in the cold weather and as late as the beginning of April.

Dendrocycna javanica (Hors.).

Large flocks frequent the more level parts of the shore in the winter and the hot season. They leave simultaneously, however,

as soon as the rains are established and I have never seen the species on the island between the end of June and November.

Dendrocycna fulva (Gmelin).

A pair frequented the island throughout the rainy season of 1919 and probably bred upon it.

Casarca rutila (Pallas).

Not uncommon on the shore in the cold weather.

Anas poecilorhyncha, Forst.

One or two pairs haunted the shores of the island in April and June, 1920, but I don't think they bred upon it.

APPENDIX.

Mr. Cedric Dover informs me that the following species have been seen by him on Barkuda.

Dendrocitta rufa (Scop.).

"A pair were observed on the top of a large fig-tree in April, 1920."

Dicrurus ater (Hermann).

"An occasional visitor to the south shore of the island."

Orthotomus sutorius (Forst.).

Mr. Dover found the Tailor-Bird not uncommon in the more wooded areas of Barkuda. It probably breeds on the island.

Alcedo ispida, Linn.

"Seen occasionally in September and October, 1919, and in August, 1920, perched on poles on the south shore of Barkuda."

Halcyon smyrnensis (Linn.).

"Not infrequently seen in August, 1920, in the same situation as the preceding species."

Strix flammea, Linn.

"A single individual was observed in the vicinity of a dis-used well at about 8 p.m. in October, 1919."



THE REPTILES AND BATRACHIA OF BARKUDA ISLAND.

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

The reptiles are proportionately well represented on Barkuda by 6 lizards, 10 snakes and one, or possibly two, crocodiles, *i.e.*, by seventeen or eighteen species in all. With one noteworthy exception all these are, however, widely distributed and adaptable animals. The exception is the limbless skink *Barkudia insularis*, which has probably escaped notice elsewhere on account of its burrowing habits. Most of the species are, moreover, scarce on the island, and several are represented in my collection by single specimens. Only two species of Batrachia, both common and widely distributed, have been observed.

Reptiles.

Gavialis gangeticus (Gmel.). I have not seen the gharial on Barkuda myself but several trustworthy observers tell me they have done so.

Crocodilus palustris (Lesson). A single individual of this species takes up its abode every year in the rainy season on a sand-bank at the N.E. corner of the island.

Hemidactylus brookii, Gray. I have not seen this gecko, one of the common house-lizards of Calcutta, on Barkuda recently, but took a specimen some years ago on the shore, feeding on sand-hoppers (*Orchestia platensis*).

Hemidactylus frenatus, D. & B. This is much the most abundant reptile on the island and is equally at home on the walls and ceiling of the bungalow, on the trunks of various species of fig-tree, and among stones on the shore, where it feeds on sand-hoppers. The eggs are usually deposited in the trunks of trees. They have a thin, brittle shell and are broadly oval or almost spherical in shape, about 8 mm. long and 7 mm. in maximum transverse diameter. Several are usually found together, but adhering neither to one another nor to extraneous objects.

Calotes versicolor major, Blyth. The Peninsular race of *C. versicolor*, though not abundant, is by no means scarce on Barkuda.

Varanus bengalensis (Daud.). Frequently seen, singly and in pairs, on the island. In September, 1920, a half-grown individual was dug out of the interior of a mound of *Termes* (*Odontotermes*) *obesus*, but a burrow is usually made among stones or the roots of fig-trees. The lizard is, unlike some of its congeners

terrestrial in habits, but has been seen on the horizontal branches of *Ficus bengalensis* near the ground and also swimming in the lake. It often frequents the sides of stone-built wells.

Lygosoma albopunctatum (Gray). By no means common. One was seen under dead weed at the edge of the lake. In this position it doubtless feeds on sand-hoppers, as its ally *L. punctatum* has been observed to do at other places on the Chilka Lake.

Barkudia insularis, Annandale.¹ Only one complete specimen, the type, has as yet been captured, but Dr. Gravely saw another in the rainy season of 1919. He managed to secure its tail, but the animal escaped. It burrows with great rapidity in the earth among the roots of fig-trees. The tail is extremely brittle.

Typhlops braminus (Daud.), *T. diardi*, Schleg., *T. porrectus*, Stol. These blind snakes are found occasionally in the same situation as *Barkudia*.

Zamenis mucosus (Linn.). I once saw a large specimen dead in one of the wells, and captured a young one on another occasion.

Dendrelaphis tristis (Daud.). This is the commonest snake on the island. It is sometimes seen on the ground, but more often coiled in an elongate figure of eight on the branches of the shrub, *Glycosmis pentaphylla*, or on the small-leaved fig-tree, *Ficus obtusa*, of which it seems particularly fond.

Dipsadomorphus trigonatus (Schneid.). A single specimen was taken.

Cerberus rhynchops (Schneid.). I have included this snake in the reptilian fauna of Barkuda (while excluding the purely aquatic *Chersydrus granulatus* and *Hydrophis obscurus*, both common in the Chilka Lake) because it sometimes comes ashore. It is common among the stones of the pier. I have seen a large gravid female sunning itself on these stones, completely out of water, in June.

Bungarus coeruleus (Schneid.). By no means common, but less rare than any other poisonous snake. I have seen four specimens in eight years. One of them was dropped by a bird on the doorstep of the bungalow in a moribund condition, but the bird was not seen.

Naia tripudians (Merr.). I have never seen a cobra on the island, but once found a large cast skin.

Vipera russelli (Shaw). A specimen was killed by Dr. Gravely and myself in a clump of prickly pear.

Batrachia.

The Batrachia are poorly represented on Barkuda. The only species I have seen are *Rana cyanophlycis*, Schneid. and *Bufo melanostictus*, Schneid., the commonest and most generally distributed Indian frog and toad. The frog is abundant in the pond

¹ *Rec. Ind. Mus.*, XIII, p. 19-21 (1917).

and in the wells on the island, in which it breeds freely, the toad is scarce. One took up its abode in the bungalow in April, 1920, and I saw another on a path in the evening, in October of the same year. I have not found tadpoles on the island.

THE CICINDELID BEETLES OF BARKUDA ISLAND

By N. ANNANDALE, D.Sc., and CEDRIC DOVER.

The beetles on which the records in this paper are based have either been identified by Dr. Walther Horn, or else very carefully compared with specimens named by him. The assistance he has given us both before and since the war has been of the greatest possible value.

In the fauna of Barkuda the Cicindelinae (s.s.) play an important part, but the Collyrinae, represented by a single species, are very rare. This is not surprising, for the latter subfamily are mostly inhabitants of damp equatorial forests, while many species of *Cicindela*, the only Cicindeline genus represented on Barkuda, love open sandy or gravelly spaces. It is in such situations that five of the eight species taken on the island occur. Of the remaining three, *C. aurovittata* is a jungle form and *C. fastidiosa* is found on damp mud, while *C. haemorrhoidalis* appears to be associated definitely with termites of the genus *Termes* and the subgenus *Odontotermes*, in the walls of the mounds of which its larva burrows.

The majority of the Cicindelinae are most abundant on the island at the end of the dry season and the beginning of the rains. As the soil becomes damp such species as *C. sumatrensis* and *C. catena* almost disappear. *C. haemorrhoidalis*, however, only appears after the wet weather is well established, and apparently only lives in the adult state for a few weeks. It is usually seen either sitting on the termite mounds or flying in open spaces in which the termite mounds exist. Dr. Gravely has found the remains of at least two adult individuals in empty burrows in a mound of *Termes obesus*, in which the larvae are often abundant.

The figures after the name of each beetle denote the page on which it is described in Canon Fowler's volume on the Cicindelidae and Paussidae in the "Fauna of British India" series, while those after it refer to the page number of Annandale and Horn's *Annotated List of the Asiatic Beetles in the Collection of the Indian Museum, Part I, Cicindelinae* (Calcutta, 1909).

Division ALOCOSTERNALIAE.

Subfamily COLLYRINAE.

Neocollyris bonelli, Guer., p. 248.

Barkuda, 2 specimens, 3-19.viii.19 (F. H. G.) and ix.20 (N. A.).

Represented in the collection of the Zoological Survey of India from Kharagpur, Calcutta, Siripur in North Bengal, Sikkim, and Sibsagar and the Kha-i Hills in Assam. Fowler remarks that the Calcutta locality is rather doubtful as it is based on a single specimen in the collection. On Barkuda the species is very scarce but we have seen it flying round shrubs (particularly *Datura*) on several occasions and alighting on the foliage.

Division PLATYSTERNALIAE.

Subfamily CICINDELINAE.

Cicindela (*Tetremytarsa*) *tetrastacta*, Wied., p. 337, p. 8.

Barkuda, 4 specimens, 20 and 21.vii.14 (*Chilka Survey*), and 15-22.vii.16 (*N A* and *F H G.*).

The Indian Museum possesses specimens from Calcutta, Birbhum, the Ganges Valley and Chota Nagpur in Bengal and from Ganta Sila on the Chilka Lake.

A common species on foot-paths and the upper part of the beach of the lake.

Cicindela fastidiosa, Dej., p. 352, p. 11.

Barkuda, 6 examples, vi.20 (*N A.*), 11.6.20 (in puddle at edge of lake, *N A.*), and 3-19.viii.19 (*F. H. G.*).

Represented in the Indian Museum collection from Trincomalee and Anuradhapura (low country) in Ceylon, and Rambha in the Ganjam district of the Madras Presidency.

Three of the six specimens captured are brownish, two are green, and one bluish in colour; the green and blue ones are labelled "aberr." by Dr. Horn. The species is by no means common, but is occasionally found on damp mud at the edge of puddles of water in the rainy season.

Cicindela undulata, Dej., p. 356, p. 11.

Barkuda, 1 example, 25.vii-4.viii.17 (*N A.*).

Represented in the Indian Museum collection from Calcutta, Maldah in East Bengal, Gopkuda Island in Lake Chilka, and Balugaon in the Puri district of Orissa. "Found from Mysore to Ceylon, Bengal" (*Horn*).

Cicindela distinguenda, Dej., p. 358.

Barkuda, 1 specimen, 2.vi.20 (on shore *N. A.*).

This species closely resembles *C. fastidiosa*, but is larger, and a rare insect in collections. Fowler records it from Pondicherry and Ceylon.

Cicindela sumatrensis, Herbst., p. 371, p. 14.

Barkuda, several specimens, 20.vii.14 (*Chilka Survey*), 15-22.vii.16 (*N A* and *F H G.*) and 25.vii-4.viii.17 (*N. A.*).

The Museum possesses specimens from Trivandrum, Calcutta, Damukdia and Chota Nagpur in Bengal, Patan in the Koyna Valley of the Satara district, Bhogpur in the United Provinces, Kumdhik and Maho in Nepal, Siliguri, base of the Eastern Himalayas, Cacara Bay in Portuguese India, Tura in the Garo Hills of Assam, Cherria Island in Lake Chilka, Cuttack in Orissa, Cochin States, and China.

This widely distributed species is the commonest of the Cicindelidae found on the island, often occurring with *C. tetrastacta*.¹

Cicindela aurovittata, Brul., p. 386, p. 24.

Barkuda, several typical examples, 17.vii.14 (*Chilka Survey*), 3-19.viii.19 (*F. H. G.*) and 25.vii-4.viii.17 (*N. A.*).

The only other specimens in the collection of the Indian Museum are from the Andaman Islands, the Chilka Lake, Ganjam, and the Salt Lakes near Calcutta. It is found also in Ceylon, in Madras and Pondicherry, Rangoon, at the Nicobars, and the Philippines.

A jungle species rather common on Barkuda.

Cicindela haemorrhoidalis, Wied., p. 402, p. 24.

Barkuda, eight examples, 21.vii.14 (*Chilka Survey*), 15-22.vii.16 (*N. A.* and *F. H. G.*) and 25.vii-4.viii.17 (*N. A.*).

Canon Fowler does not record the following localities (represented by specimens in the collection of the Indian Museum) in his volume in the "Fauna." Burkul and Angul in Orissa, Ganta Sila on Lake Chilka, Ganjam, and Rawalpindi in the Punjab.

This beetle is usually found in the neighbourhood of termite mounds in the walls of which its larva burrows.²

Cicindela catena, Fabr., p. 426, p. 28.

Barkuda, many specimens 17-20.vii.14 (*Chilka Survey*), 15-22.vii.16 (*N. A.* and *F. H. G.*), and 25.vii-4.viii.17 (*N. A.*).

"Found from Ceylon to Mysore and Bengal, up to Darjiling" (*Horn*). Its occurrence in the localities Ranchi and Cherria Island in Lake Chilka has not we believe been previously noticed. This tiger beetle is not uncommon on the island with *C. sumatrensis* and *C. tetrastacta*.

¹ Cf. Gravely, *Rec. Ind. Mus.*, VII, p. 207 (1912) for an account of habits of this and other tiger-beetles from Orissa.

² Cf. Horn, *Deuts. Entom. Zeits.* 1899, pp. 234 and 395.

THE CARABIDAE OF BARKUDA ISLAND.

By H. E. ANDREWES.

I give below a list of some 36 species submitted to me for determination. I have not been able to put names to all of them, because, owing to the war, I have not yet had the opportunity of seeing various types in the Museums and collections on the continent. The Carabidae of Barkuda Island do not appear to offer any special features, and most of the species are widely spread through India and Ceylon. Perhaps the most interesting insect taken is the example of *Scarites terricola*, Bon., a northern form of which I have seen no other Indian specimens. A series of *Comsodiscus picturatus*, Andr., was taken, of which species only two other examples have hitherto been found elsewhere: nothing is yet known of its life-history or habits. I describe a new genus *Velinda* for an insect taken at Barkuda, of which by the same mail I received a second example taken by Mr. F. A. D'Abreu in the Central Provinces; it lives under bark and careful search will no doubt produce other examples.

1. *Oxylobus costatus*, Chaud.

Mon. des Scaritides, i, *Ann. Soc. Ent. Belg.* 1879, 134.

With the single exception of *O. dissors*, Tchitch. (on which further light is required), the genus is peculiar to India and Ceylon; the species are numerous and many are still undescribed. *O. costatus* is widely spread in India and is variable both in the amount of puncturation on the ventral surface, and specially so in the sculpture of intervals 2 and 4 of the elytra. These may form well developed ridges, like the other intervals, or they may be reduced, even to the extent of disappearing altogether. In the specimens before me these ridges are reduced but quite distinct, and the size of the insects is a little less than that of the type.

4 ex. (*N. Annandale* and *F. H. Gravely*).

2. *Scarites terricola*, Bon.

Obs. Ent. ii, 1813, 471; Chaud Mon. des Scaritides, ii, *Ann. Soc. Ent. Belg.* 1880, 100.

Scarites arenarius, Bon., *Obs. Ent.* ii, 1813, 472.

„ *pacificus*, Bates, *Trans. Ent. Soc. Lond.* 1873, 238.

The occurrence of this well-known palaearctic species in sub-tropical India is very unexpected, but I have compared the example with specimens from China, Japan, and Southern Europe, and do not feel any doubt about the identification. The only other

record from India is given by Mr. P. Lesne (*Mission Pavie*, 1904, 63), who mentions "Pondicherry (*M Maindron*).'' There are examples in the Indian Museum from Baluchistan, Nushki district (*E. Vredenburg*), and from both the Seistan Commission and the Baluchistan-Afghanistan Boundary Commission. The range of the species is from the Mediterranean basin, through Central Asia, to Japan.

1 ex. (*F H Gravely*).

3. *Scarites indus*, Oliv.

Ent. iii, 1795, 36, 9, t. 1, f. 2 a, b; Chaudoir, *Mon. des Scaritides*, ii, *Ann. Soc. Ent. Belg.* 1880, 102;
Scarites mancus, Bon., *Obs. Ent.* ii, 1813, 473.

The commonest Indian species of the genus.

3 ex. (*F H Gravely*).

4. *Clivina attenuata*, Herbst.

Nat. Ins. Käf. X, 1806, 264, t. 176, f. 7; Putzeys, *Mon. des Clivina*, *Mém. Liège* ii, 1846, 626 (sep. 108); *id.* *Rév. Gén. des Clivinides*, *Ann. Soc. Ent. Belg.* x, 1867, 110.

Common in the North, but not extending further South than the Central Provinces.

1 ex. (*F. H Gravely*); 1 ex. (*N Annandale*). "In nest of *Phidola rhombinoda*."

5. ? *Clivina lobata*, Bon.

Obs. Ent. ii, 1813, 481; *Dej. Sp. Gen.* i, 1825, 414; Putzeys, *Mon. des Clivina*, 599 (Sep. 81); *id.*, *Rév. Gén. des Clivinides*, 120.

The specimens which served as types to Bonelli and Dejean came from the same source, and Putzeys assumed that they belonged to the same species. As far as I am aware no entomologist dealing with this genus has examined Bonelli's type, and for the present this identification is doubtful. The supposed locality is Bengal. In addition to the example from Barkuda Island, there are in the Indian Museum collection 4 ex. from Orissa, Puri district, Balugaon (*N Annandale*).

8 ex. (*F H Gravely*).

6. ? *Clivina mordax*, Putz.

Postscr. ad Cliv. Mon., *Mém. Liège* xviii, 1863, 67; *id.*, *Rév. Gén. des Clivinides*, 133.

This specimen agrees with others determined by Bates, but I have not seen the type, and Putzeys two exiguous descriptions are not very helpful. If the determination is correct, *C. mordax* is widely spread in the East.

1 ex. (*N. Annandale*).

7. *Clivina* sp.

I cannot identify this species at present.

2 ex. (*N. Annandale* and *F. H. Gravely*).

8. *Dyschirius* sp.

If described, only to be identified by comparison with Putzeys, types.

1 ex. (*F. H. Gravely*).

9. *Pogonus Biroi*, Cziki.

Ann. Mus. Hung. V, 1907, 574.

The only *Pogonus* described from India, as *P. hindustanus*, Motch. (*Bull. Mosc.* 1864, iii, 192) probably does not belong to the genus. I have not seen the type, which came from Bombay, but the specimens agree with the description, though the hind angles of the prothorax are very nearly right.

In addition to the specimens taken on Barkuda Island, there are others in the Indian Museum from "Chilka Survey Stations, Orissa, Puri District, Balugaon (*N. Annandale*), and Ganges delta. Sorabkatti (*Jenkins*).

3 ex., two of them "at light" (*F. H. Gravely*).

10. *Tachys ornatus*, Apetz.

Col. Brehm. 1854, 12,

Tachys orientalis, Nietn., *Ann. Mag. Nat. Hist.* (3), II, 1858, 425.

The species was described by Apetz from Upper Egypt, and Bates gives Yemen also as a locality. Nietner redescribed it from Ceylon, and I have seen examples from many parts of India. There are in the Indian Museum specimens from Bengal, Ranchi, and Orissa, Puri.

5 ex. (*F. H. Gravely*); 6 ex. (*N. Annandale*). "On damp mud at edge of puddle of rain-water."

11. *Tachys emarginatus*, Nietn.

Ann. Mag. Nat. Hist. (3), ii, 1858, 425.

A common species all over the East.

3 ex., all very dark (*F. H. Gravely*); 5 ex. (*N. Annandale*). "Taken with the preceding species."

12. *Craspedophorus bifasciatus*, Cast.

Et. Ent. 1835, 155; Andr., *Trans. Ent. Soc. Lond.* 1919, 126.

Epicosmus castelnaui, Chaud., *Mon. sur les Panagæides*, *Ann. Soc. Ent. Belg.* 1878, 112.

Hitherto recorded only from S. India and Ceylon, where it seems to be far from common.

3 ex. (*F. H. Gravely*).

13. *Callistomimus*, sp. nov.1 ex. (*N Annandale*.)

A novelty which is interesting as combining some of the characters of *Callistomimus* and *Pristomachaerus*. Unfortunately only a single example has been discovered.

14. *Chlaenius henryi*, Andr.*Ann. Mag. Nat. Hist.* (9), iv, 1919, 11.

I described this species from a single example sent to me from Ceylon by Mr. G. M. Henry. I have since seen a specimen in the collection of the Brussels Museum taken at Barway by Père Cardon.

2 ex. "at light" (*N Annandale* and *F H Gravely*).15. *Coleolissus*, sp. nov.

This species belongs to the group proposed by Bates (*Ann. Mus. Civ. Gen.* 1892, 339) for glabrous Eastern *Hypolithus*. There is only one example (♀), almost certainly undescribed, and the ♂ remains to be discovered.

1 ex. (*F. H Gravely*).16. *Dioryche colombensis*, Nietn.*Journ. As. Soc. Beng.* 1857, ii, 151; *id.*, *Ann. Mag. Nat. Hist.* (2), xx 1857, 373.

Generally distributed throughout India and Ceylon, but not elsewhere; I have, however, seen an example from the Maldive Is. (*J Stanley Gardiner*).

4 ex. "at light" (*N Annandale* and *F. H Gravely*).17. *Dioryche nagpurensis*, Bates.*Compt. rend. Soc. Ent. Belg.* 1891, 329.1 ex. (*N Annandale*.)

Common in Bengal, Chota Nagpur and Orissa.

18. *Dioryche chinnada*, sp. nov.

Length 7.5—8.0 mill.

Piceous: upper side aeneous, finely shagreened, under side with a faint green reflection, joints 1-2 of antennae and legs (except knees and tarsi) testaceous, last joint of labial and last two joints of maxillary palpi (except apex) fuscous.

Head (1.75 mill. wide) convex behind, flattened in front, front of clypeus bordered and strongly emarginate, suture fine, ending on each side in a fine point, eyes moderately prominent, antennae hardly reaching beyond base of prothorax, surface very finely and sparsely punctate.

Prothorax transverse (1.9×2.5 mill.), moderately convex, widest rather before middle, base rather wider than apex, sides gently rounded, not sinuate behind, hind angles obtuse, basal foveae moderately deep, surface faintly laterally strigose, finely and sparsely punctate, base closely punctate, with some minute longitudinal striae in the middle.

Elytra (2.9×4.5 mill.) rather flat, elongate, sides parallel, base strongly bisinuate, border forming a well-marked angle on shoulder, sides rather deeply emarginate before apex, striae clearly cut but not deep, impunctate, not becoming deeper near apex, scutellary striae very short, arising from an umbilicate pore, intervals flat, even ones much narrower than odd ones towards apex, 3, 5, and 7 seriate-punctate, the punctures rather large and conspicuous, 5 depressed near apex, marginal series interrupted in middle, surface finely punctate.

Rather larger than *D. nagpurensis* Bates and a little brighter in colour, femora testaceous, head finely punctured, base of prothorax much more finely punctate, elytra longer, more sharply angled at shoulder, alternate intervals similarly narrowed at apex, but flatter, serial pores larger. The species is also closely allied to *D. indochinensis* Bates, from Indo-China and Burma, but the colour of this latter species is a little cupreous, the elytra are much shorter and wider, and the serial pores even larger than in *D. chinna*.

Madras: Ganjam Dist., Chilka Lake, Barkuda I. (*N Annandale*), 1 ex. "at light" U. P., Gorakhpur 1 ex.

Bombay: Satara, Medha 1 ex., Ratnagiri, Pimpri, Rashishti Valley (*F. H. Gravely*), 1 ex.—Ind. Mus.

Madras (*Capt. W. Patton*), 2 ex.—Bombay Nat. Hist. Soc.

Bengal, Pusa, 1 ex. Bombay, Belgaum, 2 ex. C. P., Bilaspur, Janjgir, 1 ex. Madras, Coimbatore, 1 ex.—Agric. Res. Inst. Pusa.

Madras, Coimbatore, 1 ex.—Agric. Coll. and Res. Inst. Coimbatore.

C. P., Nagpur, Raipur Dist., Tumgaon (*E. A. D'Abreu*), many ex.—Centr. Mus. Nagpur.

Mysore State (*Dr. T. V. Campbell*), 1 ex.—E. A. Butler coll.

Pondicherry, 3 ex.—Oxford University Museum (Hope Dept.)

Bombay: Belgaum (type) (*H. E. Andrewes*), Kanara (*T. R. D. Bell*).

Madras, Bangalore, Malabar, Pondicherry, Bombay, Ceylon, Trincomali (*C. F. S. Baker*), 5 ex.—British Museum.

19. *Platymetopus rugosus*, Nietn.

Journ. As. Soc. Beng. 1857, ii, 150; *id.*, *Ann. Mag. Nat. Hist.* (2), xx, 1857, 373.

Generally distributed in India and Ceylon, but apparently uncommon.

7 ex. (*F. H. Gravely*, *N Annandale*, and *Chilka Survey*).

20. *Platymetopus flavilabris*, F.

Suppl. Ent. Syst., 1798, 59.

Widely distributed in the East. I saw the type last autumn in Copenhagen, and my notes on this and other Fabrician species will appear in the *Transactions of the Entomological Society of London* for the current year.

1 ex. "at light" (*N. Annandale*).

21. *Barysomus semivittatus*, F.

Suppl. Ent. Syst., 1798, 59.

Spread over Southern China, Indo-China, India, and Ceylon, but nowhere common. There are other examples in the Indian Museum from Bengal, Orissa, and Ceylon.

2 ex. (*N. Annandale*).

22. *Harpalus advolans*, Nietn.

Journ. As. Soc. Beng. 1856, vi, 526.

Ann. Mag. Nat. Hist. (2), xix, 1857, 377.

I have not had the opportunity of examining Nietner's type; examples both from India and Ceylon which I have examined are darker and less aeneous than the description indicates, but otherwise agree with it fairly well.

1 ex. "at light" (*N. Annandale*).

23. *Amblystomus punctatus*, Bates.

Ann. Mus. Civ. Gen. 1892, 335; *id.*, *Ann. Soc. Ent. Belg.* 1892, 231.

Described by Bates from Bengal and Mandalay. I have seen examples from various parts of India, but not from Ceylon.

2 ex. (*F. H. Gravely*).

24. *Abacetus reflexus*, Chaud.

Essai monographique sur le genre Abacetus, *Bull. Mosc.* 1869, ii, 358.

I have seen a good many examples of this species from Central India, Nagpur (*E. A. D'Abreu*), and Bombay, Belgaum (*H. E. Andrewes*) and N. Kanara (*T. R. D. Bell*). Chaudoir's specimen came from "N. India."

1 ex. (*F. H. Gravely*).

25. *Abacetus antiquus*, Dej.

Spec. Gen. iii, 1828, 246; Chaud. *Mon.*, 391.

I have seen the type of this species in Mr. Oberthür's collection, but have no specimen for comparison. The examples from Barkuda Island agree fairly with my notes and my recollection. According to Chaudoir the species has been taken at Pondicherry, in Ceylon, and in Burma.

4 ex. (*N. Annandale* and *F. H. Gravely*).

26. *Abacetus*, sp. nov.

1 ex. "found together with young cockroaches in an ants' nest (*Camponotus* sp.)" (C. Dover).

27. *Morio orientalis*, Dej.

Sp. Gen. i, 1825, 432; Chaudoir, *Essai monographique sur les Morionides*, *Bull. Mosc.* 1880, ii, 338.

Widely distributed in the East. The species of this genus are very difficult to distinguish from each other, and I think too many have been described.

1 ex. (F. H. Gravely).

28. *Cosmodiscus picturatus*, Andr.

Ann. Mag. Nat. Hist. (9), V, 1920, 447.

The genus was formed for a species found in Queensland. In my recent paper I pointed out that a species from Japan (Lewis), described by Bates as *Stomonoxus platynotus* (*Trans. Ent. Soc. Lond.* 1873, 283), belonged actually to this genus, and further that the same species had lately been taken by Mr. H. Stevens in Sikkim. I have now received from Mr. T. G. Sloane—to whom we are indebted for the genus—two specimens taken by H. Fruhstorfer in Western Java (Mons. Gede and Pengalengan, both at 4000 feet), which also seem to be identical with Bates' species. By a curious chance I have within the last few days seen an example, belonging to Rev. J. A. O'Neil of Salisbury, Rhodesia, of a species taken in that locality and very closely allied to *C. picturatus*. The genus is evidently widely spread. In redescribing this genus I have said of the elytra "interval 3 impunctate." This is true of *C. rubripictus*, Sl. (*rubropictus* in error in the table of species) and *C. platynotus*, Bates, but not of *C. picturatus*, M., which has a well-marked setiferous pore on interval 3, adjoining stria 2, at a third from apex. The specimens of *C. picturatus* were taken both on Barkuda and Gopkuda Islands. The type came from Nagpur (E. A. D'Abreu), and I know of one other example in the Oxford University Museum (Hope Dept.).

11 ex. in all (N. Annandale and F. H. Gravely).

29. *Ophionea indica*, Thunb.

Nov. Spec. Ins. pt. iii, 1784, 68, f. 81; Andr., *Ann. Mag. Nat. Hist.* (9), III, 1919, 476.

Cicindela cyanocephala, F., *Suppl. Ent. Syst.* 1798, 60.

A very common species near water.

4 ex. (N. Annandale).

30. *Omphra complanata*, Reiche.

Ann. Soc. Ent. Fr. 1842, 342.

Omphra brevis, Chaud., *Bull. Mosc.* 1850, i, 36 *id.*, *Rev. et Mag. Zool.* 1872, 141.

I happen to have seen the types of both these species, which, as indicated by Chaudoir, are identical, so that I feel no doubt about the identification.

I have seen examples from various localities in India from Nepal to Madura, generally one at a time. There is an example from Ratnagiri in the Indian Museum.

2 ex. (*N. Annandale*). "Common in deserted termites galleries in dead wood."

31. *Omphra atrata*, Klug.

Jahrb. Ins. 1834, 72.

Many examples taken "with termites on path under dead leaves." I don't think this genus has been mentioned hitherto as having been found in association with termites. One or two specimens were also received in spirit, taken by Mr. Gravely in holes under stones, along with a number of oval whitish bodies (3.0 mm. in length), which show no structural characters and which may be the eggs of the beetle.

I have put a name to this species with hesitation, for I have not seen the type and the description leaves a good deal of room for doubt. The specimens agree fairly well, however, with one determined by Chaudoir as Klug's species.

Many ex. (*N. Annandale* and *F. H. Gravely*).

32. *Pheropsophus tripustulatus*, F.

Ent. Syst. i, 1792, 145.

A single example, which differs slightly from the type and seems to form a link with *P. curtus* Arrow (*Trans. Ent. Soc. Lond.* 1901, 204, t. 9, f. 3). From the type it differs only in the reduced apical patch on the elytra, from *curtus* in the absence of the dark frontal spot and also of the dark colour at the apex of the femora. It is quite possible that these forms may prove to be one species, which in that case would bear Fabricius' name. *P. tripustulatus* was said by its author to come from Siam, but the type bears no label to that effect; *P. curtus* was described from Malabar and N. Kanara.

1 ex. (*N. Annandale*).

33. *Orthogonius* sp.

This seems to be closely allied to *O. fugax*, Chaud., described from a single example taken by Nietner in Ceylon. Although numerous species of this genus have been described from the East, only about half a dozen of these came from India itself, and this represents only a fraction of those awaiting description.

3 ex. (*N. Annandale* and *Chilka Survey*).

34. *Coptodera transversa*, Schm. Goeb.

Faun. Col. Birm. 1846, 54.

Chaudoir has published a Monograph on this group, but I think that both he and Bates have misidentified some of the

species described by Schmidt-Goebel in his *Faunula Coleopterorum Birmaniae*.

A fairly common species which is found from S. India to Hongkong. Specimens have been taken in the Nilgiri Hills (*H. L. Andrewes*) in a toad-stool, and others in the Forest Research Inst., Dehra Dun, were taken under *sál* bark.

2 ex. (*F. H. Gravely*). Dr. Gravely also took an example on Gopkuda Island.

35. ***Tetragonoderus quadrinotatus*, F.**

Suppl. Ent. Syst., 1798, 55.

A common Indian and Ceylon species.

1 ex. (*F. H. Gravely*).

***Velinda*, gen. nov.**

Ligula short, quadrate, bisetose at apex, paraglossae wanting (or completely fused with the ligula). Mentum wide, edentate, sinus wide and shallow, epilobes well developed, lobes rounded externally and bluntly pointed at apex. Maxillae curved, sharp, ciliate, stipes with two long setae on outer margin, one at base, the other at a third from apex. Maxillary palpi cylindrical, glabrous, last joint obliquely truncate at apex, two and a half times as long as penultimate, labials with penultimate joint widening from base to apex, bisetose, apical joint tapering at extremities, half as long again as penultimate. Mandibles short, curved, sharp, right one with a small tooth in middle and another at base. Antennae moniliform, pilose from 4 to apex, 1 wider and a little longer than 3, 2 half as long as 1, from 3 decreasing slightly in length towards apex, 11 a little longer than 10. Labrum short, sexsetose, a longitudinal ridge along median line, front margin arcuate; clypeus bisetose. Eyes moderately prominent. Head longitudinally striate. Prothorax cordate, side margin slightly angled at a fourth from apex, with a seta at angle, a pore visible at hind angle (seta probably abraded), base slightly produced in middle. Elytra truncate at apex, three tactile setae along each side margin, one behind shoulder, one behind middle, and one before the truncature. Apex of last ventral segment with two setae on each side. Fourth joint of tarsi entire, claws faintly dentate. Upper side (except head) shortly setose, under side glabrous.

Allied to *Dromius*, but in that genus the ligula is sexsetose, the antennae filiform, and the sculpture of the upper surface quite different.

36. ***Velinda lirata*, sp. nov.**

Length 3.75 mm. Width 1.30 mm. Piceous: prothorax dark red; antennae, buccal organs, a basal spot on each elytron, a common apical spot (just divided by the darker suture) and margin of elytra, sterna, median part of ventral surface, and legs testaceous; a transverse dark line in front of each ventral segment.

Head moderately wide, flat, closely punctate between the longitudinal wrinkles. *Prothorax* rather flat, very little wider than head, slightly emarginate in front, front angles quite rounded, sides very gently rounded, sinuate behind, hind angles slightly reflexed, projecting laterally, but rounded, owing to the oblique sides of base; median line fine but clear, surface dull, rugose, with indications of longitudinal striation along each side of median line. *Elytra* moderately shiny, parallel, half as long again as wide, striae very shallow, a row of fine setiferous punctures along the outer side of each stria; surface finally shagreened, front spot large, more or less quadrate, covering intervals 2—8, common spot behind transverse, reaching stria 4 on each side.

I am unable to compare this species with any other because I know none like it. Barkuda Island, 1 ex. (*F. H. Gravely*). Central Provinces: Bhandara district, Gothangaon 1 ex. (type) under bark of *Terminalia arjuna* (*E. A. D'Abreu*). Mr. D'Abreu has kindly allowed me to retain the type in my collection.

THE BUTTERFLIES OF BARKUDA ISLAND

By N. ANNANDALE, D.Sc., F.A.S.B., and CEDRIC DOVER, F.E.S.

We are indebted for the identification of all but a few common and conspicuous species of the butterflies to Lt.-Col. W. H. Evans, R.E., whose experience of the Indian species and races of this group renders the names we employ at any rate consistent. There are few groups of animals in which there is greater divergence of opinion as to taxonomy and nomenclature than the butterflies, and there are doubtless some entomologists to whom the names used by the late Col. Bingham in his two volumes in the "Fauna of British India," or those used in yet some other work by some other author, would be more acceptable. The names here used are mostly those employed by Col. Evans, in his valuable list of the Indian Butterflies published in the *Journal of the Bombay Natural History Society*, Vol. XXI (1911-13). The numbers in brackets after the name of each species refer to the page numbers of his paper. In a few minor cases names have been altered to accord with recent advances in knowledge. We must express to Col. Evans our sincere thanks for his assistance in naming specimens, without which our records would have had little value. We have also to thank him for looking through our manuscript and for making valuable suggestions.

GENERAL CHARACTER OF THE BUTTERFLY FAUNA.

The general character of the butterfly fauna of the island may be indicated briefly. It consists almost exclusively of wide-ranging, adaptable species of common occurrence in the central part of Peninsular India. None of the species or races peculiar to the Ganjam or adjacent districts are found. The only geographical interest of the fauna is that it provides evidence that the southern end of the Chilka Lake is to some extent the frontier, so far as the butterflies are concerned, between the fauna of the central and that of the southern districts of the Peninsula. The peculiar character of the vegetation of the island,¹ however, has proved a selective influence, and the caterpillars of the resident forms are such as are able to feed on tough, leathery leaves (e.g. *Papilio polytes* on *Glycosmis pentaphylla*), or, on very small herbs capable of existing on dry stony soil, as *Hypolimnastis bolina* on *Justicia diffusa* var. *procumbens*. Species that feed on grasses or on the

¹ See Annandale, *Mem. Asiat. Soc. Bengal* VII, No. 4 (*in the Press*).

larger herbaceous plants are either absent, or occur merely as occasional visitors in the imago state. In many cases the food-plants are not those with which the caterpillar is commonly associated. The fact that a single larva of *Papilio aristolochiae* (usually a rare butterfly on the island, on which *Aristolochias* do not grow) was found associated with one of *P. hector* (a butterfly of fairly common occurrence but not abundant on Barkuda) and feeding on the leaves of the Sword-bean *Canavalia ensiformis* is particularly noteworthy in this connection. The scarcity of the Satyrinae and the comparative paucity of most Lycaenid and Hesperiid genera are also noteworthy features, and are probably due to the absence of suitable food-plants. The few skippers that occur are mostly immigrants.

The habit of immigration is also prevalent among some of the most abundant resident Nymphalidae and Papilionidae such as *Danaïs chrysippus*, *Papilio polytes* and *P. demoleus*, while it is probably habitual among the larger Pieridae such as the species of *Catopsilia*. No large flights of any butterfly were observed: the immigrants flew singly across the lake.

THE ENEMIES OF BUTTERFLIES ON BARKUDA.

Insectivorous mammals, birds and reptiles are scarce on Barkuda, and many of the common species known to feed on butterflies, absent. Those enemies of butterflies that exist on the island do not seem to be particularly discriminate in their choice of food, as the remains of unpalatable butterflies such as the Danaines are not infrequently to be found in circumstances that prove they have served as food for vertebrates. On the few occasions that mynas and crows were seen actually attacking a butterfly, it was either the "distasteful" *Danaïs chrysippus*, or a Lycaenid. The "Blues", however, seemed to form quite an appreciable part of the daily diet of the mynas, and these birds have been watched eating the butterflies, frequently denuding them of their wings and legs before doing so.

Small flocks of Bee-eaters (*Merops viridis*) often fly over from the mainland and do much damage among *Papilio polytes*, in spite of its skill in eluding pursuit among thickets of shrubs. The remains of this butterfly can be seen on the ground, under the branches where these birds have perched in the intervals of their short and rapid flights.¹

In short, the butterflies most liable to attack by birds on Barkuda are the commonest and most conspicuous species. Conditions are peculiar, however, in that the two genera of birds that most frequently attack butterflies are not habitual butterfly-eaters in the sense that the bee-eaters, etc., are. The more indis-

¹ Marshall, (*Trans. Ent. Soc. Lond.*, 1909, p. 339) remarks that Bee-eaters probably cut off the wings of the butterflies they capture before eating them. To this view we ourselves incline as the wings only of *P. polytes*, in most cases neatly severed from the humerus, were found.

criminate feeders among birds, such as crows and mynas, which (as is evident from their omnivorous habits) are indifferent to the precise nature and taste of their food, will probably eat almost anything not actually poisonous when pressed by hunger. Moreover, though the proof that birds do eat butterflies, unpalatable and otherwise, is now convincing, the number of individuals they destroy must be comparatively small, as is shown by the amount, and kind of evidence it was necessary to collect all over the tropics in order to prove that they did so. We have no evidence that the crows and mynas seen attacking distasteful butterflies on Barkuda were young birds. Nor were such attacks often observed, and it is by no means improbable that creatures so perverse as the Indian crows, in which something very like reason and almost what we may call a sense of humour are strongly developed, may sometimes attack and even devour butterflies in mere wantonness.

Lizards (*Calotes versicolor major*) were observed devouring *Danais chrysippus* both on the island and on the mainland a few miles away, and a tree-snake (*Dendrelaphis tristis*) was once seen eating a specimen of *Colotis calais amatus*. These reptiles, though by no means abundant on Barkuda, are not actually scarce.

EVIDENCES OF THE ATTACKS OF ENEMIES.

In writing on butterflies showing evidence of the attacks of enemies, it is necessary not to regard every damaged butterfly as one which has been attacked, for it is probable that butterflies are often damaged in sudden gusts of wind while wending their way through dense jungle, and that these damages sometimes look like the injuries caused by enemies. As a general rule, however, the results of wear and tear show mostly on the forewings, while the injuries caused by birds or lizards are usually present on the hind wings. The only instances in which it is reasonably certain that a butterfly has been attacked by a vertebrate enemy are those in which its injuries are quite symmetrical, but in others, with caution and experience, a fairly accurate conclusion may be reached. In drawing up the table on p. 352 we have been careful to include in the "injury" columns only those specimens which have been symmetrically injured, or, *perfectly fresh* specimens which have undoubtedly been injured by a bird or lizard, as is shown by the form of the injury. Worn specimens though apparently damaged by an enemy have been included in the "perfect or worn" section, as it is possible that their injuries have been caused by various accidents.

Only the commonest or more interesting species have been included in the table. The data we have collected would seem by themselves to show that the local Lycaenidae and Hesperidae are either rarely attacked by enemies, or, are not able to escape at the cost of a damaged wing, but it is significant that the Pieridae would seem also to be more or less immune from attack. This is probably due to a number of factors in environment and

Name of Species.	No. of individuals captured.	No. of symmetrically injured individuals.	No. of individuals apparently injured by birds.	No. of individuals apparently injured by lizards.	No. of perfect or worn individuals.	REMARKS.
NYMPHALIDAE.						
<i>Danaüs chrysippus</i>	15 ♂, 5 ♀	..	2 ♂, 1 ♀	1 ♀	13 ♂, 3 ♀	..
<i>Euploea core</i>	1 ♂, 10 ♀	1 ♀	...	...	1 ♂, 9 ♀	...
<i>Hypolimnäs bolina</i>	6 ♂, 8 ♀	1 ♂, 1 ♀	1 ♂, 2 ♀	1 ♀	4 ♂, 4 ♀	The females seem to be more attacked than the male in spite of the "mimicry."
<i>Junonia lemonias</i>	8 ♂, 4 ♀	..	2 ♂	..	6 ♂, 4 ♀	....
<i>Telchinia violae</i>	12 ♂, 4 ♀	..	..	..	12 ♂, 4 ♀	..
PAPILIONIDAE.						
<i>Papilio hector</i> ..	3 ♂, 1 ♀	..	2 ♀	..	1 ♂, 1 ♀	One of the perfect specimens was bred from the larva.
<i>Papilio aristolochiae</i>	3 ♂, 4 ♀	2 ♀	...	..	3 ♂, 2 ♀	....
<i>Papilio demoleus</i>	4 ♂, 3 ♀	..	1 ♀	..	4 ♂, 2 ♀	This butterfly is very common at certain seasons, but damaged specimens have seldom been observed.
<i>Papilio polytes romulus</i> , ♂ ..	33	1	1	1	30	The males seem to possess the greatest protection.
<i>Papilio polytes romulus</i> , ♀ f. cyrus, ..	2	..	..	..	2	....
<i>Papilio polytes romulus</i> ♀ f. polytes, ..	30	2	2	1	25	Specimens have often been seen with the greater part of the hind-wing torn off apparently by a bird.
<i>Papilio polytes romulus</i> , ♀ f. romulus, ..	11	1	..	..	10	Appears to be better protected than the preceding ♀ form.
PIERIDAE.						
<i>Leptosia xiphia</i>	8 ♂, 2 ♀	..	..	...	8 ♂, 2 ♀	.
<i>Ixias pyrene pirenassa</i> ..	7 ♂, 4 ♀	1 ♂	2 ♂	..	4 ♂, 4 ♀	..
<i>Pareronia valeria hippia</i> ..	12 ♂	..	2	..	10	..
<i>Colotis calais amatus</i> ..	15 ♂, 3 ♀	..	..	1 ♂	14 ♂, 3 ♀	..

habits, amongst others that bush-lizards are rare on the island, and bush-hunting birds practically non-existent, while the mynas usually seize butterflies by the body rather than the wings.

NOTES ON THE FLIGHT OF SUNDRY BUTTERFLIES ON THE ISLAND.

The mode of flight of butterflies is dependent to a large extent on circumstances such as the time of day, the strength and direction of the wind, the condition of the barometer, the approach of enemies and sexual excitement. Hence isolated observations are often apt to be misleading. We offer the following observations for what they are worth.

One of two captured specimens of the Satyrine, *Melanitis leda ismene*, was found flying at dusk in a slow jerky manner making short circuits and settling on a shrub for a moment. It returned again and again to the same tree. The same habit was observed in other specimens not captured.

The female of *Hypolimnas bolina* has occasionally been seen flying along at the height of about a hundred feet, rapidly vibrating its wings for a short while, then gliding for a few yards, often ascending higher and higher. Then, after reaching a considerable height, it descends quite near to the ground. Apparently *Euploea core* often flies in like manner, but it is impossible to distinguish the two species at the elevation reached, and it is only after they have descended that we have been able to discriminate them.

Neptis hylas astola (= *eurynome*, Bing.) has a peculiar, fluttering weak flight, but when alarmed it worms its way through thick shrubbery or ascends to considerable heights. It has a peculiar habit of returning to its old beat after a time.

The Junonias as a rule fly low and swiftly.

The Acraeid *Telchinia violae* hovers about low herbage and is quite easy to capture, though it seems to suffer little from the attacks of enemies.

Papilio hector does not fly swiftly, but it steers an even course and has a sustained flight. The general impression gained is that it is flying mainly with its forewings. *P. aristolochiae* flies in a somewhat similar manner, but sails about more slowly, and the vibrations of the forewings are not so pronounced.

The flight of all the forms of *Papilio polytes* is more or less similar, except that the *romulus* form of female has a stronger and higher flight than the rest. In *P. polytes* the flight is generally swift and erratic and it seems as if the whole wing surface and not only the forewings were being used. Often the flight is slow and somewhat similar to that of *Euploea core*, from which at a distance, the males and *cyrus* female can scarcely be distinguished.

Papilio demoleus flies rather low but very rapidly, and is one of the most difficult Papilios to capture.¹ A peculiarity about

¹ Dr. Hankin (*Proc. Third Ent. Meet. Pusa*, III, pp. 900-903, 1920) notes the comparative invisibility of *P. demoleus* during flight.

most Papilios is that while at rest on a tree, especially when feeding on flowers, they keep on fluttering their wings. This habit is least marked in *P. demoleus* and most pronounced in *P. polytes*, the "mimetic" females especially. It is possibly connected with the maintenance of balance.

The larger Pierids on the island fly high and swiftly, and are able to wend their way through thick jungle with remarkable dexterity. *Colotis calais amatus* flies rather feebly and low. The feeblest Pierid on the wing is the little *Leptosia xiphia*, which rarely rises more than a few feet from the ground and is most at home among undergrowth.

OBSERVATIONS ON THE DANAINAE.

On Barkuda the habits of this interesting group are very much the same as those described by previous authors elsewhere. The statement that the butterflies are capable of flying long distances is borne out by the fact that we have often seen individuals flying in their characteristic manner over a considerable stretch of water to the mainland, to the neighbouring islands and even across the lake, a distance of about six miles.

In *Euploea core*, *Danais plexippus* and *D. chrysippus* the mating is usually prolonged, the pair flying about from plant to plant. The male often takes an active part in the nuptial flight, but also, perhaps in the latter part of the flight, is often quite inert, being dragged behind her through the air by the female. The pair occasionally rest on a shrub for a period during which they are very sluggish and can be captured with ease. In *Euploea* the anal pencils of the male are erected continuously for long periods during flight, probably before mating takes place. The male of *Hypolimnias bolina* has on two occasions been observed hovering round *Euploea core*, as if uncertain whether it was the female of his own species or not.

When separated during mating, or when attacked, a drop of straw-coloured fluid is emitted at the tip of the pencils and from the scent glands on the wing, but we have not observed any approximation of the two pairs of organs.¹

MISCELLANEOUS NOTES.

In August, 1920 a single specimen of *Vanessa cardui* was observed to turn its tail towards the sun deliberately, in such a way as to cast no shadow, but this does not necessarily imply that it did so for a purpose. The movement may have been due purely to temperature reaction.

The black and white *Neptis hylas astola* is very inconspicuous when resting on a leaf. It deliberately selects a leaf situated under an overhanging bough, so as to receive the benefit of the shade that is thrown on it. The butterfly rests pressed against

¹ See Eltringham, *Trans. Ent. Soc. Lond.*, 1913, p. 399, and for a description of the scent organs in *Danais chrysippus*, Eltringham, *ibid.*, 1915, pp. 166-168.

the leaf with its wings in line with the body in typical moth-like fashion, and is very difficult to distinguish.

Resistance to pressure on the thorax and to cyanide has been confirmed by us in the case of the Danaines, *Euploea core*, *Danaïs plexippus* and *D. chrysippus*, *Papilio hector*, *P. aristolochiae* and *P. polytes* have also been noted by us as "tenacious of life." Specimens of these species have not infrequently been found alive in the papers weeks after having been apparently killed.

"Gregariousness" has been noted in *Euploea core*, *Danaïs chrysippus*, *Hypolimnas bolina* and *H. misippus*. *Papilio polytes* is also a gregarious insect and hundreds of them swarm round their favourite food-plant, *Glycosmis pentaphylla*, in the "rains." Of the Pieridae, the Catopsilias, Ixias, and Terias have been noted as fond of congregating. On a single occasion *Colotis calais amatus* was seen in fairly large numbers round a tree (probably *Salvadora persica*) by the shore, and the little Lycaenid *Chilades laius* was also found congregating in numbers which did not exceed forty, round a low bush. As we have already noted, however, no large flights of any specimens were observed.

OBSERVATIONS ON *Papilio polytes*.

Much has been written on the polymorphism and sexual habits of this butterfly and an excellent summary of the work of previous authors will be found in Punnett's *Mimicry in Butterflies* (Cambridge: 1915). The most detailed investigation is that of Fryer published in the *Phil. Trans. Roy. Soc. Lond.* (ser. B.) Vol. CCIV (1914). Two brief notes have recently been published by P. Susainthan and Bainbrigge-Fletcher in *Bulletin* No. 89, of the *Agricultural Research Institute, Pusa*. Poulton has also published a paper in the *Proc. Third Ent. Meet. Pusa*, III, pp. 903-905 (1920), in which he has recounted the data on the numerical ratio of the female forms which have appeared in the Entomological Society's "Proceedings."¹

We offer no opinion on the origin or function of the mimicry believed to exist in this species, but print our observations for their face value.

In 1919 and 1920, the following observations were made on Barkuda, where this butterfly is probably the most abundant. Its caterpillar feeds there on the leaves of the shrub *Glycosmis pentaphylla* of the family Rutaceae, one of the most abundant plants on the island.

Courtship.

In natural conditions the courtship is normally prolonged. In one instance a pair were found *in copula* in which the wings of the female were still damp and flaccid, but this was evidently abnormal as the nuptial flight (in which the male is carried passively, adhering to the female) is as a rule prolonged and vigorous. There is evidence, moreover, that generally some time elapses after the imago emerges before court-

¹ Prof. Poulton will also shortly publish a paper in the *Proc. 4th Ent. Meet.* at Pusa, in 1921.

ship takes place. Large numbers of individuals of both sexes with quite fresh but stiff wings, were often observed feeding on the honey of the flowers of *Vitis vitiginea*, *Zizyphus oenoplia*, *Premna latifolia* and *P. wightiana* without manifesting any sexual attraction to one another, whereas a large proportion of the individuals seen mated had worn wings.

When the female is ripe for mating she sits on a leaf in a conspicuous position, with the wings spread out, but with the forewing turned a little backwards over the hind-wing. If a male approaches she raises and flutters her wings gently. The male flies up to her with a fluttering motion from behind and they often sit together for some time, both waving their wings. They then begin to fly together for short or even for long distances, moving their wings very rapidly but progressing slowly, each occasionally striking the other with the forewings. This process goes on for some time, often as long as half an hour, and the female appears at times to be as ardent as the male. The pair occasionally settle and then flutter away for a short distance before settling again. They often hover vertically in the air for a time without changing their position. While the courtship is in progress a second male often approaches. Sometimes the first suitor gives way to him, and sometimes the new comer flies off himself, after fluttering round the pair for a short while. On more than one occasion a male of *Euploea core* has been observed fluttering round a courting pair but, though evidently attracted, he never stayed for long.¹ Nothing of the nature of a fight ever takes place. The curious thing about the whole affair is that in a very large proportion of cases the male apparently tires of his courtship before mating, and suddenly flies away. Rarely, the female flies after him. A sudden and premature conclusion to the courtship seems to occur more frequently than not. Either the female has the power of repelling the male after a mere flirtation, or else a large proportion of the males are incapable, or not desirous, of mating, though eager for courtship. These facts may express the difficulty experienced by Fryer in getting captive butterflies of this species to mate.²

Numerical ratio of the female forms. All three forms of the female of *P. polytes* were taken on Barkuda and numerous attempts were made to ascertain the proportionate numbers in which they normally occurred. Two facts were clear: that the *polytes*³ form

¹ Ghosh (*Mem. Dept. Agric. Ind.*, V, No. 1, p. 34) states that he has seen a male of *Papilio demoleus* apparently attempting to mate with a female of *P. polytes* (= *pammon*). On a single occasion this was observed in Calcutta, and *P. demoleus* has also often been seen interrupting a courting pair. Ghosh's paper also contains a good description of the life-history of *P. demoleus* and *P. polytes*, the caterpillars of which often live together.

² Cf. Fryer (*op. cit.*, p. 231). He gives a description of what he calls an absolutely typical mating, but his observations were made on captive butterflies, and the description he gives applies to a case similar to the one cited above as abnormal.

³ We also obtained a variety of this form known as *stichius*, Hub., in which there is no white spot on the cell of the hind wing.

(resembling *P. aristolochiae*) was much the most abundant and that the *cyrus* form (resembling the male of its own species) was extremely rare. Though large numbers of males were caught and examined, only one female of this type was taken in two seasons. We failed to obtain any very exact data as to the relative numbers of the *polytes* and *romulus* forms for three reasons: firstly, because it is often very difficult to distinguish the latter from *P. hector* on the wing in dense thickets when the colour of the body cannot always be seen;¹ secondly, because this form has a stronger and higher flight than the *cyrus* form and is therefore less easily captured; and lastly, because we found very great discrepancy in the numbers taken on different occasions even at the same season. On the whole it seems probable that on Barkuda the *polytes* form is at least three times as abundant as the *romulus* form.

In Calcutta and its environs the *polytes* form is at least twice (if not more) as common as the *romulus* form,² while the *cyrus* form is decidedly rare. *P. hector*, it may be mentioned, appears to be sometimes more abundant here than *P. aristolochiae*, but at one time when a species of *Aristolochia*, was cultivated in the Museum garden, *P. aristolochiae* became very common in the compound. Tytler speaks of the *cyrus* form in Manipur as "decidedly rare" and Bell speaks of this form in similar terms in Bombay. In the Eastern and Western Himalayas this form is also scarce and even in parts of South India (as Bangalore and Madras) it is the rarest of the three female forms. Punnett's remark, "It is generally agreed among observers who have studied this species that of the three forms of female the M [*cyrus*] form is distinctly the most common, while of the other two the H [*romulus*] is rather more numerous than the A [*polytes*]" is therefore not applicable to Barkuda or to the other places mentioned. Indeed, it is probably inapplicable to all parts of continental India.

We give here a tabular *resumé* of what else is known on the proportions of the female forms of *P. polytes* as it is likely to prove an useful addition to the remarks we have made above.

¹ We cannot accept Punnett's statement that to the ordinary man accustomed to use his eyes the *romulus* form is easily distinguishable from *P. hector*. (At any rate it is not my experience after twenty years of the jungle. N. A.)

² Col. Evans reminds us that the *polytes* form may be commoner still as the *romulus* form gradually disappears to the north-east with the disappearance of *P. hector*.

In a fortnight's visit to Chandipore, on the sea-coast of Orissa, neither *Papilio hector* nor *P. aristolochiae* were seen. The proportions of the various forms of female of *P. polytes* were curious. The *romulus* ♀ was the most abundant, while the *polytes* ♀ was extremely rare. The *cyrus* ♀ was never captured. The males, though not as abundant as the *romulus* ♀, were not uncommon and, strangely enough, the majority were the form with reddish markings. This would seem to corroborate Prof. Punnett's theory that these males are in some way connected with the *hector*-like female of the species. C. D.

Locality.	References.	REMARKS
Ashambo Hills, 6 to 40 miles N.W. of Cape Comorin. Bangalore district ...	Pusa, ¹ p. 904 ... J.B.N.H.S. XXI, p. 699, Ent. Month Mag. 1920, p. 201.	The <i>romulus</i> ♀ apparently nearly twice as common as the <i>polytes</i> ♀, and <i>cyrus</i> ♀ extremely rare. The <i>polytes</i> ♀ the prevailing form.
Benares...	J.B.N.H.S. XXVI, p. 690.	The <i>cyrus</i> ♀ and the <i>polytes</i> female not uncommon. Only one damaged <i>romulus</i> ♀ taken.
Burma ...	.....	Col. Evans informs us that the <i>romulus</i> ♀ does not occur in Burma.
Dehra Dun ...	.....	The <i>romulus</i> ♀ not common. The <i>cyrus</i> ♀ is not as common as the <i>polytes</i> ♀.
Hong Kong and Macao districts.	Pusa, p. 905 ...	The male-like ♀ commonest, <i>polytes</i> ♀ rare, <i>romulus</i> ♀ unknown.
Johore, Malay Peninsula.	Pusa, p. 905 ...	The <i>polytes</i> ♀ apparently nearly twice as common as <i>cyrus</i> . Dr. Seitz only remembers the <i>polytes</i> ♀ in this locality.
North Kanara ...	P.E.S. 1914, p. 99 ...	The <i>cyrus</i> ♀ exceedingly rare, <i>polytes</i> and <i>romulus</i> ♀ ♀ about equally common, the latter perhaps slightly the commoner.
The Konkan ...	J.B.N.H.S. XV p. 52.	The commonest female is <i>polytes</i> , <i>romulus</i> ♀ is not rare, and <i>cyrus</i> entirely (?) absent.
Kumaon ...	J.B.N.H.S. XX, p. 361.	The <i>romulus</i> ♀ seems to occur only in the Terai; <i>cyrus</i> ♀ never seen.
Lucknow district ...	J.B.N.H.S. XIV, p. 492.	The <i>cyrus</i> ♀ absent, <i>polytes</i> ♀ common, and <i>romulus</i> ♀ rare. "Its (<i>romulus</i> ♀) appearance is rather surprising as its model is never, as far as I know, found in Upper India."
Madras city ...	P.E.S. 1915, pp. 92-94.	The <i>cyrus</i> ♀ absent, <i>polytes</i> and <i>romulus</i> ♀ ♀ about equally common.
Singapore Island ...	Pusa, p. 905.	The <i>polytes</i> ♀ commoner than <i>cyrus</i> ♀.
Tavoy district ...	J.B.N.H.S. XXVII, p. 895.	Only two forms of ♀ have been taken; the <i>cyrus</i> and <i>stichius</i> .
Tharawaddy and the Pegu Yoma.	J.B.N.H.S. XXV, p. 111.	The <i>aristolochiae</i> like ♀ (<i>polytes</i>) was the only one taken.

Red markings of the male.

In *Spolia Zeylanica*, pp. 21 and 22, Prof. Punnett has suggested that there might be some connection between the amount of red markings and the constitution of the male, and that the "red" males are intimately connected with the *romulus* female, in which the red markings are most developed. With this theory in mind we examined all the males brought from Barkuda with the following results: of 33 individuals

¹ Rep. Proc. 3rd Ent. Meet. Pusa, III, p. 904-905 (1920).

27 were of the variety without red markings, 5 corresponded to Prof. Punnett's "Int. II" series, and a single individual to his "Int. I." Our observations in the field also show that the "no red" males are the most abundant, while the "red" or "Int. I" males are very scarce. The scarcity of males with red markings may be connected to some extent with the comparatively hot and dry climate of Barkuda, but further investigations are necessary.

We obtained no direct evidence as to the utility of mimicry in this species. *Papilio hector* is fairly common but never very abundant on the island, while *P. aristolochiae* is usually rare, although it became common in September and October, 1920. Both species are, however, common in the neighbouring districts; neither breeds habitually on Barkuda, and both are capable of flying over from the mainland. Indeed, even *P. polytes* was frequently observed doing so, though it certainly breeds in considerable numbers in the thickets of *Glycosmis* that cover a large part of the island. In our opinion its abundance is probably due not so much to any special freedom from attack bestowed upon it by its polymorphic and "mimetic" females as to the abundance of its food-plants both as larva and as imago, the scarcity of competitors, and its skill in threading its way through the dense branches and foliage of the shrubs.

The observation that *Euploea core*, which has a distinct resemblance on the wing to the male and *cyrus* form of *P. polytes*, is attracted to apparent but not prolonged rivalry by the courtship of the *Papilio* is not without interest in suggesting speculations as to the role of colouration in the sexual life of butterflies. The female in the instances in which this was noted was of the *romulus* form.¹

LIST OF THE SPECIES OF BARKUDA.

Family NYMPHALIDAE.

Danaïd limniace, Cram.
Danaïd plexippus, Linn.
Danaïd chrysippus, Linn.
Euploea core, Cram.
Mycalesis visala, Moore.
Melanitis leda ismene, Cram.
Eulepis athamas, Drury.
Neptis hylas astola, Moore.
Junonia lemonias, Linn.
Junonia orithyia, Linn.
Junonia almana, Linn.
Vanessa cardui, Linn.
Hypolimnas bolina, Linn.
Hypolimnas misippus, Linn.

Atella phalanta, Drury.
Telchinia violae, Fab.

Family PAPILIONIDAE.

Papilio hector, Linn.
Papilio aristolochiae, Fab.
Papilio demoleus, Linn.
Papilio polytes romulus, Cram.
Papilio nomius, Esp.
Papilio doson eleius, Fruh.

Family PIERIDAE.

Leptosia xiphia, Fab.
Anaphaeis mesentina, Cram.
Huphina nerissa evagete, Cram.
Appias libythea, Fab.

¹ See Eltringham, *Trans. Ent. Soc. Lond.* 1919, pp. 1-49.

Appias albina confusa, Fruh.
Ixias pyrenè pirenassa, Wall.
Ixias marianne, Cram.
Catopsilia pyranthe, Linn.
Catopsilia pomona, Fab.
Terias libythea, Fab.
Terias hecabe, Linn.
Terias silhetana, Wall.
Colotis calais amatus, Fab.
Pareronia valeria hippia, Fab.

Azanus ubaldus, Cram.
Castalius rosimon, Fab.
Lampides hochus, Cram.
Lampides celeno, Cram.
Polyommatus boeticus, Linn.
Curetis thetis, Drury.
Curetis bulis, Db. and Hew.
Aphnaeus vulcanus, Fab.
Iraota timoleon, Stoll.
Loxura atymnus, Cram.

Family LYCAENIDAE.

Neopithecops zalmora, But.
Chilades lunus, Cram.
Zizera lysimon karsandra, Moore
Catachrysops strabo, Fab.
Catachrysops cnejus, Fab.

Family HESPERIIDAE.

Badamia exclamationis, Fab.
Hasora butleri, Aurivill.
Telicota bambusae, Moore.
Parnara bada, Moore.
Parnara colaca, Moore.

ANNOTATED LIST OF THE SPECIES OF BARKUDA.¹

Family NYMPHALIDAE.

Danais limniace, Cram. (560).

1905. *Danais limniace*, Bing., *Faun. Brit. Ind.*, *Butt.* I, p. 16.
 1910. *Danaida limniace*, Fruh., in Seitz's *Macrolepidop. World*, div. 11,
 Sect. 11, p. 204.

Barkuda, I-ix-19.

Hab.—India, Burma, Ceylon and the Nicobars. Also Siam and China.

Remarks.—A single female was the only one captured, but the species is not uncommon in thickets in October.

Danais plexippus, Linn. (560).

1905. *Danais plexippus*, Bing., *tom. cit.*, p. 10.
 1910. *Danaida plexippus*, Fruh., *tom. cit.*, p. 194.

Barkuda, II and 24-viii-19; II and 22-iv-20.

Hab.—Throughout our limits, including the Nicobars, and extending to Siam, China and the Malay Peninsula.

Remarks.—Rather scarce, but occurs at all seasons.

Danais chrysippus, Linn. (560).

1905. *Danais chrysippus*, Bing., *tom. cit.*, p. 11, pl. 1, fig. 11.
 1910. *Danaida chrysippus*, Fruh., *tom. cit.*, p. 193.

Barkuda, vii, viii and ix-19; I-29-iv-20; viii-20.

Hab.—A widely distributed species found throughout India, Burma and Ceylon; the Andamans and the Nicobars.

¹ The remarks on distribution are taken mainly from Col. Evans' "List."

Remarks.—One of the commonest butterflies on the island at all seasons. A white pupa was found in October on *Calotropis gigantea*.

Euploea core, Cram. (561).

1905. *Euploea core*, Bing., *tom. cit.*, p. 32, text-fig. 11.

1910. *Euploea core*, Fruh., *tom. cit.*, p. 235.

Barkuda, 10-30-viii-19; 1-6-ix-19; 11-15-xii-19; 9-iv-20.

Hab.—India, Burma and the Andamans.

Remarks.—Fairly common during the "rains," appearing as soon as they commence.

Mycalesis visala, Moore (568).

1905. *Mycalesis visala*, Bing., *tom. cit.*, p. 60.

1911. *Mycalesis visala*, Fruh., *tom. cit.*, p. 346, pl. 91 f.

Barkuda, iv-20.

Hab.—Kumaun to Burma, Central India, Madras.

Remarks.—Occasionally seen among very dense undergrowth in the dry season. The only specimen that was captured flew out into the open at dusk.

Melanitis leda ismene, Cram. (570).

1905. *Melanitis ismene*, Bing., *tom. cit.*, p. 158, text-fig. 36.

1911. *Melanitis leda ismene*, Fruh., *tom. cit.*, p. 362.

Barkuda, 15-xii-19; iv-20.

Hab.—India, Burma and Ceylon.

Remarks.—Also seen occasionally in the dry season. All specimens were of the dry season form.

Eulepis athamas, Drury (572).

1905. *Eulepis athamas*, Bing., *tom. cit.*, p. 220, text-fig. 41.

Barkuda, 18-viii-19.

Hab.—Northern India to Burma.

Remarks.—A single specimen was the only one seen and taken.

Neptis hylas astola, Moore (577).

1905. *Neptis eurynome*, Bing., *tom. cit.*, p. 322, text-fig. 59, pl. ix, fig. 64.

1912. *Neptis hylas astola*, Fruh., *tom. cit.*, p. 602.

Barkuda, 19-viii-20.

Hab.—Himalayas to Upper Burma (hills).

Remarks.—Several individuals were seen in August resting like moths on the leaves of trees in the shade. This species, though mainly a hill species, has also been captured in various localities in the plains.

Junonia lemonias, Linn. (579).

1905. *Junonia lemonias*, Bing., *tom. cit.*, p. 357.

1912. *Precis lemonias*, Fruh., *tom. cit.*, p. 520.

Barkuda, 10-viii-19; 3-ix-19; 1-29-iv-20.

Hab.—India, Burma and Ceylon.

Remarks.—This butterfly was most abundant in April when other butterflies are scarce.

***Junonia orithyia*, Linn. (579).**

1905. *Junonia orithyia*, Bing., *tom. cit.*, p. 358.

1912. *Precis orithyia*, Fruh., *tom. cit.*, p. 522.

Barkuda, 18-viii-19; 3 and 29-ix-19.

Hab.—India, Burma and Ceylon, extending to the Malayan subregion.

Remarks.—Not a common species.

***Junonia almana*, Linn. (579).**

1905. *Junonia almana*, Bing., *tom. cit.*, p. 361.

1912. *Precis almana*, Fruh., *tom. cit.*, p. 519.

Barkuda, 7 and 18-viii-19; 11 and 19-iv-20.

Hab.—India, Burma and Ceylon, extending to China.

Remarks.—Fairly common in August, 1919 and in April, 1920. No specimens were taken in August 1920.

***Vanessa cardui*, Linn. (579).**

1905. *Vanessa cardui*, Bing., *tom. cit.*, p. 365, text-fig. 67.

Hab.—Distributed over the whole world and found in all parts of India, Burma and Ceylon.

Remarks.—Seen once in June, 1920 and in August of the same year.

***Hypolimnas bolina*, Linn. (580).**

1905. *Hypolimnas bolina*, Bing., *tom. cit.*, p. 386, text-fig. 69.

1912. *Hypolimnas bolina*, Fruh., *tom. cit.*, p. 547, pl. 118b.

Barkuda, 10-25-viii-19; 1-4-ix-19, 13-xii-19.

Hab.—India, Burma and Ceylon, extending to the Malayan subregion and China.

Remarks.—Rather common in 1919 in the months stated above but very much scarcer in 1920. The female, which somewhat resembles *Euploea core* on the wing, is approximately twice as common as the male.

The caterpillar was sometimes very abundant in the vicinity of *Justicia diffusa* var. *procumbens*, a plant that exists on dry stony soil. They are black, or very dark rich brown in colour, with nine longitudinal rows of branched spines that extend as far as the 10th segment. The 4th segment has eight spines and the 12th and 13th only two. The head is square in shape and ochraceous or ochraceous-brown in colour, with a pair of branched spines that are rather longer and thicker, and much darker than those on the body.

***Hypolimnas misippus*, Linn. (580).**

1905. *Hypolimnas misippus*, Bing., *tom. cit.*, p. 388.

1912. *Hypolimnas misippus*, Fruh., *tom. cit.*, p. 547.

Barkuda, 27-viii-19 ; 3-6-ix-19 ; 9-iv-20.

Hab.—The same as that of *H. bolina*.

Remarks.—Scarce as compared with the preceding species.

***Atella phalanta*, Drury (581).**

1905. *Atella phalanta*, Bing., *tom. cit.*, p. 412, text-fig. 75.

1912. *Atella phalanta*, Fruh., *tom. cit.*, p. 471.

Hab.—Nearly throughout the Indian Empire extending to China, Japan and the Malayan subregion.

Remarks.—A rather scarce species on Barkuda, occasionally seen during the rains.

***Telchinia violae*, Fab. (384).**

1905. *Telchinia violae*, Bing., *tom. cit.*, p. 471.

Barkuda, 11-18-viii-19 ; iv-20.

Hab.—India and Ceylon.

Remarks.—Usually found, according to Bingham, in regions of heavy rainfall, but on Barkuda commoner in April (when there is practically no rain) than in the "rains." The island is not a region of heavy rainfall.

Family PAPILIONIDAE.

***Papilio hector*, Linn. (969).**

1907. *Papilio hector*, Bing., *Faun. Brit. Ind.*, Butt. II, p. 19, pl. xi, fig. 83.

1909. *Papilio hector*, Jordan. in Seitz's *Macrolepidop. World. div.* II, sect. II, p. 34, pl. 15a.

Barkuda, 1 and 7-ix-19.

Hab.—Bengal ; the southern half of Peninsular India and Ceylon.

Remarks.—A rather scarce species on the island though fairly common on the mainland a few miles away. It flies higher than *P. polytes romulus* and usually frequents more open country. A single full-grown caterpillar was taken on Barkuda in company with one of *P. aristolochiae* on the Sword-Bean (*Canavalia ensiformis*), on the 18th August, 1919. It was of a blackish colour with rather paler processes along each side of the abdomen. Along the anterior half of the body there were a few pale yellow isolated spots of small size. This larva pupated on the 20th of the same month.

The chrysalis was fastened at the tip of the abdomen to the side of the breeding cage, by a number of radiating, strong, black silk threads and supported further by a couple of strings, each double, of similar silk, one extending from the suture between the first and second abdominal sutures to the support, the other from the middle of the ventral surface of the thorax. It was 25 mm. long and 15 mm. wide. The sculpture and colouration was elaborate. The head was produced in front into a broad, flattened,

truncate, somewhat rounded lobe. The anterior end of the thorax was defined by an irregular, semicircular ridge and each side into a prominent, flattened, slightly upturned lobe which was rounded at the apex. Behind the anterior ridge there was a broad ill-defined, transverse groove, and behind this the dorsal surface was produced into a broad protuberance, the anterior part of which was strongly ridged, while the posterior part was obliquely truncate and the whole somewhat compressed. The posterior part (the larger) was flattened above, concave at the sides and produced into a small rounded lobe at the upper anterior angle at each side. The abdomen was strongly curved and bore at each side a series of prominent, rounded, flattened, upwardly directed lobes. The wing cases were produced into strong keels above.

The colouration was still more elaborate. The ground colour was pale lutescent. On the anterior part of the thorax, just behind the anterior ridge were a pair of somewhat elongate, white rimmed black spots, which gave this region a strange resemblance to a caricature of a monkey's face. The concave lateral region of the thorax was variegated with deep chestnut and white, and there was an irregular longitudinal stripe of the former colour running along the variegated area not far from its inner margin. The upper part of the flattened area was clearly chestnut with a small round spot of the same colour on each side in the variegated area above. From the chestnut area a fine stripe of paler tint extended backwards, expanding between the front pairs of abdominal processes. The abdomen was faintly spotted with pale brown.

The butterfly hatched out at about 4 A.M. on the morning of the 7th September. It took much longer in drying than the following species, which began to flutter about two hours after emerging. It began to flutter about four hours after hatching, but its upper wings were still curved down along the upper margin.

Papilio aristolochiae, Fab. (969).¹

1907. *Papilio aristolochiae*, Bing., *tom. cit.*, p. 20, text-figs. 3a and 3c.

1909. *Papilio aristolochiae*, Jordan, *tom. cit.*, p. 38, pl. 16a.

Barkuda, 7-ix-19; 5-vi-20; ix-20.

Hab.—India.

Remarks.—This is usually a very scarce butterfly on the island, but fresh specimens were seen in considerable numbers in September, 1920. A single pair was captured round flowers of *Premna latifolia* in June, 1920 and a single butterfly was reared from the larva in September, 1919. The caterpillar was found with that of *P. hector* on the Sword-Bean (*C. ensiformis*).

It was about half the size of the caterpillar of the preceding species, and was somewhat similar in colour, but the pale yellow spots found on *P. hector* was here replaced by a similarly coloured transverse line. It pupated on the 24th of August and the pupa resembled that of *P. hector* in every respect, except that it was

about $\frac{2}{3}$ of the size of the other and the colours were much deeper. A small female hatched out at about 6 P.M. on the 7th of September. If touched, or otherwise disturbed, as by tapping on the glass of the breeding cage while still in a tender condition, it would emit a few drops of clear fluid from the vent. This was not observed in *P. hector*. The wings as we have already remarked became dry and stiff much quicker than those of the preceding species.

***Papilio demoleus*, Linn. (971).**

1907. *Papilio demoleus*, Bing., *tom. cit.*, p. 39 text-fig. 7.

1909. *Papilio demoleus*, Jordan, *tom. cit.*, p. 48.

Barkuda, 9-29-vii-19; 1-6-ix-19.

Hab.—India, Upper Burma, China and Persia.

Remarks.—Common during the "rains." It disappears almost completely in the dry weather, but fresh specimens appear in large numbers within a day or two of the commencement of the wet season, indicating that the species estivates in the pupal stage.

***Papilio polytes romulus*, Cram. (972).**

1907. *Papilio polytes*, Bing., *tom. cit.*, p. 61, text-fig. 13.

1909. *Papilio polytes romulus*, Jordan, *tom. cit.*, p. 61, pl. 3a and 32a.

Barkuda, viii and ix-19; iv and vi-20.

Hab.—India, Burma and Ceylon.

Remarks.—Jordan confines *P. polytes* to China giving the Indian race as *romulus*, the name under which the *hector*-like female was originally described. Col. Evans writes us that the names of the female forms should stand as follows:—

Papilio polytes romulus, ♀ f. *cyrus*, Fab. (resembling the male of its own species).

Papilio polytes romulus, ♀ f. *polytes*, Linn. (resembling *P. aristolochiae*).

Papilio polytes romulus, ♀ f. *romulus*, Cr. (resembling *P. hector*).

Stichius, Hub. is a variety of the *polytes* ♀ in which there is no white cell spot on the hind wing.¹

Papilio polytes is perhaps the commonest butterfly on the island at all seasons except the end of the dry weather, when only a few battered individuals are to be seen. Its abundance is due to a large extent to the abundance of the favourite food plant of its caterpillar—*Glycosmis pentaphylla*. Unlike *P. demoleus* the young brood of the early part of the "rains" does not appear immediately on their commencement. Numerous young caterpillars were, however, observed on *Glycosmis* a few days after the beginning of the wet weather in June, 1920, and it is probable that the eggs of the winter brood do not hatch until the air becomes damp.

¹ This is somewhat contrary to the views expressed by him in his "List," (p. 972).

Papilio polymnestor*, Cram. (972).**1907. *Papilio polymnestor*, Bing., *tom. cit.*, p. 50, pl. xii, fig. 85.1909. *Papilio polymnestor*, Jordan, *tom. cit.*, p. 70, pl. 26a.*Hab.*—Sikkim, South India and Lower Bengal.*Remarks.*—A single individual was seen on several occasions in October, 1919 and another in the same month in 1920.Papilio nomius*, Esp. (973).**1907. *Papilio nomius*, Bing., *tom. cit.*, p. 201, text-figs. 33a and 33b.1909. *Papilio nomius*, Jordan, *tom. cit.*, p. 87.

Barkuda, 9-iv-20.

Hab.—Sikkim, Central and Southern India.*Remarks.*—A pair taken *in copula* were the only individuals seen and taken on the island.***Papilio doson eleius*, Fruh. (973).**1907. *Papilio euryplus*, Bing., *tom. cit.*, p. 106.1909. *Papilio doson eleius*, Jordan, *tom. cit.*, p. 97.

Barkuda, 8-15-viii-19; 9-20-iv-20, 1-11-vi-20.

Hab.—South India.*Remarks.*—The remarkable similarity between *doson* and *euryplus* led Jordan and Rothschild in their revision of the Oriental Papilios, and afterwards Bingham, to unite the two species under the one name *euryplus*. Dr. Jordan in the paper cited in the synonymy separates the two species mainly on the structure of the genitalia. Superficially *doson* differs from *euryplus* in that the short brown-black costal band, which bears the red costal spot on the underside of the hind wing, does not unite with the brown-black sub-basal band, but terminates inside the silver one. In *euryplus* it does unite with the sub-basal band. Our subspecies (*eleius*, Fruh.) differs from typical *doson* in having the green spots in the apical half of the forewing somewhat yellower, and the median band always broader.

The species is as common in April as in the "rains," but is never very abundant on the island. Individuals were somewhat scarcer in 1920 than in 1919.

Family PIERIDAE.

***Leptosia xiphia*, Fab. (975).**1907. *Leptosia xiphia*, Bing., *tom. cit.*, p. 138, text-fig. 36.1910. *Leptosia xiphia*, Fruh., *tom. cit.*, p. 121, pl. 62f.

Barkuda, 12-20-viii-19; 23-x-19; 11-xii-19; 16-20-iv-20.

Hab.—India, Burma and Ceylon, also Siam and Annam.*Remarks.*—Common in damp weather in undergrowth, and among vegetation on the shore. A few individuals were seen in April, 1920.

Anaphaeis mesentina, Cram. (975).

1907. *Anaphaeis mesentina*, Bing., *tom. cit.*, p. 155, text.-fig. 39.
 1910. *Anaphaeis mesentina*, Fruh., *tom. cit.*, p. 137.

Barkuda, 15-22-vii-16; 9 and 10-iv-20.

Hab.—India and the Nicobars.

Remarks.—Never very common on the island, but less scarce in April and the early part of the “ rains.”

Huphina nerissa evagete, Cram. (977).

- 1780-82. *Papilio evagete et zeuxippe*, Cram., *Pap. Exot.* III, pl. 221, figs. F, G and IV, pl. 362, figs. E, F.
 1910. *Huphina nerissa evagete*, Fruh., *tom. cit.*, p. 141.

Barkuda, 9-29-viii-19; 3-6-ix-19; 11-xii-19; 9-19-iv-20.

Hab.—South India and Ceylon.

Remarks.—Fairly common at all seasons, but especially so in August.

Appias libythea, Fab. (977).

1907. *Appias libythea*, Bing., *tom. cit.*, p. 200.
 1910. *Appias libythea*, Fruh., *tom. cit.*, p. 148, pl. 58a.

Barkuda, 6-viii-19.

Hab.—Punjab to Sikkim; Southern India and Ceylon.

Remarks.—Rare at all seasons.

Appias albina confusa, Fruh. (977).

1910. *Appias albina confusa*, Fruh., *tom. cit.*, p. 154.

Barkuda, 17-21-iv-20.

Hab.—Sikkim to Burma; Bengal.

Remarks.—A few specimens were obtained for the first time in April, 1920. The species was not seen in July or August of the same year.

Ixias pyrene pirenassa, Wall. (978).

1907. *Ixias pyrene*, var. *pirenassa*, Bing., *tom. cit.*, p. 194, pl. xviii, fig. 120.
 1910. *Ixias pyrene pirenassa*, Fruh., *tom. cit.*, p. 159.

Barkuda, 9-19-viii-19; 7-iv-20.

Hab.—Plains of India and Burma.

Remarks.—Very common in August and in the beginning of September, 1919. In August, 1920 it was seen in large numbers, flying high, among species of *Ficus* and *Euphorbia* at the back of a small pond on the island.

Ixias marianne, Cram. (978).

1907. *Ixias marianne*, Bing., *tom. cit.*, p. 196.
 1910. *Ixias marianne*, Fruh., *tom. cit.*, p. 159, pl. 72a.

Barkuda, 18-viii-19.

Hab.—Kumaun to South India; Ceylon.

Remarks.—A single male was the only specimen captured. The species was seen occasionally in April. No specimens were seen in August, 1920.

***Catopsilia pyranthe*, Linn.**

1907. *Catopsilia pyranthe*, Bing., *tom. cit.*, p. 221.

1910. *Catopsilia pyranthe*, Fruh., *tom. cit.*, p. 162.

Barkuda, 19-29-viii-19.

Hab.—India, Burma and Ceylon.

Remarks.—Common during the rains.

***Catopsilia pomona*, Fab. (979).**

1907. *Catopsilia crocale*, Bing., *tom. cit.*, p. 219.

1910. *Catopsilia pomona*, Fruh., *tom. cit.*, p. 163. pl. 69b.

Barkuda, 24-viii-19.

Hab.—India, Burma and Ceylon.

Remarks.—Fruhstorfer separates *C. pomona* from *C. crocale* chiefly on the difference in the sexual organs. Superficially the differences are slight. The antennae are red and not black, and white silver dots occur in the disc of the underside of both wings. The females show lesser variability in colour than *crocale*. *C. pomona* is essentially a butterfly of the woods, generally flying high among dense jungle, while *C. crocale* is usually found in open country among flowers. The habits of *C. pyranthe* on Barkuda are similar to those of *C. pomona*.

It is probable that the species of *Catopsilia* do not breed on the island, as they are frequently seen flying over from the mainland. Moreover, there are on Barkuda no plants of the genus *Cassia*, on which their caterpillars are said to feed exclusively, while *Cassias* are abundant on the neighbouring mainland.

***Terias libythea*, Fab. (980).**

1907. *Terias libythea*, Bing., *tom. cit.*, p. 247.

1910. *Terias libythea*, Fruh., *tom. cit.*, p. 166.

Barkuda, 30-viii-6-ix-19.

Hab.—India, Burma and Ceylon.

Remarks.—Not a very common butterfly at any season.

***Terias hecabe*, Linn. (980).**

1907. *Terias hecabe*, Bing., *tom. cit.*, p. 250, text-figs. 60 and 60b; pl. xvi, fig. 106.

1910. *Terias hecabe*, Fruh., *tom. cit.*, p. 166-167, pl. 73f.

Barkuda, 11-18-viii-19; 4-15-ix-19.

Hab.—India, Burma and Ceylon. Also the Andamans and Nicobars.

Remarks.—Common, especially in the latter part of the "rains"; scarce in the latter part of the dry weather.

***Terias silhetana*, Wall. (980).**1907. *Terias silhetana*, Bing., *tom. cit.*, p. 257, text-fig. 65a and 65b.1910. *Terias blanda silhetana*, Fruh., *tom. cit.*, p. 169, pl. 73c.

Barkuda, 29-viii-19; 2-7-ix-19.

Hab.—Sikkim, Burma, South India and the Andamans.

Remarks.—Not so common as the preceding species. The larva of this species is slender, cylindrical and greenish in colour, rather paler towards the anal extremity, and has a pale yellow, ill-defined lateral stripe which is, however, in some individuals absent. It is furnished with very close, rather bristly hairs along the back, and fine, short ones laterally. The head is black, or very dark brown, with fine, pale, in most cases scattered, hairs. In the Cochin States Dr. Gravely found that these caterpillars were eaten by the Reduviid bug, *Panthous bimaculatus*.

***Colotis calais amatus*, Fab. (980).**1907. *Colotis amata*, Bing., *tom. cit.*, p. 261.1910. *Teracolus amata*, Fruh., *tom. cit.*, p. 173.

Barkuda, 6-29-viii-19; 3-29-ix-19; 23-x-19; 15-xii-19; 8-20-iv-20.

Remarks.—“*Amatus* constantly differs from *calais* in that the black spot on the margin near the dorsum is not detached and quadrate.” (*Evans*). The form of female in which the ground-colour ranges from pale primrose-yellow to pure white has been named *albina* by Col. Evans. It is rare on Barkuda. The species was quite common on the island among low herbage from August to October, 1919. In April, 1920 it was abundant on the shore around *Salvadora persica*, but was entirely absent in June and July, and in August was not so plentiful as in 1919. The Chilka Lake represents, according to Col. Evans, the extreme north-eastern limit of the geographical range of this insect.

***Hebomoia glaucippe* ? *australis*, Bert. (980).**1907. *Hebomoia glaucippe* race *australis*, Bing., *tom. cit.*, p. 275.1910. *Hebomoia glaucippe australis*, Fruh., *tom. cit.*, p. 175.*Hab.*—Southern India and Ceylon.

Remarks.—We have seen this butterfly on several occasions in April, and from August to September, but were unable to capture it on account of its habit of flying very high among dense growths of *Euphorbia* and *Ficus*, chiefly round a small pond on the island. The race *australis* and typical *glaucippe* are so alike that it is impossible to distinguish them on the wing, but the insect we saw is probably *australis* as this is the South Indian race of the species. We cannot, however, be certain as both *glaucippe* and *australis* sometimes fly together in South India.

***Pareronia valeria hippia*, Fab. (981).**1907. *Pareronia hippia*, Bing., *tom. cit.*, p. 278.1910. *Pareronia valeria hippia*, Fruh., *tom. cit.*, p. 178, pl. 66a and 66b.

Barkuda, 24-viii-19, 3-6-ix-19; 11-xii-19, 10-20-iv-20.

Hab.—India and Burma.

Remarks.—Common in the beginning of April and during the “rains.” It generally flies high among dense jungle and somewhat resembles *Danais limniace* on the wing.

Family LYCAENIDAE.

Neopithecops zalmora, But. (981).

1907. *Neopithecops zalmora*, Bing., *tom. cit.*, p. 309.

1905-10. *Neopithecops zalmora*, Swin., *Lep. Ind.* VII, p. 230, pl. 627, figs. 2, ♂, 2a, ♀, 2b, ♂ (*wet-seas. brood*); 2c, ♂, 2d, ♀ (*dry-seas. brood*); 2e, ♂ (*ex-dry-seas. brood*).

Barkuda, 15-xii-19.

Hab.—India, Burma and Ceylon.

Remarks.—Scarce.

Chilades laius, Cram. (984).

1907. *Chilades laius*, Bing., *tom. cit.*, p. 365, pl. xix, fig. 135.

1905-10. *Chilades laius*, Swin., *tom. cit.*, p. 271, pl. 638, figs. 3, ♂, 3a, ♀, 3b, ♀ (*wet-seas. brood*); 3c, ♂, 3d, ♀, 3e, ♂, 3f, ♀ (*dry-seas. brood*).

Barkuda, 15-22-vii-16; 18-viii-19. The specimens captured on other dates have been lost.

Hab.—India, Burma and Ceylon.

Remarks.—One of the commonest Lycaenids on the island at all seasons, generally found in the neighbourhood of *Ficus bengalensis* and *F. infectoria*. Very abundant in the more open parts of the island in the latter part of October, 1920.

Zizera lysimon karsandra, Moore (984).

1907. *Zizera lysimon* var. *karsandra*, Bing., *tom. cit.*, p. 358.

1905-10. *Zizera lysimon karsandra*, Swin., *tom. cit.*, p. 258, pl. 635, figs. 3, ♂, 3a, ♀, 3b, ♂ (*wet-seas. brood*); 3c, ♂, 3d, ♀ (*dry-seas. brood*).

Barkuda, 11-iv-20.

Hab.—India, Burma and Ceylon. The Nicobars?

Remarks.—The two specimens taken on the date given above were the only ones captured. We did not see this butterfly again.

Catachrysops strabo, Fab. (985).

1909. *Catachrysops strabo*, Bing., *tom. cit.*, p. 411, pl. xix, fig. 143.

1907. *Catachrysops strabo*, Swin., *Lep. Ind.* VIII, p. 47, pl. 650, figs. 3, ♂, 3a, ♀, 2b, ♀ (*wet-seas. brood*); 3c, ♂, 3d, ♀ (*dry-seas. brood*).

Barkuda, 30-viii-19, 1-ix-19; 10-21-iv-20.

Hab.—India, Burma, Ceylon, the Andamans and the Nicobars.

Remarks.—Common as compared with most of the other Lycaenids found on the island.

Catachrysops cnejus, Fab. (985).

1907. *Catachrysops cnejus*, Bing., *tom. cit.*, 415.

1910-11. *Euchrysops cnejus*, Swin., *tom. cit.*, p. 40, pl. 649, figs. 2, ♂ 2a, ♀ 2b, ♂ (wet-seas. brood); 2c, ♂ 2d, ♀ (dry-seas. brood).

Barkuda, 10-19-viii-19; 16-iv-20.

Hab.—Throughout our limits.

Remarks.—Relatively rare.

Azanus ubaldus, Cram. (985).

1907. *Azanus ubaldus*, Bing., *tom. cit.*, p. 362, pl. xix, fig. 138.

1910-11. *Azanus ubaldus*, Swin., *tom. cit.*, p. 33, pl. 648, figs. 2, 2a, ♀ 2b, ♂.

Barkuda, 29-ix-19.

Hab.—India, Burma and Ceylon.

Remarks.—One specimen only has been obtained.

Castalius rosimon, Cram. (985).

1907. *Castalius rosimon*, Bing., *tom. cit.*, p. 424, text-fig. 90.

1905-10. *Castalius rosimon*, Swin., *Lep. Ind.* VII, 239, pl. 630, figs. 1, ♂, 1a, ♀ 1b, ♂ (wet-seas. brood); 1c, ♂, 1d, ♀ (dry-seas. brood) 1f, ♂, 1g, ♀ (ex-dry-seas. brood).

Barkuda, 6-18-viii-19; 6-29-iv-19; 11-xii-19.

Hab.—India, Burma, Ceylon, the Andamans and the Nicobars.

Remarks.—Probably the commonest Lycaenid on the island at most times.

Lampides bochus, Cram. (987).

1907. *Lampides bochus*, Bing., *tom. cit.*, p. 398.

1910-11. *Famides bochus*, Swin., *Lep. Ind.* VIII, p. 58, pl. 652, figs. 3, ♂, 3a, ♀, 3b, ♀.

Barkuda, 8-20-iv-20 (*W. A. Burns*).

Hab.—India, Burma, Ceylon and the Andamans.

Remarks.—A few specimens were obtained for the first time in April, 1920.

Lampides celeno, Cram. (987).

1907. *Lampides celeno*, Bing., *tom. cit.*, p. 404.

1910-11. *Famides celeno*, Swin., *tom. cit.*, p. 66, pl. 655, figs. 1, ♂, 1a, ♀ 1b, ♂ (wet-seas. brood); 1c, ♂, 1d, ♀ 1e, ♂ (dry-seas. brood); 1f, larva and pupa.

Barkuda, 2-24-vii-19, 15-xii-19; 11-21-iv-20.

Hab.—India, Burma and Ceylon.

Remarks.—Fairly common at all seasons.

Polyommatus boeticus, Linn. (987).

1907. *Polyommatus boeticus*, Bing., *tom. cit.*, p. 432.

1910-11. *Lampides boeticus*, Swin., *tom. cit.*, p. 44, pl. 650, figs., 2, ♂, 2a, ♀ 2b, ♂.

Barkuda, 8-15-viii-19.

Hab.—Throughout our limits. A very widely distributed species.

Remarks.—Fairly common in August, 1919, but since then it has become rather scarce.

***Curetis phaedrus*, Fab. (988, as *thetis*).**

1907. *Curetis thetis*, Bing., *tom. cit.*, p. 437, text-fig. 93a and 93b.

1910-11. *Curetis thetys*, Swin., *tom. cit.*, p. 239, pl. 698, figs. 1, ♂, 1a, ♀, 1b, ♂, 1c, larva and pupa (nat. size), 1d, larva and pupa, with brush on 12th seg. extruded and enlarged.

1915. *Curetis phaedrus*, Chapman, *Nov. Zool.* XXII, p. 88, pl. 3, and pl. 18, fig. 78, fig. 7; appendages, pl. 13, figs. 62-68.

Barkuda, 15-22-vii-16 (*Gravelly*); 9-15-viii-19; 11-xii-19; 11-iv-20.

Hab.—South India, Ceylon, Bombay, Balai, Malabar.

Remarks.—In his analysis of the genus *Curetis* published in *Novitates Zoologicae*, Dr. Chapman separates *thetis* and *phaedrus* mainly on genital differences. The superficial differences are slight and are enumerated by him on page 85 of his paper and by Bingham on page 439 of the "Fauna." It is a fairly common butterfly on the island.

***Curetis bulis*, Db. and Hew.¹ (988).**

1907. *Curetis bulis*, Bing., *tom. cit.*, p. 441, text-fig. 95.

1910-11. *Curetis bulis*, Swin., *tom. cit.*, p. 244, pl. 699, figs. 2, ♂, 2a, ♀, 2b, ♂ (*bulis* form); 3, ♂, 3a, ♀ 3b, ♂ (*discalis* form).

1915. *Curetis brulis*, Chap. *op. cit.*, p. 95, pl. 3, fig. 5; appendages, pls. 6 and 7, figs. 31-40.

Barkuda, 15-22-vii-16 (*Gravelly*).

Hab.—India and Upper Burma.

Remarks.—Col. Evans tells us that it is somewhat curious that *bulis* and *phaedrus* were taken together, as they do not fly in company as a rule. In Pachmari only *bulis* is found, in South India only *phaedrus*. The south end of the Chilka Lake probably represents the boundary of the range of these two species. Both are usually found on, or near, the pea *Crotolaria striata*, which grows in cleared land.

***Aphnaeus vulcanus*, Fab. (989).**

1890. *Aphnaeus vulcanus*, De Nic., *Butt. Ind.* III, p. 349.

1911-12. *Aphnaeus vulcanus*, Swin., *Lep. Ind.* IX, p. 158, pl. 733, figs. 1, ♂, 1a, ♀ 1b, ♂, 1c, larva and pupa.

Barkuda, 18-viii-19. 11-iv-20.

Hab.—Sikkim. South India and Ceylon.

Remarks.—Rather scarce.

***Iraota timoleon*, Stoll. (990).**

1890. *Iraota timoleon*, De Nic. *tom. cit.*, p. 213, pl. xxvii, figs. 192 and 193.

¹ Dr. Chapman gives the authors' names as Db. and West., though the species is generally supposed to have been described by Db. and Hew., *Gen. Diurn. Lep.* As we have been unable to verify Dr. Chapman's statements we have followed general opinion and given the authors' names as Db. and Hew.

- 1910-11. *Iraota timoleon*, Swin., *Lep. Ind.* VIII, p. 132, pl. 669, figs. 3: ♂, 3a, 9, 3b, ♂, 3c, ♀ (*wet-seas. brood*); 3d, ♂ (*dry-seas. brood*) 3c, *larva and pupa*.

Barkuda, 8-10-viii-19. 11-iv-20.

Hab.—India and Burma.

Remarks.—Only four specimens have been obtained; all on, or in the neighbourhood of, large fig trees (*Ficus infectoria* or *F. bengalensis*). They resembled moths very closely. Indeed, so close was the resemblance that on two occasions the collector was deceived and labelled them “moth.”

***Loxura atymnus*, Cram. (996).**

1890. *Loxura atymnus*, De Nic., *tom. cit.*, p. 436, pl. xxix, fig. 232.

- 1911-12. *Loxura atymnus*, Swin., *Lep. Ind.*, IX, p. 213, pl. 744, figs., 1, ♂ 1a, ♀, 1b, ♂, 1c, *larva and pupa*.

Barkuda, 19-viii-20.

Hab.—South India.

Remarks.—A single specimen, probably an immigrant, was the only one obtained.

FAMILY HESPERIIDAE.

***Badamia exclamationis*, Fab. (1007).**

1896. *Badamia exclamationis*, El. and Edw., *Trans. Zool. Soc. Lond.*, XIV, p. 306.

- 1911-12. *Badamia exclamationis*, Swin., *tom. cit.*, p. 259, pl. 753, figs., 3, ♂, 3a, ♂, 3b, ♂, 3c, ♀ 3d, 3e, 3f, *larva and pupa*.

Barkuda, 18-viii-6-ix-19. viii-20.

Hab.—India, Burma and Ceylon.

Remarks.—Common as compared with the other HesperIIDae. Often seen round *Pongamia glabra*, flying jerkily from tree to tree.

***Hasora butleri*, Aurivill. (1007).**

1897. *Hasora butleri*, Aurivill. *Ent. Tidskrift*. XVIII, p. 150.

- 1911-12. *Parata butleri*, Swin., *tom. cit.*, p. 255, pl. 753, figs. 1, ♂, 1a, ♀ 1b, ♂.

Barkuda, 18-30-viii-19. 8-iv-20.

Hab.—India, Burma and Ceylon.

Remarks.—Scarce.

***Telicota bambusae*, Moore (1004).**

1896. *Telicota bambusae*, El. and Edw., *op. cit.*, p. 251, pl. xxv, fig. 63.

- 1912-13. *Telicota bambusae*, Swin., *Lep. Ind.* X, p. 248, pl. 813, figs., 3, ♂, 3a, ♀ 3b, ♂, 3c, *larva and pupa*.

Barkuda, 3-ix-19.

Hab.—India, Burma and Ceylon.

Remarks.—One specimen only was obtained, probably an immigrant.

***Parnara mathias*, Fab. (1006).**

1896. *Parnara mathias*, El. and Edw., *op. cit.*, p. 275, pl. xxvi, fig. 84

- 1912-13. *Chapra mathias*, Swin., *tom. cit.*, p. 320, pl. 831, figs., 3, ♂ 3a, ♀ 3b, ♀ 3c, *larva and pupa*.

Barkuda, 18-viii-19.

Hab.—India, Burma, Ceylon and the Andamans.

Remarks.—A single specimen.

Parnara bada, Moore (1006).

1896. *Parnara guttatus*, El. and Edw., *op. cit.*, p. 283, pl. xxvi, fig. 76.

1912-13. *Parnara bada*, Swin., *tom. cit.*, p. 329, pl. 834, figs., 1, ♂, 1a, ♀ 1b, ♂ 1c, ♀

Barkuda, 18-viii-19.

Hab.—India, Burma and Ceylon.

Remarks.—A single male.

Parnara colaca, Moore (1006).

1896. *Parnara colaca*, El. and Edw., *op. cit.*, p. 283, pl. xxvi, fig. 81.

1912-13. *Caltores colaca*, Swin., *tom. cit.*, p. 316, pl. 831, figs., 1, ♂, 1a, ♀ 1b, ♀ 1c, larva and pupa.

Barkuda, 15-30-viii-19.

Hab.—India, Burma, Ceylon, the Andamans and Nicobars.

Remarks.—Five examples only were captured.

REFERENCES TO LITERATURE.

- Annandale, N. . "The Fauna of an Island in the Chilka Lake." *Mem. Asiat. Soc. Beng.* VII, No. 4 (*in the Press*).
- Bingham, C. T. The Fauna of British India, Butterflies, I and II. London, 1905-07.
- Chapman, T. A. "An Analysis of the genus *Curetis*." *Nov. Zool.*, xxii, pp. 80-104, 1915.
- De Niceville, L. The Butterflies of India Calcutta, 1890.
- Dover, C. "The Enemies of Butterflies." *Journ. Bomb. Nat. Hist. Soc.*, xxvii, pp. 642-43, 1921.
- Eltringham, H. "On the Scent Apparatus in the Male of *Amauris naivius*, Linn." *Trans. Ent. Soc. Lond.*, 1913, pp. 399-406.
- Eltringham, H. "Further Observations on the Structure of the Scent Organs in certain Male Danaine Butterflies." *Ibid.*, 1915, pp. 152-176.
- Eltringham, H. "Butterfly Vision." *Ibid.*, 1919, pp. 1-49.
- Elwes, H. J and Edwards, J "A Revision of the Oriental Hesperiidæ." *Trans. Zool. Soc. Lond.*, xiv, pp. 101-324, 1896.
- Evans, W H. "A List of the Indian Butterflies." *Journ. Bomb. Nat. Hist. Soc.*, xix, pp. 553-584 and pp. 969-1008, 1911-13.
- Evans, W H. . "Notes on Indian Butterflies." *Ibid.*, xxvii, pp. 86-93 1920.
- Fryer, J C. F. "An Investigation by Pedigree Breeding into the Polymorphism of *Papilio polytes*, Linn." *Phil. Trans. Roy. Soc. Lond.*, B, CCIV, pp. 227-54, 1914.

- Fryer, J. C. F. "Pupal Colouration in *Papilio polytes*, Linn." *Trans. Ent. Soc. Lond.*, 1913, pp. 414-419.
- Fryer, J. C. F. "Field Observations on the Enemies of Butterflies in Ceylon." *Proc. Zool. Soc. Lond.*, 1913, pp. 613-619.
- Ghosh, C. C. "Life Histories of Indian Insects, v, Lepidoptera--Butterflies." *Mem. Dep. Agriculture Ind., Ent. Series*, v, No. 1, pp. 1-72, 1912.
- Hankin, E. H. "The Comparative Invisibility of *Papilio demoleus* during flight." *Rep. Proc. 3rd Ent. Meet. Pusa*, iii, pp. 900-03, 1920.
- Marshall, G. A. K. "Birds as a Factor in the Production of Mimetic Resemblances among Butterflies." *Trans. Ent. Soc. Lond.*, 1909, pp. 329-83.
- Poulton, E. B. "The Proportion of the Female forms of *P. polytes* in the Different Parts of its Geographical Range." *Rep. Proc. 3rd Ent. Meet. Pusa*, iii, pp. 903-06, 1920.
- Punnett, R. C. "Mimicry in Ceylon Butterflies, with a Suggestion as to the Nature of Polymorphism." *Spol. Zeylanica*, vii, pp. 1-24, 1911.
- Punnett, R. C. *Mimicry in Butterflies.* Cambridge, 1915.
- Seitz, A. *The Macrolepidoptera of the World.* Stuttgart, 1908 onwards. (Not yet complete).
- Swinhoe, F. *Lepidoptera Indica*, vii, viii, ix and x. London, 1905-13.



THE MOTHS OF BARKUDA ISLAND.

By CEDRIC DOVER, *Assistant, Zoological Survey of India.*

The fact that the majority of the moths taken on Barkuda are widely distributed and easily recognised species has made it possible for me without any special knowledge to identify them with certainty. In the annotated list that follows I have thought it convenient to adopt the arrangement given in Hampson's volumes on moths in the "Fauna of British India" series, as, to have followed the system at present in vogue among Lepidopterists would have led to unavoidable complications, chiefly because the extensive moth collections of the Indian Museum have not as yet been brought up to date.

The moths have received sufficient in the way of introduction in Dr. Annandale's general introduction to the fauna of the island; and it seems only necessary to recapitulate here that they are fairly well represented, when one considers the peculiar features of Barkuda and the disadvantages to moth-life that they offer.

We have to thank Mr. T. Bainbrigge-Fletcher, R.N., F.L.S., F.E.S., F.Z.S., Imperial Entomologist, for the identification of the Micros and assistance in naming other specimens.

ANNOTATED LIST.

Gunda lugubris Drury. 1 ex., 25-x-19 (*Annandale*).

Cephanodes hylas Linn. 1 ex., 15-22-vii-16 (*Annandale and Gravely*). The only Sphingid occasionally seen on Barkuda.

Syntomis passalis Fabr. 4 ex., 3-19-viii-19 (*Gravely*); ix-19 (*Dover*); 16-viii-20 (*Dover*). Not a rare moth on the island.

Thyrassia subcordata Wlk. 3 ex., 3-19-viii-19 (*Gravely*); 17-viii-20 (*Dover*). The species was occasionally seen in September, 1919 and in August, 1920.

Euproctis sp. 1 ex., 3-19-viii-19 (*Gravely*).

Perina nuda Fabr. 2 ex., 3-19-viii-19 (*Gravely*). Not a common species on Barkuda.

Hypsa alciphron Cram. 1 ex., 3-19-viii-19 (*Gravely*).

Alphaea vittata Moore. 1 ex., 9-x-20 (*Annandale*). Rare.

Deiopeia pulchella Linn. 4 ex., 3-19-viii-19 (*Gravely*); 9-vii-19 (*Annandale*); 14-viii-20 (*Dover*). One of the commonest moths on the island.

Duomitus mineus Cram. This species has been seen by Dr. Annandale who remarks on its resemblance to a large Buprestid beetle in his introduction to these reports.

Thosea cana Wlk. 3 ex., 18-ix-19 (*Brunetti*). Two of the three

specimens were taken *in copula* on the doorstep of the bungalow in the dark.

Parasa hilaris West. 2 ex., 3-19-viii-19 (*Gravelly*); 14-viii-20 (*Dover*). A common Indian species not rare on Barkuda.

Narosa sp. 1 ex., 3-19-viii-19 (*Gravelly*).

Lymantria rhodina Wlk. 4 ex., 3-19-viii-19 (*Gravelly*), 15-viii-20 (*Dover*). Hampson in the "Fauna" records this species from Sikkim and the Khasi Hills. On the island it is generally found on the trunks of fig-trees, and in this situation is almost invisible.

Prodenia litura Fabr. 2 ex., 3-19-viii-19 (*Gravelly*). A widely distributed species rather rare on the island.

Hyblaea puera Cram. 10 ex. 15-22-vii-16 (*Annandale and Gravelly*); 3-19-viii-19 (*Gravelly*); viii-20 (*Annandale*); 14-viii-20 (*Dover and Ribeiro*); 1-6-ix-19 (*Annandale*). This is one of the commonest moths on the island, being found especially on fig-trees and on the shrub *Glycosmis pentaphylla*. Two full-fed caterpillars were taken by Dr. Annandale on 19-viii-20. They started pupating on the next day and hatched out on the 28th of the same month. The pupae, which are brownish in colour, are generally found along the midrib of a leaf, the edges of which it draws together so as to conceal it almost entirely. The larvae have been proved pests of teak and rice.

Odontodes aleuca Guen. 1 ex., 3-19-viii-19 (*Gravelly*). Rare.

Nyctipao macrops Linn. 1 ex., 1-6-ix-19 (*Annandale*).

Sphingomorpha chlorea Cram. 1 ex., 25-vii-4-viii-17 (*Annandale*).

Ophiusa mezentia Cram. 3 ex., 3-19-viii-19 (*Gravelly*); 29-iv-20 (*Dover*). Not an uncommon moth during the rains.

Ophiusa dolata Fabr. 1 ex., 25-vii-4-viii-17 (*Annandale*). Not seen of late years on Barkuda.

Ophiusa coronata Fabr. 3 ex., 3-19-viii-19 (*Gravelly*); 17-ix-19 (*Annandale*); 13-viii-20 (*Dover and Ribeiro*). This species was sometimes abundant in the rains. Dr. Annandale has made the interesting observation that certain individuals developed the curious habit of coming to drink out of the glasses at dinner. They were by no means teetotal in their taste, and could imbibe quite an appreciable amount of whisky without being inebriated.

Micronia aculeata Guen. 3 ex., 3-19-viii-19 (*Gravelly*); 1-6-iv-19 (*Annandale*). This species is not uncommon on Barkuda on the trunks of trees. One of the specimens has a bit torn out of the left hindwing as if by a lizard.

Botyodes asialis Guen. 1 ex., 3-19-viii-19 (*Gravelly*). A rare species.

Glyphodes negatalis Wlk. A common species on the island, being found in abundance on the walls of the bungalow at all seasons.

Leucinodes apicalis Hampson. 2 ex., 14-viii-20 (*Dover*). A common moth in August and September on Barkuda.

The following species have been identified by Mr. Fletcher:—

Asura conferta Wlk. 2 ex., ix-19 (*Dover*); viii-20 (*Annandale*). Dr. Annandale's example was caught in the pupal stage on 16-viii-20 and it hatched out on 24-viii-20.

Asura rubricosa Moore. 3 ex., 3-19-viii-19 (*Gravelly*); 15-viii-20 (*Dover*); iv-20 (*Annandale and Dover*).

Amsacta lineola Fabr. 2 ex., 14-viii-20 (*Dover*).

Spodoptera mauritia Boisd. 1 ex., 3-19-viii-19 (*Gravelly*).

Schoenobius bipunctifer Wlk. 1 ex., 19-ix-19 (*Brunetti*).

Cydia pseudonictis Meyr. 1 ex., 3-19-viii-19 (*Gravelly*).

Phycodes minor Moore. 1 ex., 3-19-viii-19 (*Gravelly*). With the wings closed this insect bears a general resemblance to a small beetle.

THE WASPS AND BEES OF BARKUDA ISLAND.

By CEDRIC DOVER, *Assistant, Zoological Survey of India.*

In spite of the fact that the Hymenoptera of Barkuda were not diligently collected, a fairly representative collection has been made and a report on them will not, I think, be without value. I have not attempted to deal with the few parasitic forms collected, nor with the ants, but of the latter it may be mentioned that a race of *Camponotus compressus*, and *Phidole rhombinoda* are not uncommon on the island.¹ Elsewhere in these reports Dr. Annandale has made some interesting bionomic notes on these insects.

Like the butterflies, the Hymenoptera are represented in the main by common and widespread species, and many forms which occur on the neighbouring islands and on the mainland are here either scarce, or entirely absent. The fossorial families are fairly well represented. Mutillids are scarce, Scoliids likewise, but the Pompilidae and Sphegidae are common. *Macromeris violaceae* and *Sceliphron violaceum* are the most abundant fossorial hymenopterons on the island. Individuals of the various species of solitary wasps found on Barkuda are rather scarce, and those of the only two species of social wasps mentioned in the list, abundant. The common yellow wasps (*Polistes hebraeus*) are not represented in the collection, but the species is one which I have occasionally seen. Individuals of the commoner species of Apidae are abundant, the larger forms being found chiefly round the pea *Crotolaria striata* and the abundant shrub *Glycosmis pentaphylla*; the smaller, as *Nomia oxybeloides*, in low herbage. The carpenter-bees are common, but not quite so common as a casual observer would think, as the brilliant effulgence of their wings and their noisy booming ways render them conspicuous. Leaf-cutting bees are abundant at certain seasons. One species (*Megachile lanata*) was very common in April, and used to build a nest, composed generally of six or seven mud cylinders, in any available hollow such as the backs of books and in keyholes and locks. The nests appeared to be parasitized by *Megachile disjuncta*. In the introduction to the fauna of the island it is stated that *Apis florea* is common and *A. dorsata* scarce, but I have never seen these species on Barkuda and they are not represented in the collection. Dr. Annandale informs me that he found honey of *A. florea* from Barkuda tasteless.

¹ The Tailor-Ant, *Oecophylla smaragdina* is found on Barkuda, but it apparently never succeeds in establishing a colony. Cf. Annandale in his introduction to these reports.

In this paper I have followed the arrangement given by Col. Bingham in his volumes on the Hymenoptera in the "Fauna of British India" series for convenience sake, and the numbers after the name of each species denote the page number of that work.

In conclusion I would like to take this opportunity of expressing my indebtedness to Dr. N. Annandale for the kindly interest he has always taken in my zoological studies, and for the opportunities he has repeatedly given me of touring under his guidance.

LIST OF SPECIES COLLECTED ON BARKUDA.

Tribe Fossores.	Tribe Diploptera.
Family Mutillidae.	Family Eumenidae.
<i>Mutilla ruficrus</i> Rad. M.S.	<i>Eumenes brevirostrata</i> Sauss.
<i>Mutilla</i> nr. <i>pondicherensis</i> Rad. and Sich.	<i>Eumenes petiolata</i> (Fab.).
<i>Mutilla sexmaculata</i> Swed.	<i>Eumenes esuriens</i> (Fab.).
<i>Mutilla</i> nr. <i>sexmaculata</i> Swed.	<i>Eumenes conica</i> (Fab.).
<i>Mutilla indostana</i> Smith.	<i>Rhynchium brunneum</i> (Fab.).
<i>Mutilla</i> sp.	<i>Odynerus punctum</i> (Fab.).
Family Scoliidae.	Family Vespidae.
<i>Elis thoracica</i> (Fab.)	<i>Polistes stigma</i> (Fab.).
Family Pompilidae.	<i>Vespa cincta</i> Fab.
<i>Macromeris violaceae</i> Lepel.	Tribe Anthophila.
<i>Salius perplexus</i> (Smith).	Family Apidae.
<i>Salius madraspatanum</i> (Smith).	<i>Nomia westwoodi</i> Grib.
<i>Pompilus analis</i> (Fab.).	<i>Nomia oxybeloides</i> Smith.
<i>Pompilus rothneyi</i> Cam.	<i>Steganomus nodicornis</i> Smith.
Family Sphegidae.	<i>Megachile disjuncta</i> (Fab.).
<i>Tachytes modesta</i> Smith.	<i>Megachile lanata</i> (Fab.).
<i>Ammophila atripes</i> Smith.	<i>Megachile coeliox sides</i> Bing.
<i>Ammophila laevigata</i> Smith.	<i>Ceratina viridissima</i> Guer.
<i>Sceliphron madraspatanum</i> (Fab.).	<i>Coelioxys fuscipennis</i> Smith.
<i>Sceliphron violaceum</i> (Fab.)	<i>Coelioxys capitatus</i> Smith.
<i>Sphex luteipennis</i> Mocs.	<i>Xylocopa tenuiscapa</i> Westw.
<i>Sphex aurulentus</i> (Fab.).	<i>Xylocopa fenestrata</i> (Fab.).
<i>Ampulex compressa</i> (Fab.).	<i>Xylocopa</i> nr. <i>fenestrata</i> (Fab.).
<i>Stizus vespiformis</i> (Fab.).	<i>Xylocopa aestuans</i> (Linn.).
<i>Cerceris vigilans</i> Smith.	<i>Xylocopa rufescens</i> Smith.
<i>Cerceris</i> sp.	Tribe Tubulifera.
	Family Chrysididae.
	<i>Stilbum cyanorum</i> var. <i>splendidum</i> (Fab.)
	<i>Chrysis lusca</i> Fab.

Tribe FOSSORES.

Family MUTILLIDAE.

Mutilla ruficrus Rad. M. S., p. 14.

Barkuda, 2 ex., 15-22-xii-16 (*Gravelly*), 10-ix-20 (*Annandale*).

Recorded by Bingham from Bhamo in Upper Burma and the Karen hills. Represented in the collection of the Z.S.I. from the Shan hills in Upper Burma, "Burma," Margherita in N. Assam, Bengal, and Dehra Dun. The specimens were obtained among low herbage on a sandy patch in the jungle.

Mutilla nr. pondicherensis Rad. and Sich., p. 18.

Barkuda, 1 ex., 15-22-vii-16 (*Gravelly*).

Mutilla pondicherensis is represented in the collection of the Z.S.I. from Calcutta, Pusa, and Bulsar, Bombay. The Barkuda specimen differs from *pondicherensis* chiefly in the colouration of the head, which in *pondicherensis* is black and in our specimen pale red. Gravelly (*Rec. Ind. Mus.* VII, p. 87) has noticed the "mimicry" of *M. pondicherensis* by a spider, ? *Coenoptichus pulchellus* Simon (= *Myctocryptus mutillarius* Karsch).

Mutilla sexmaculata Swed., p. 25.

Barkuda, 2 ex., 21-vii-14 (*Chitka Survey*); 25-vii-4-viii-17 (*Annandale*).

Represented in the Z.S.I. collection from Meerut, a cantonment in N. W. India, Deesa, in the Bombay Pres., Purneah, and the Bijnor dist. in the United Provinces. I saw this species on two occasions in October, 1919.

Mutilla nr. sexmaculata Swed.

Barkuda, 1 ex., 15-22-vii-16 (*Annandale* and *Gravelly*).

Differing from the preceding species only in the colouration of the head and thorax which is dark red.

Mutilla indostana Smith, p. 47.

Barkuda, 2 ex., iv-20 (*Annandale* and *Dover*); ix-20 (*Annandale*).

The only other identified specimen in the Indian Museum is from Surat, in the Bombay Presidency.

Mutilla sp.

Barkuda, 1 ex., 3-19-viii-19 (*Gravelly*).

A small Mutillid which has been too badly preserved to render its specific determination possible.

Family SCOLIIDAE.

Elis thoracica (Fab.), p. 99.

Barkuda, 1 ex., ix-20 (*Gravelly*).

The following localities represented by specimens in the collection of the Z.S.I. are not recorded by Bingham in the "Fauna"; Thibet, Nepal Terai, Kichna in the Naini Tal dist., Calcutta, Karachi, Ranchi, and Perak in the Malay Peninsula.

Family POMPILIDAE.

Macromeris violacea Lepel., p. 105.

Barkuda, 5 ex., 25-vii-4-viii-17 (*Annandale*); 16-ix-18 (*Annandale*).

The species is found, except in very dry regions, throughout India, Burma, Tenasserim, and the Andamans. It is fairly common on Barkuda.

***Salix perplexus* (Smith), p. 130.**

Barkuda, 2 ex., 25-vii-4-viii-17 (*Annandale*).

Represented in the collection of the Z.S.I. from Bangalore, Ranchi, Satara district in the Bombay Presidency, and Gopkuda I. in Lake Chilka.

***Salix madraspatanus* (Smith), p. 139.**

Barkuda, 5 ex., 15-22-vii-16 (*Gravely*); 25-vii-4-viii-17 (*Annandale*).

This species is common all over the Indian Empire and in Ceylon. It is the most abundant Pompilid on the island.

***Pompilus analis* (Fab.), p. 150.**

Barkuda, 4 ex., 15-22-vii-16 (*Gravely*); 3-19-viii-19 (*Gravely*); 25-vii-4-viii-17 (*Annandale*); 16-ix-19 (*Brunetti*).

Found throughout India, Burma and Ceylon extending to the Malayan subregion. The labels on three of the specimens bear the remarks "carrying a large Thomisiid," "carrying a large *Sparassus*," and "carrying a young cockroach," which seem to corroborate Bingham's description of the habits of the genus.

***Pompilus rothneyi* Cam., p. 169.**

Barkuda, 1 ex., 17-vii-14 (*Chilka Survey*).

Recorded from Sikkim, Barrackpore, Burma, Tenasserim, and Ceylon; the species is represented in the Z.S.I. collection by only one specimen—the present one. This form closely resembles, and is probably a variety of, *P. pedestris* Smith, and also inhabits the same area as that species. *P. rothneyi* is usually rarer in collections and on this point Bingham remarks:—"The two species exist together, but, so far as I have been able to observe, *P. rothneyi* frequents the thickest forest, while *pedestris* is to be found in the open and occasionally comes into houses,"

Family SPHEGIDAE.

***Tachytes modesta* Smith, p. 190.**

Barkuda, 1 ex., 21-vii-14 (*Chilka Survey*).

Calcutta and Bangalore (represented by specimens in the Z.S.I. collection) may be added to the localities given by Bingham. The species is common in Calcutta and Barrackpore.

***Ammophila atripes* Smith, p. 229.**

Barkuda, 7 ex., 21-vii-14 (*Chilka Survey*); 15-22-vii-16 (*Gravely*); 25-vii-4-viii-17 (*Annandale*), 19-ix-19 (*Brunetti*); 3-19-viii-19 (*Gravely*).

Found throughout India, Burma, Tenasserim and Ceylon extending to China and probably to the Malayan subregion.

***Ammophila laevigata* Smith, p. 231.**

Barkuda, 3 ex., 12-19-vii-14 (*Chilka Survey*), xi-14 (*Annandale*).

Represented in the collection of the Z.S.I. from Kangra valley in Sikkim, Jhansi in N. W. India, Bangalore, and Pusa. A rare species on the island.

***Sceliphron madraspatanum* (Fab.), p. 237.**

Barkuda, 5 ex., iv-20 (*Annandale* and *Dover*).

A common species found throughout our limits. It was not uncommon on Barkuda in April, 1920.

***Sceliphron violaceum* (Fab.), p. 240.**

Barkuda, 18 ex., 21-vii-14 (*Chilka Survey*), 15-22-vii-16 (*Gravelly*), 25-vii-4-viii-17 (*Annandale*); 3-19-v-19 (*Gravelly*); 2-vi-20 (*Annandale*); 14-16-viii-20 (*Dover* and *Ribeiro*).

Widely distributed, its range extending from S. Europe to Australia. It is the commonest Sphegid on Barkuda where it often builds its curious little mud-cells in the oddest corners in the bungalow. Individuals with the wings dark fusco-violaceous on the apical half or two-thirds are rare.

***Sphex luteipennis* Mocs., p. 247.**

Barkuda, 2 ex., 15-22-vii-16 (*Gravelly*); 25-vii-4-viii-17 (*Annandale*).

The Z S.I. possesses specimens from Karachi, Satara dist., in the Bombay Pres., Waltair, and Katmandu in Nepal. This species was never seen in 1919 and 1920.

***Sphex aurulentus* (Fab.), p. 250.**

Barkuda, 2 ex., 17-vii-14 (*Chilka Survey*); 3-19-viii-19 (*Gravelly*).

Widely distributed in the Oriental region and found in China and N. Australia. Our specimens correspond to the var. *ferrugineous* Lepel.

***Ampulex compressa* (Fab.), p. 25.**

Barkuda, 1 ex., iv-20 (*Annandale* and *Dover*).

A rather widely distributed species comparatively rare on Barkuda.

***Stizus vespiformis* (Fab.), p. 277.**

Barkuda, 3 ex., 21-vii-14 (*Chilka Survey*); 15-22-vii-16 (*Gravelly*) 3-19-viii-19 (*Gravelly*).

The species is represented in the Z.S.I. collection from Calcutta, Gopkuda I., L. Chilka, Kalka at the base of the Simla hills, Bangalore, Siliguri, Ranchi, Deesa, and the Ganjam dist. I have seen this species occasionally in April and August, 1920.

***Cerceris vigilans* Smith, p. 308.**

Barkuda, 1 ex., 17-vii-14 (*Chilka Survey*).

Represented in the collection of the Z.S.I. from Calcutta and Sikkim.

***Cerceris* sp.**

Barkuda, 1 ex., 21-vii-14 (*Chilka Survey*).

I am unable to identify this insect specifically at present.

Tribe DIPLOPTERA.

Family EUMENIDÆ.

***Eumenes brevirostrata* Sauss., p. 337.**

Barkuda, 4 ex., 15-22-vii-16 (*Gravelly*); 16-20-ix-19 (*Brunetti*); 8-x-20 (*Annandale*).

Previously recorded from Sikkim, Madras and Calcutta. Not uncommon on the island. It is generally found along the shore.

***Eumenes petiolata* (Fab.), p. 341.**

Barkuda, 5 ex., 21-vii-14 (*Chilka Survey*); 16 and 17-ix-19 (*Brunetti*); 3-19-viii-19 (*Gravelly*); iv-20 (*Annandale* and *Dover*).

A rather widely distributed species fairly common on Barkuda.

***Eumenes esuriens* (Fab.), p. 342.**

Barkuda, 2 ex., 19-iv-20 (*Annandale* and *Dover*).

A common plains species found throughout India, Burma and Tenasserim. It was not uncommon on Barkuda in April, 1920.

***Eumenes conica* (Fab.), p. 343.**

Barkuda, 2 ex., 25-vii-4-17 (*Annandale*); 18-ix-19 (*Brunetti*).

Distributed throughout the plains of India, Burma, and Ceylon extending to China and the Malayan subregion. This species was seen occasionally in September and October, 1919, and in August, 1920.

***Rhynchium brunneum* (Fab.), p. 355.**

Barkuda, 2 ex., 18-ix-19 (*Brunetti*).

A common and widely distributed species apparently not found at great altitudes. One of the two specimens approaches the var. *carnaticum* of this species.

Odynerus punctum (Fab.), p. 365.

Barkuda, 1 ex., 15-22-vii-16 (*Annandale* and *Gravelly*). A rather widely distributed species not common on the island.

Family VESPIDAE.

Polistes stigma (Fab.), p. 396.

Barkuda, 16 ex., 15-22-vii-16 (*Gravelly*); 16-20-ix-19 (*Brunetti*); 25-vii-4-viii-17 (*Annandale*), 3-19-vii-19 (*Gravelly*); iv-20 (*Annandale* and *Dover*), 17 and 18-viii-20 (*Dover* and *Ribeiro*).

Specimens from the following localities unnoticed by Bingham are represented in the collection of the Z.S.I.: Kangra valley in Sikkim, Shillong, Lucknow, Nepal Terai, Naini Tal dist., Gopkuda I., Bengal and Thibet. A common insect at all seasons.

Vespa cincta Fab., p. 402.

Barkuda, 3 ex., 25-vii-4-viii-17 (*Annandale*); 17-18-viii-20 (*Dover* and *Ribeiro*).

Found throughout our limits. This species is quite common in a cleared space enclosed for the most part by the sword-bean (*Canavalia ensiformis*). In a similar situation, and round flowers of *Pongamia glabra*, is also found the Meloid *Zonabris pustulata*, to which *V. cincta* bears a fanciful resemblance on the wing. It causes some damage among individuals of the preceding species and the bee *Nomia oxybeloides*. I have noticed the insect-eating habits of this hornet more fully in *Journ. Bomb. Nat. Hist. Soc.*, XXVII, p. 960 (1921). I have seen the common house gecko (*Hemidactylus frenatus*) raid the nest of this species and *Polistes* on Barkuda and elsewhere, without being stung, and Rothney notices that the Indian squirrel (*Sciurus palmarum*)¹ clears out the hornets feeding on the juice of the date-palm with its paws, without being molested in any way. Yet it is not an unknown incident for the Indian hornet to attack even elephants.²

Tribe ANTHOPHILA.

Family APIDAE.

Nomia oxybeloides Smith, p. 457.

Barkuda, 9 ex., 21-vii-14 (*Chilka Survey*); 25-vii-4-viii-17 (*Annandale*); 23-iv-20 (*Annandale* and *Dover*).

Recorded by Bingham from Bengal, Bombay, Punjab, and Karachi extending to Aden. The only named specimens in the Indian Museum are from Calcutta. The species is very common round low herbage at all seasons. An Asilid which Mr. Brunetti

¹ The generic name of this species has, I believe, been altered to *Fundambulus*.

² See Rothney, *Trans. Ent. Soc. Lond.*, 1903, p. 114.

has identified as *Allocotasia aurata* F. was taken while preying on a bee belonging to this species.

***Nomia westwoodi* Grib., p. 449.**

Barkuda, 2 ex., 17-viii-20 (*Dover*), 17-ix-19 (*Brunetti*).

Bingham records this species from Bengal. It is represented in the collection of the Z.S.I. from the Kangra valley, Paresnath and Calcutta.

***Steganomus nodicornis* Smith, p. 460.**

Barkuda, 1 ex., 25-vii-4-viii-17 (*Annandale*).

Previously known from Barrackpore in Bengal, Lucknow and Allahabad. There are specimens in the Z.S.I. collection from Sikkim, Siripur in N. Bengal, Bangalore, Mussorie, Dehra Dun and Lucknow. Rothney, (*loc. cit.* p. 115) says of this species: "It is a charming little bee and has a quite wierd little flight of its own, which is very puzzling till you get accustomed to it. The little white flowers of a species of *Pulicaria* are much frequented, and it has a habit of settling drawn up in a little compact ball on the stem beneath the flower, when it is almost impossible to discover it. I have been out collecting with a friend a whole day where this bee was fairly common without his capturing a single specimen until initiated in their ways." I have shared a similar experience myself, and it is this habit which probably accounts for the fact that only a single specimen was collected on Barkuda.

***Megachile disjuncta* (Fab.), p. 480.**

Barkuda, 4 ex., 15-22-vii-'16 (*Gravelly*); 3-19-viii-19 (*Gravelly*); 20-ix-20 (*Brunetti*); 7-iv-20 (*Annandale*).

Recorded from India, Burma and Tenasserim. Somewhat scarcer than the following species.

***Megachile lanata* (Fab.), p. 480.**

Barkuda, 3 ex., ix-20 (*Gravelly*); iv-20 (*Annandale* and *Dover*).

A common insect recorded from most parts of India, Burma, Tenasserim and Ceylon. This solitary bee was common to the extent of being a nuisance on Barkuda in April, 1920, where it used to build its cartridge-shaped mud nest in the backs of books and in every available hole and corner.¹ Its nest appeared to be parasitized by *Megachile disjuncta*.

¹ Cf. Horne, *Trans. Zool. Soc. Lond.*, VII, p. 176 (1872) for a description of the habits of this species and for many other common species mentioned in this paper.

Megachile coelioxsides Bing.

1898. *Megachile coelioxsides* Bing., *Fourn. Bomb. Nat. Hist. Soc.* XII, p. 126.

Barkuda, 1 ex., 24-iv-20. (*Dover*).

Represented in the Z.S.I. collection from Deesa and Quetta.

Ceratina viridissima Guer., p. 501.

Barkuda, 9 ex., 21-vii-14 (*Chilka Survey*); 16 and 17-viii-20 (*Dover*); ix-20 (*Annandale*).

Found throughout our limits. The species was abundant in August, 1920.

Coelioxys ? fuscipennis Smith, p. 511.

Barkuda, 2 ex., 17-vii-14 (*Chilka Survey*), 18-ix-'19 (*Brunetti*).

Represented in the collection of the Z.S.I. from the Kangra valley, Dehra Dun, Surat in the Bombay Pres., Calcutta and Bangalore. In the older of the two specimens from Barkuda the snow-white pubescence on the front and clypeus, and the transverse bands on the abdomen both dorsally and ventrally are wanting.

Coelioxys capitatus Smith, p. 512.

Barkuda, 2 ex., iv-20 (*Annandale* and *Dover*).

Bangalore and Ranchi, represented by specimen in the Z.S.I. collection, may be added to the localities given by Bingham.

Xylocopa tenuiscapa Westw., p. 537.

Barkuda, 3 ex., 25-vii-4-viii-19 (*Annandale*), 18-ix-19 (*Brunetti*).

Represented in the Z.S.I. collection from Bangalore, Murshidabad, Calcutta, Peradeniya in Ceylon and Tindharia. Occasionally seen in 1920.

It is rather difficult to separate the females of *L. tenuiscapa* from those of *X. latipes* on Bingham's descriptions alone. Smith's monograph on *Xylocopa* (*Trans. Ent. Soc.* 1874), Perez [*Act. Soc. Linn. Bordeaux* LVI, Ser. 6, VI, p. 50 (1901)] and Maidl [*Ann. Nat. Hofmus. Wien.* XXVI, p. 294 (1912)] should also be consulted.

Maidl (*op. cit.*, p. 295) regards Sichel's *albofasciata* as a female of *X. tenuiscapa*. As I can offer no opinion, never having seen Sichel's species, I quote Maidl's remarks *in extenso*. He says: "Ein ♀ von Ceylon ges. auf der "Novara" Reise ist als Type von *albofasciata* Sichel bezeichnet. Es ist ganz unzweifelhaft ein *tenuiscapa* ♀, nur finden sich an den Abdominaltergiten Reste weisser Fettausschwitzungen. Diese weisser Fettausschwitzungen sind die weisser Binden Sichels! Zu Zeit Sichels waren sie wahrscheinlich starker, den inzwischen ist das Tier offenbar einmal in Benzin gewaschen worden, wobei sich die Binden aufgelöst haben! Die Art ist als synonym zu *X. tenuiscapa* Westw. zu setzen."

***Xylocopa fenestrata* (Fab.), p. 539.**

Barkuda, 2 ex., 25-vii-4-viii-17 (*Annandale*); ix-19 (*Brunetti*).
A widely distributed species rare on the island.

***Xylocopa* nr. *fenestrata* (Fab.)**

Barkuda, 1 ex., iv-20 (*Annandale* and *Dover*).

This specimen seems to be intermediate between *X. fenestrata* (Fab.) and *X. lunata* Klug, which Bingham doubtfully sunk as a synonym of the former species. It differs from both forms in the possession of a comparatively large and a small, almost reniform, hyaline marking on the hindwings. Were it not for the fact that the large marking on the right hindwing is almost lost I might have been tempted to describe this as a new variety of *X. fenestrata*.

***Xylocopa aestuans* (Linn.), p. 540.**

Barkuda, 18 ex., 3-19-viii-19 (*Gravelly*); 16-20-ix-19 (*Brunetti*); 25-vii-4-viii-17 (*Annandale*); 26-iv-20 (*Dover*), 7-vi-20 (*Annandale*).

The most abundant *Xylocopa* on the island at all seasons. Its favourite food-plant appears to be the pea *Crotolaria striata*. It often bores in a dead log, cutting a rather neat round hole as an entrance to the nest. The handle of a disused *palki* (a sort of native carriage) was completely ruined by these insects in this manner.

***Xylocopa rufescens* Smith, p. 543.**

Barkuda, 3 ex., 25-vii-4-viii-17 (*Annandale*); 1-6-ix-19 (*Annandale*); 26-iv-20 (*Dover*).

Previously recorded by Bingham from Sikkim, Burma, Tenasserim, Java, Sumatra, and Borneo. It is represented in the collection of the Z.S.I. from the Andamans, Singapore, Sikkim, Murshidabad and the Ganjam dist. A comparatively rare bee of crepuscular habits. Its capture in the plains of Peninsular India is interesting.

The Indian Museum possesses three specimens from South Malabar identified as *Xylocopa ferruginea* Lepel., a species relegated to a foot-note description in Bingham's volume, as he had not been able to identify it. I am inclined to think that these examples are in reality *X. rufescens*, but they are in too bad a condition to admit of a definite opinion being expressed.

Tribe TUBULIFERA.**Family CHRYSIDIDAE.*****Stilbum cyanorum* var. *splendidum* (Fab.), II, p. 432.**

Barkuda, 1 ex., iv-20 (*Annandale* and *Dover*).

A cosmopolitan species.

Chrysis lusca Fab., II, p. 484.

Barkuda, 6 ex., 15-22-vii-16 (*Gravelly*); 18-20-ix-19 (*Brunetti*); ix-20 (*Annandale*).

Found throughout our limits. The species is rather common in the island.

THE DIPTEROUS INSECTS OF BARKUDA ISLAND.

By CEDRIC DOVER, Assistant, Zoological Survey of India.

The present note can only be said to illustrate the general character of the dipterous fauna of Barkuda as it has been found impossible to name all the species collected; and it is for this reason that I have arranged this paper in the form of notes under each family. We have to thank Mr. Brunetti for naming some specimens and for confirming the identifications of the others. Mr. Edwards has identified the Culicidae. In the arrangement I have followed Sedgwick's "Zoology."

Family CULICIDAE.

Anopheles subpictus Grassi and *Stegomyia albopicta* Skuse are the commonest mosquitoes on the island. *A.?* *culicifacies* Giles, *Culex concolor* R. D., and *Culex?* *sitiens* Wied., have also been taken. *Stegomyia w-alba* Theo. is not uncommon.

Family CHIRONOMIDAE.

Culicoides peregrinus Kieff. occurs in vast numbers at the end of the rainy season, swarming with other forms round lamps in the verandah of the bungalow. *Calyptopogon albitarsis* Kieff. has also been taken.

Family PSYCHODIDAE.

A small species of *Phlebotomus* occurs, but is rather scarce.

Family TIPULIDAE.

The only Tipulid taken on the island is the widely distributed *Conosia irrorata* Wied., which is fairly common.¹

Family BIBIONIDAE.

Plecia tergorata Rond. is often abundant during the rains. It has been seen hovering in the air about six to ten feet from the ground in considerable numbers on dull showery mornings.

Family STRATIOMYIDAE.

The only members of this family taken on Barkuda were a single specimen of *Odontomyia minuta* Fabr. (10-iv-20, *Annan-dale*), and of a new genus of Pachygastrinae.

¹ Cf. Gravely, *Rec. Ind. Mus.* XI, p. 508, 1915, for notes on habits.

Family TABANIDAE.

The common horse-fly, *Tabanus striatus* Fabr., was taken in June and October on Barkuda, where it is not a rare species. Two species of *Haematopota* are also not uncommon.

Family BOMBYLIIDAE.

Exoprosopa flammea Brun., was rather common in April, 1920, round flowers of the Tree-Euphorbia (*E. neriifolia*) on the island and I have also seen it at Rambha on the mainland. The species was previously recorded from Pusa and Trincomalee. I might mention in passing that the female on which Brunetti's original description was based was taken at Trivandrum and not at Pusa as stated by him.¹ *Exoprosopa pennipes* Wied., known previously from the lower ranges of the N. Khasi Hills and Kohima in Assam, and Karachi, Pusa, and Calcutta, was also not uncommon in April, 1920. *Hyperalonia suffusipennis* Brun., which has already been previously recorded from South India, occurred in fairly large numbers in company with *Ex. flammea*. Other Bombylids taken on Barkuda were a single specimen of the widely distributed *Anthrax afra* Fabr. and several specimens (one pair *in copula*) of *Bombylius wulpii* Brun., in April, 1920. A single example of a new species of *Bombylius* was also taken.

Family ASILIDAE.

Four or five species of Asilidae have been taken on Barkuda where they frequent dense jungle, but the only one we have been able to have identified is *Allocotasia aurata* Fabr., a single specimen of which was taken (14-viii-20, Dover) while preying on the common bee, *Nomia oxybeloides*. Two of the other Asilids captured appear to represent undescribed species of *Leptogaster*. We cannot assign generic names to the others, but Mr. Brunetti, who is engaged on a revision of the Asilidae of the East, will probably deal with them later.

Family DOLICHOPODIDAE.

We have only a single specimen, probably of the genus *Psilopus*, from Barkuda.

Family PHORIDAE.

A species of the genus *Termitoxenia* has been found in the fungus combs of *Termes* (*Odontotermes*) *obesus* Ramb. Prof. Silvestri will deal with it later.

¹ *Rec. Ind. Mus.* VI p. 466, 1909, and *Faun. Brit. Ind. Brachy.* I, p. 184, 1920.

Family SYRPHIDAE.

A single specimen of *Paragus serratus* Fabr. was taken in September, 1919, and several examples (in bad condition) of the genus *Chilosia*.

Family SEPSIDAE.

Sepsis, the only genus of this family found on Barkuda, inhabits the dung of the Chital (*Cervus axis*). Only one species, probably *Sepsis coprophila* de Meij., is represented in the collection.

Family EPHYDRIDAE.

Several species, that breed at the edge of the lake and fly to light at night, cannot be identified at present.

Family DROSOPHILIDAE.

Drosophila, which lives round bananas and other fruit, is common on Barkuda. Dr. Baini Prashad has succeeded in breeding these flies in Calcutta, they are thought by Mr. Brunetti to be new to science.

Family TRYPETIDAE.

Callistomyia pavonina Bezzi, a species which has been taken on the neighbouring islands of the Chilka Lake and in the Ganjam District, is apparently the only fruit-fly that occurs on the island.

Family ORTALIDAE.

A few Ortalids have been taken on Barkuda, but it is impossible to identify them at present.

Family ANTHOMYIIDAE.

The Anthomyids taken on Barkuda are entirely confined to the shores of the island where they are extremely abundant in damp mud and decaying algae. They sometimes fly to light. They all belong to the genus *Lispa* and seem to be four different species, two of which are *Lispa glabra* Wied. and *L. ? assimilis* Wied. The former is represented in the Museum collection from Calcutta, the latter from Jubbulpore, 1,300 feet, and Rangoon.

Family TACHINIDAE.

The identification of the Tachinids is impossible at present. Apparently three species have been taken on Barkuda, either on tree-trunks or on termite mounds.

Family SARCOPHAGIDÆ.

Two or three species of *Sarcophaga*, not represented in the collection of the Indian Museum, are not uncommon on Barkuda.

Family MUSCIDÆ.

A single female of *Lyperosia minuta* Bezzi, an apparently widely distributed form, and two or three species of *Lucilia* have been captured on the island. One of the latter is certainly *L. dux* Erichs., represented in the Museum collection from Calcutta, Sikkim, Rangoon and Mergui. The larvae of *L. dux* is apparently parasitic on the Chital (*Cervus axis*). A single female of *Idielliopsis similis* Towns. (3-19-viii-19), a recently described species, was taken by Dr. Gravely on Barkuda.

Family HIPPOBOSCIDÆ.

Mr. Brunetti has identified a fly that occurs on the Chital as *Lipoptena cervi* Linn., a European species, which has also been taken in Africa.

THE NEUROPTEROID INSECTS OF BARKUDA ISLAND.

By CEDRIC DOVER, *Assistant, Zoological Survey of India.*

Under this convenient title I propose to give a list of the various net-winged insects other than dragonflies and termites at one time included in the order Neuroptera, that have been taken on Barkuda. The Myrmeleonidae are the only family at all well represented on the island. Three species of *Palpares*, and two of *Acanthoclis* only were captured, but it is probable that a few smaller species belonging to other genera also occur. All the species have been carefully compared with authentically named specimens in the collection of the Zoological Survey of India.

Family EPHEMERIDAE.

An Ephemerid is abundant in the rains, breeding in the lake and in the pond. It is probably a species of *Caenis*.

Family HEMEROBIIDAE.

The only Hemerobiid taken on the island is a species of *Sisyra* on which Dr. Annandale remarks: "The insect is certainly a *Sisyra*, but is distinct from the only described Indian species, *S. indica* Needham¹. Its larva is parasitic on the sponge, *Spongilla alba*, in the pond on Barkuda, but leaves the water before pupating and spins a small cocoon on a blade of grass or some similar situation, often at a distance of several yards from the edge of the pond." Notes on the association of Indian *Sisyra* with sponges are given by Annandale in *Journ. As. Soc. Beng.* (n.s.) II, p. 194, 1906.

Family MYRMELEONIDAE.

Acanthoclis horridus Wlk.

Barkuda, 2 examples, 13-19-ix-19 (*Gravelly*).

Represented in the collection of the Zoological Survey of India from Cherria Island in Lake Chilka and Sibsagar in Assam. The species is fairly common on Barkuda, being found generally on the foliage or branches of the pipal tree (*Ficus religiosa*).

Acanthoclis edax Wlk.

Barkuda, 1 example, viii-19 (*Gravelly*).

¹ *Rec. Ind. Mus.*, iii, p. 206, 1909.

Represented in the Museum collection from Ramnad in South India, and Rambha in the Ganjam district.

***Palpares contrarius* Wlk.**

Barkuda, 1 specimen, iv-20 (*Dover*).

The Museum has specimens from Khurda Road in Orissa, Coorg in South India, 2,000 feet, and the Koyna Valley in the Satara District of the Bombay Presidency. The example was taken on the trunk of the Banyan (*Ficus bengalensis*).

***Palpares pardus* Rbr.**

Barkuda, many examples, 24-x-20 (*Annandale*); 12-x-20, 27-x-20 (*Annandale*, "at light") 3-19-ix-19 (*Gravely*).

Represented in the Museum collection by specimens from Sikkim, Purulia in the Manbhum District, Ambaoli in the Ratnagiri District, Purneah District, Khurda Road, Rambha in Ganjam, Barkul on Lake Chilka, Dehra Dun and Bangalore. Apparently a widely distributed species in India, common on Barkuda, where it is often taken fluttering round lamps.

***Palpares patiens* Wlk.**

Barkuda, 1 specimen, 15-22-vii-16 (*Annandale* and *Gravely*).

This seems to be an extra-Indian species of which we have examples from Bushire and Seistan in Persia. After careful comparison I am unable to separate the Barkuda specimen from Persian examples.

Family NEMOPTERIDAE.

***Croce filipennis* Westw.**

Barkuda, 1 example, 20-22-vii-20 (*Annandale*).

The Indian Museum possesses specimens of this handsome little insect from Calcutta, the Purneah District and Lucknow. In Calcutta it is often very common about April, and large numbers may sometimes be taken at dusk. In the day, as a general rule, they are found singly, resting on walls and window panes. The species is rare on Barkuda.¹

¹ Cf. Lefroy, *Fourn. Bomb. Nat. Hist. Soc.* XIX, p. 1005, 1910, for notes on the food and the larva of this species.

THE SPIDERS AND SCORPIONS OF BARKUDA ISLAND.

By F. H. GRAVELY, *D.Sc.*, *Superintendent, Government
Museum, Madras.*

(Plates XVII—XIX.)

Barkuda is an island situated in the Ganjam District of the Madras Presidency in the southern part of the Chilka Lake. Its general features have been described by Annandale (*Mem. As. Soc. Beng.* VII, No. 4 in the press). Its fauna is not a rich one, a fact which facilitates detailed biological work ; and a careful study of its spiders has revealed many features of interest. The scorpions have been less fully studied.

Order SCORPIONES.

Family BUTHIDAE.

***Charmus laneus*, Karsch.**

Charmus laneus, Pocock, 1900, p. 32.

Three specimens found among loose soil and bark at the foot of trees in the rains.

***Lychas scaber*, Pocock.**

Lychas scaber, Pocock, 1900, p. 38.

Not uncommon under loose bark.

***Isometrus assamensis*, Oates.**

Isometrus assamensis, Pocock, 1900, p. 48.

Not uncommon in the house.

Order ARANEAE.

Suborder MYGALOMORPHAE.

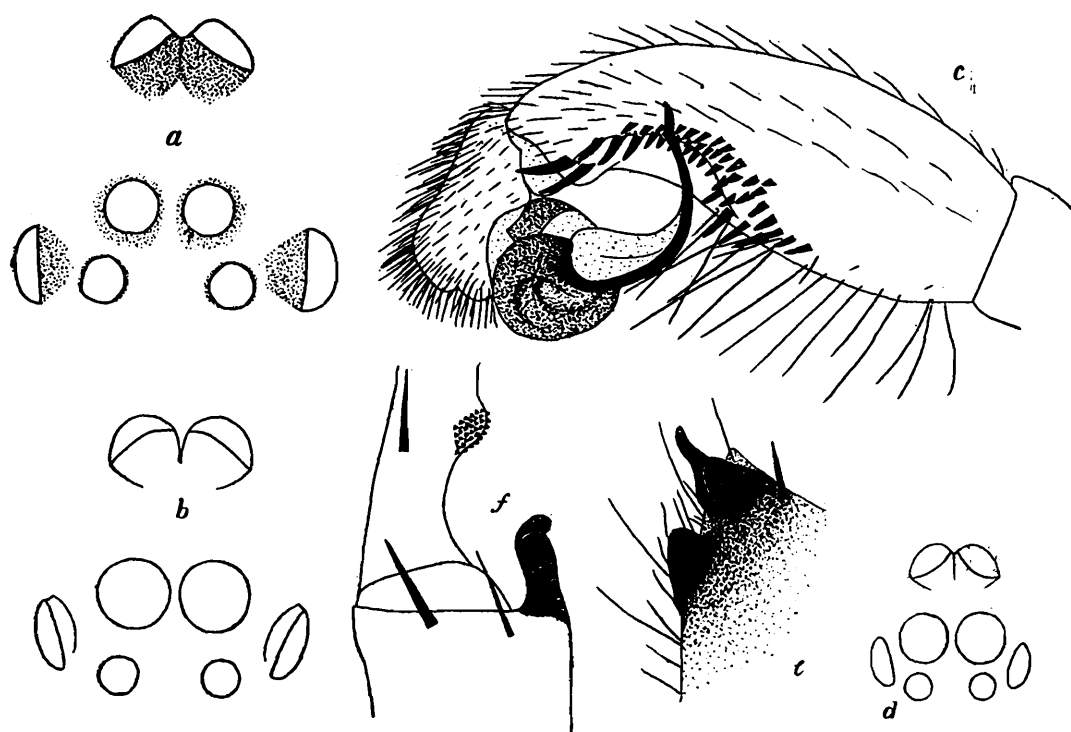
Family CTENIZIDAE.

***Acanthodon barkudensis*, sp. nov.**

Text-fig. 1, *b-e* ; pl. xvii, figs. 4-6 ; pl. xviii, fig. 9.

Also found at Rambha on the mainland at the southern end of the Chilka Lake.

A large and obese spider of a dark greenish black hue, becoming paler and browner in spirit. It forms somewhat short broad burrows lined with closely adherent silk and closed by a strong and closely fitting trap-door (pl. xvii, figs. 4-6; pl. xviii, fig. 9), to which the spider clings vigorously when any attempt to open it is made, retreating as a rule only when it has been forced open. These burrows are commonly found in soil that has accumulated among adventitious *Ficus* roots, where these anastomose over the surface of the trunk. They are also found in termite mounds. They are usually more or less horizontal, the trap-door, which is very firm and strong, being hinged on or towards the upper margin. Males were obtained in August, but not later.



TEXT-FIG. 1.

- a. *Acanthodon constructor* ♀, eyes.
 b. " *barkudensis* ♀, eyes.
 c. " " ♂, palpal organ.
 d. " " ♂ eyes.
 e. " " ♂, end of tibia of first leg with apophysis.
 f. *Damarchus excavatus* ♂ junction of tibia and tarsus of right first leg from below; hairs omitted.

♀ Total length up to about 23 mm. exclusive of chelicerae and spinnerettes. Length of carapace 10 mm., breadth 9 mm.

The coxa of the 4th leg is without spinules below and the tibia of the 3rd leg is slightly longer than wide. In this respect the species resembles *A. crassus* and *A. opifex*, but it differs from both in having the anterior median eyes only about half a diameter apart. They are about twice as large as the posterior medians which are situated about as far behind them as the anterior medians are from each other. The posterior medians are separated by a space equal to nearly three of their own dia-

meters, their outermost points being almost as far apart as those of the anterior medians. The posterior laterals are long and narrow, and markedly oblique, their posterior ends being separated from the posterior medians by about one posterior median diameter, and their anterior ends from the anterior medians by about one anterior median diameter. The anterior laterals are very strongly prominent, more so than in *A. constructor* from Madras, which also has the anterior and posterior medians of almost equal size, and the latter occupying a much wider area than the former (text-fig. 1a). The protarsi of the 3rd and 4th legs are much narrower distally than at the base, and the tarsi of these legs are distinctly more slender than in *A. constructor*.

♂ Males have only been found in August, and then much more rarely than females. They vary considerably in size. The type specimen has a total length of 11 mm., its carapace being $5\frac{1}{2}$ mm. long by 5 mm. broad. The eyes (text-fig. 1e) are more compact than in the female (this is more marked even than in *A. constructor*) and the anterior laterals are somewhat less prominent. Their arrangement otherwise resembles that of the female. The tibia of the palp (text-fig. 1c) is inflated and furnished distally with a ventral concavity whose outer margin is bordered by stout spines which are longer at the two ends than in the middle. This concavity is longer and shallower than in *A. constructor*, occupying rather more instead of less than half the length of the tibia, and not forming a complete semicircle. The tarsus has a somewhat rounded external process distally. The spine of the palpal organ is broad at the base, slender and bent distally with blunt tip, much as in *A. constructor*. The tibia of the first leg is practically straight. It bears a row of spines on its outer side as in *A. constructor*, and has its distal extremity armed on the inner side with two tubercles situated one behind the other as in that species, but somewhat smaller (text-fig. 1e). The proximal tubercle is a simple conical process, somewhat blunter than in *A. constructor*. The distal one is longer and is strongly grooved both above and below; it is somewhat slenderer than in *A. constructor* distally. The protarsus lacks the large submedian conical spur characteristic of *A. constructor*.

The spinules on the hind coxae, which help to distinguish the female of *A. constructor* from that of *A. barkudensis*, are not found in the male.

Nemesiellus sp.

Pl. xviii, fig. 8.

This species appears to be darker in colour than *N. montanus* but as it fades in spirit from dark olive green to brownish it is possible that it may fade still further. It resembles *N. montanus* in all other points mentioned in Pocock's very brief description (1900, pp. 167-8) but differs from specimens which I have recently obtained from an altitude of about 6500-7000 ft. in the Nilgiris in the dentition of the mandibles, a character not referred to in the

description of *N. montanus*¹ The Nilgiri specimens resemble the Barkuda ones in size and colour. Only females have been obtained. They attain a total length of 26 mm. with the carapace $10\frac{1}{2}$ mm. long by $8\frac{1}{2}$ mm. broad.

The burrow (pl. xviii, fig. 8) is more or less vertical and much longer than that of *Acanthodon barkudensis*. The silk with which it is lined is of a somewhat firm consistency and may readily be withdrawn from the burrow in tubular form. It is continued beyond the mouth of the burrow as a somewhat thin and flexible flap, which forms the trap-door, covering the entrance, but not strong enough to close it securely. When disturbed, therefore, the spider retreats at once into the depths of its burrow which are commonly so completely surrounded by tree roots as to make its capture by digging almost impossible. Sometimes, however, this species may also be found in termite mounds.

The Nilgiri specimens were found on a roadside cutting where their burrows were easily dug out. They bifurcated near the bottom, and had a trapdoor between the two arms. Nothing of the sort was noticed in the few burrows that I dug out under less favourable conditions on Barkuda Island. The trapdoor at the entrance to the nest of the Nilgiri species resembled that of the Barkuda species, but was on the vertical face of the cutting instead of on a horizontal surface.

***Damarchus excavatus*, sp. nov.**

Text-fig. 1/; pl. xviii, fig. 7.

Also found at Balasore, Orissa (female only).

A spider of moderate size, dark brown in colour with conspicuous oblique whitish markings on the dorsal surface of the abdomen. It forms long narrow oblique burrows whose entrance is not closed by a trap-door, but is surrounded by a more or less definite lip composed of small particles of soil fastened together with silk. Often the burrows are completely shut off from the surface, ending in an upwardly directed tube with domed roof about an inch from the surface. In the case of a specimen which constructed its tube against the side of a glass jar the only entrance to the tube was closed thus for several weeks, and I think it probable that this is done whenever the spider is not hungry. The burrows are usually found in light soil under trees and bushes in considerable numbers, and it is not impossible that they may branch and open into each other, but I have not succeeded in finding anything of the sort. This, however, must not be taken as proof that it does not exist, as it is by no means easy to trace the burrows far. Males were sought at intervals from August to December, but were not obtained till the latter month.

♀ Total length up to about 16 mm. Length of carapace

¹ Mr. Hirst informs me that the Nilgiri specimens agree with *N. montanus* in dentition so far as he can judge from the immature type of that species.

5½ mm., breadth 4 mm. Distinctly smaller than the females of *D. assamensis* in which Hirst (1909, pp. 383-4) was unable to find any structural difference from *D. oatesi*. The largest of the three females of *D. assamensis* in the Indian Museum collection is about 20 mm. long, with a carapace 8 mm. long by 5½ broad. Thorell gives the length of females of *D. oatesi* as 22 mm., the carapace being 9 mm. long by 6½ mm. broad (1895, p. 5). The legs of *D. excavatus* are shorter and thinner than in *D. assamensis*, the tarsus and protarsus of the fourth pair being together distinctly shorter than the carapace instead of about equal to it (4½ mm. in type-specimen with carapace 5½ mm. long).

♂ Length 10-11½ mm. when mature. Carapace 5-5½ mm. long by 2½-3 mm. broad. This spider is thus decidedly smaller than the male of either *D. oatesi* or *D. assamensis*. It differs from both these species in having the tibia of the palp about twice instead of three times as long as broad, and also in the form of the tibial apophysis which is very stout with an abrupt inward bend distally. The base of the protarsus of the first leg (text-fig. 1f) is strongly excavate on the inner side, as though to accommodate the tibial apophysis, and the distal border of the excavation bears a very distinct group of thick-set denticles. There is no such excavation or group of denticles in *D. assamensis*.

Family BARYCHELIDAE.

Diplothele walshi, Cambridge.

Pl. xviii, fig. 11.

Diplothele walshi, Poc. 1900, p. 175.

The species commonly known by this name was also described by its collector, J. H. Tull Walsh, under the name *Adelonychia nigrostriata* (*Journ. As. Soc. Beng.* LIX [ii], pp. 269-270). It is unfortunate that the burrow of the type specimen was not described, as the empty burrow which is described undoubtedly belonged to a different and much larger species and agrees in its characteristics with the burrows of *Acanthodon barkudensis* and *constructor*. *Diplothele walshi* never attains any large size, a mature specimen which was taken with young in its nest being only 9 mm. long; and Walsh must therefore have been wrong in supposing that the type-specimen (10 mm. long) was immature.

I have never myself found its burrow associated with burrows of *Acanthodon*. *Acanthodon* usually (though not always) chooses firmer soil in a more exposed situation for its burrow, and finds sites specially suitable for its burrows among the adventitious roots of Banyans and other species of *Ficus*. *Diplothele walshi* constructs a small chamber, usually in light soil under bushes, often against the base of a tree. The upper wall of this chamber is on a level with the surrounding soil, and is pierced by two apertures, each closed by a neatly made trap-door of the "wafer" type about 6 mm. in diameter in the nest

of a full-grown spider. The two doors open outwards, as in the nest of spiders of the genus *Sason* (Pocock, 1900, p. 173 ; Gravely, 1915 *a*, p. 265 and *b*, p. 533), but are separated by a space equal to their own diameter, or even more, instead of being hinged together as in that genus, the chamber being deeper and more like a curved tube (compare figs. 10 and 11 of pl. xviii).

***Sasonichus arthropophysis*, Gravely.**

Pl. xviii, fig. 12.

Sasonichus arthropophysis, Gravely, 1915 *a*, pp. 264-5.

A moderately large dark brown spider with reddish femora. The male with tibiae adorned distally by whitish hairs, which lose their characteristic appearance at once when put into spirit. The nest is constructed among stones and more or less loose soil and rubbish among the roots of Banyans, Pipals, etc. It consists of a short and almost straight tube somewhat swollen in the middle and closed at each end by a trap-door which is always hinged on the lower side, so that it hangs open when not held in place by the spider. Empty nests are thus somewhat conspicuous objects, the whitish lining of the trap-door contrasting with the mouth of the dark burrow above it. The trap-door of a full grown spider is about 10 mm. in diameter. Males were obtained in August, but not later.

♀ The female has not yet been described. The single spirit specimen at present before me is slightly under 20 mm. in length ; it is probably mature, but the abdomen is frequently much more distended than in this specimen. Its carapace is about 8 mm. long by 6 mm. wide. In spirit specimens the carapace, chelicerae (except the extreme base), last three joints of the palps and last four joints of the legs are of a dull sepia tint somewhat paler than the blacker abdomen and darker than the spinnerettes. In life all these parts are practically black. The sternum, coxae, trochanters and femora are ochraceous in spirit, reddish in life, except for a brownish dorsal line on the femora, which expands across the whole dorsal surface distally. The ocular tubercle is yellowish in the spirit specimen before me, but black like the rest of the carapace in the living one. The eyes resemble those of the male. The carapace is relatively somewhat narrower and more elevated than in the male, and the legs are somewhat less slender.

Family THERAPHOSIDAE.

***Plesiophrictus* sp.**

This species, like others of the group of genera to which it belongs (Gravely, 1915 *b*, p. 533), appears to make no burrow. It lives among loose soil and stones at the base of *Ficus* trees. It is not common and in the absence of mature males it cannot be described satisfactorily.

Suborder ARANEAE VERAE.

Family ULOBORIDAE.

A small black *Uloborus* is common among webs of *Cyrtophora cicatrosa*. This or a closely allied species appears to have a wide distribution in India and Burma, where it occurs in association with *C. citricola* as well as with *C. cicatrosa*. It is much smaller than *U. servulus*, Simon, which was found in association with a *Cyrtophora* of great size in Venezuela (Simon 1892 *a*, p. 213; 1892 *b*, p. 427).

The Uloborid already reported from Cochin (Gravely, 1915 *b*, p. 534), which spins a remarkable snare consisting of a horizontal orb-web above a funnel of different mesh, has also been found on Barkuda Island. It belongs to the genus *Uloborus* and though distinct from, is evidently related to, *U. quadri-tuberculatus*, Thorell in Mss., which is figured with its similar web by Workman (1896, pl. 18).

Family DICTYNIDAE.

Amaurobius sp.

A brown spider (becoming paler in spirit) of moderate size, spinning an untidy cobweb on leaves and twigs round about its lair. The lair is usually concealed in one or two curled leaflets, often of the common jungle shrub, *Glycosmis pentaphylla*, or may be beneath the spines of a Prickly Pear.

A single male was obtained in August.

This appears to be the first record of the genus from India, though *A. taprobanicola* was described by Strand (1907, p. 110, figs. 49-50b) from Ceylon. In the absence of the description of *A. taprobanicola* and of specimens of other species for comparison I prefer to leave the Barkuda form undescribed at present.

Dictyna spp.

Pl. xvii, figs. 2-3.

Two of the Barkuda spiders appear to belong to the genus *Dictyna*. One is a minute brown spider which spins untidy little cobwebs over the twigs of a Caperid bush, hiding itself in the fork formed by a leaf stalk or a second twig.

The other is a small bright green spider with whitish mid-dorsal line on the carapace and lateral lines on the abdomen, the latter united dorsally by three more or less distinct transverse whitish lines. Both sexes spin little white sheets across a slightly curved leaflet (pl. xvii, figs. 2-3), usually of *Glycosmis pentaphylla*, and live singly beneath them. They mature in October or thereabouts, after which the female deposits a number of clusters of eggs on the surface of the leaf which has formed her home. The European *D. viridissima* (Walckenaer) appears to have similar habits (Simon, 1892 *a*, p. 234).

Family ERESIDAE.

Stegodyphus sarasinorum, Karsch.

Stegodyphus sarasinorum, Pocock, 1900, p. 209, fig. 65.

Colonies of this spider are rare on the island, though abundant on the mainland near by. For an account of the habits see Gravely, 1915*b*, pp. 534-536, where other references will be found.

Family FILISTATIDAE.

Filistata sp.

A species of *Filistata* is common, especially in termite runs on tree trunks and under bark. It appears to make use of old nests made by other spiders, and is often found among foliage in what seem to be deserted nests of the species of *Amaurobius* (Fam. Dictynidae) above referred to.

Only females have yet been found. They probably belong to the *Filistatoides* group.

Family SICARIIDAE.

Scytodes sp. nr. *pallida*, Doleschall.

This species closely resembles *T. pallida*, Doleschall (1859, p. 48, pl. vi, figs. 3-3*b*) in general appearance, but differs in the arrangement of the dark lines on both carapace and abdomen. On the carapace there are 5 (sometimes 7) longitudinal dark lines, one being always median, whereas in *S. pallida* there is no median line, the total number being an even one (probably six), judging from Doleschall's figure. On the abdomen there are three or four more or less complete transverse black lines and none of the longitudinal ones found in *S. pallida*.

The Barkuda species, like *S. pallida* (Simon, 1892 *a*, p. 276), lives among foliage, making itself a retreat by spinning together a few leaves.

Family DYSDERIDAE.

Ariadna ? *nebulosa*, Simon.

Ariadna nebulosa, Simon, 1906, p. 280.

A species of *Ariadna*, possibly identical with Simon's *A. nebulosa* from Madura, is common under stones and among loose soil, where it spins long tubes of soft but moderately tough whitish silk of very characteristic texture and appearance.

Family DRASSIDAE.

Several small species are to be found under stones, among loose soil, in crevices in the bark of trees and on foliage. I have not been able to identify any of them.

Family PALPIMANIDAE.

Sarascelis ? *raffrayi*, Simon.

Sarascelis raffrayi, Simon, 1893, p. 313.

A bright orange-red spider occasionally found under stones or on tree trunks. The sexes appear to occur in about equal numbers, and do not differ from one another except as regards the sexual organs.

Mature males vary from $3\frac{1}{2}$ –5 mm. in length, the largest female being $6\frac{1}{2}$ mm. long. The type of *S. raffrayi* was a male 7 mm. long—much larger than either of the Barkuda males, and twice as long as the smaller of the two. Apart from this difference in size Simon's description of *S. raffrayi* appears to apply to the Barkuda specimens.

Family ZODARIIDAE.

Hermippoides arjuna, gen. et. sp. nov.

Text-fig. 2e.

A medium sized and somewhat rotund black spider spotted with white, found running about under trees and occasionally on foliage. The genus differs from *Hermippus*, Sim. (1892, p. 425) only in the possession of all six spinnerettes, instead of only one pair of them.

The anterior row of eyes is very slightly procurved, with the medians slightly larger than the laterals and separated from each other by little more than half a diameter and from the laterals by about one and a half diameters. The posterior row is slightly wider and more procurved than the anterior; its eyes are about equal in size to the anterior laterals. The ocular quadrangle is practically square, but the posterior laterals, being smaller than the anterior laterals, are more widely separated.

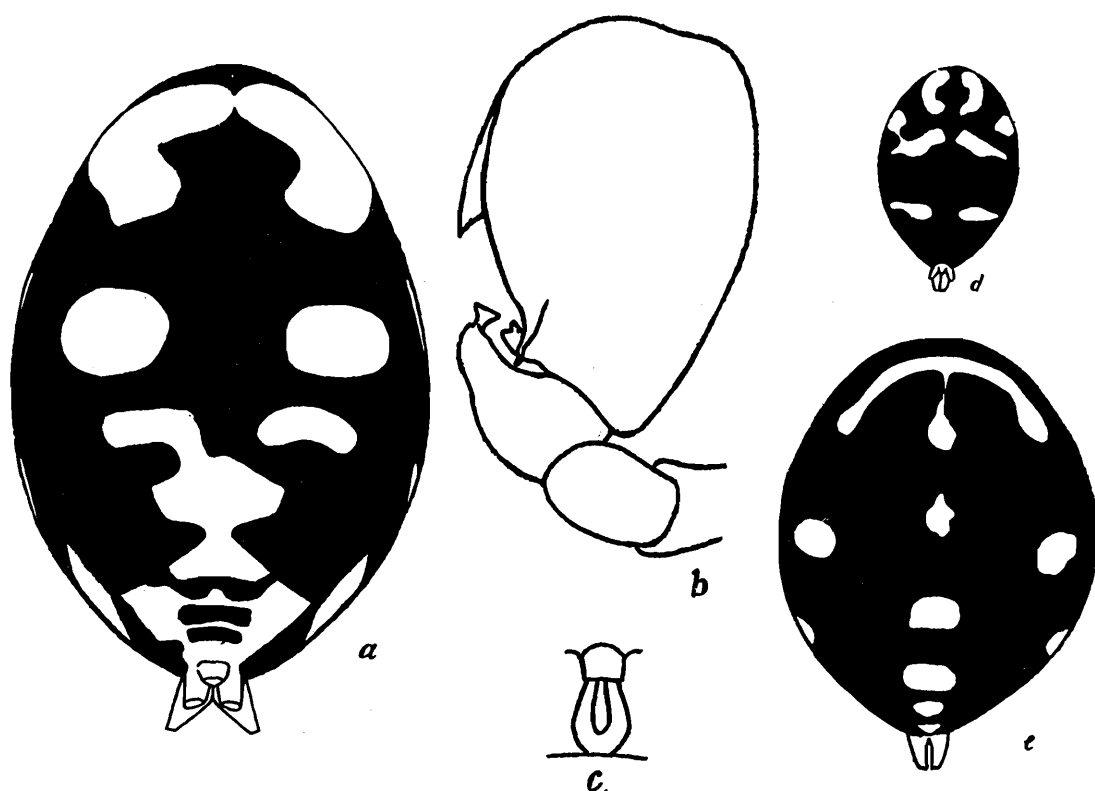
The cephalothorax is blackish brown, with a white margin ventrally. The sternum and labium are brown. The appendages and spinnerettes are pale yellowish, except the tarsus of the palp which is brown. The abdomen (text-fig. 2 e) is black with five whitish longitudinal lines or rows of spots. The mid-dorsal row is straight and consists of about ten spots, of which the posterior are more crowded together than the anterior. The foremost spot is, however, united by a thin line with the second spot of its own row and with the foremost spot of the lines next to it on either side, which together produce the figure of a bow and arrow (without the cord). The dorso-lateral rows each consist of the spot included in this figure and three others behind it, all separate. The ventro-lateral row consists of four or five spots, often partially united, of which the third is somewhat out of line, being at a higher level than the rest. Ventrally there is a pair of wavy and more or less broken lines. There is also a small spot close to the spinnerettes, towards which the two lateral rows of spots tend to converge;

and there may be a more or less conspicuous pair of spots immediately behind the lung-sacs, between the ventral and ventrolateral lines.

Storena birenifer, sp. nov.

Text-fig. 2 a-c.

A medium sized dark brown spider with conspicuous ochraceous markings, found among soil and stones under shady trees in the jungle. Males were obtained in July. They differ from females chiefly in the smaller relative size of the abdomen, and in having the anterior median eyes distinctly larger than the rest.



TEXT-FIG. 2.

- a. *Storena birenifer* ♀ dorsal surface of abdomen.
 b. " " ♂ left palpal organ.
 c. " " ♀ genital aperture.
 d. *Suffucia cingulata* ♀ dorsal surface of abdomen.
 e. *Hermippoides arjuna* ♀ " " " "

The species appears to resemble *S. redimita*, Simon (1905, pp. 173-4) from Pondicherry and Genji, but the anterior median eyes of the female are scarcely larger than the anterior laterals, instead of almost twice as large as in that species.

The carapace is black. The abdomen (text-fig. 2a) is black with conspicuous pale ochraceous markings as follows: an anterior pair of kidney-shaped patches, more or less confluent across the middle line in front, followed first by a pair of large and then a pair of smaller spots of the same colour. The posterior pair are often confluent with a median triangular patch behind them, and this usually joins the anterior angle of the posterior median patch,

which has the form of a more or less complete square with one angle directed forwards and the opposite one in contact with the spinnerettes. This square, however, contains about three transverse black bars, or pairs of spots, which may be confluent with the black ground colour, thus breaking up part of the outline of the square. In front of the lateral angles of the square the sides of the abdomen bear three parallel oblique ochraceous bars. The ventral surface is ochraceous with a pair of dark longitudinal bands, confluent behind and extending forwards not quite as far as the genital orifice.

The genital orifice of the female is shown in text-fig. 2c.

The palpi and legs are yellowish, except the palpal organ of the male and the femora of both sexes, which are brown or black. The palpal organ of the male is shown in text-fig. 2b. Its tarsus is flattened dorsally and somewhat keeled laterally.

? *Storena* sp.

A minute spider with yellowish feet, darker femora, dark reddish carapace and black abdomen, the abdomen adorned in the male with five conspicuous white spots arranged in a pentagon, the median spot behind the two pairs.

Males were found running in the open on a jungle path after rain; females were found among soil; both were found during August. The species is closely allied to *Storena*, with which it agrees in the form of the sternum, and in the possession of 6 mammillae and a high clypeus. It differs, however, from all representatives of the genus with which I am familiar in having the lateral eyes of both rows obliquely elongate and in having the anterior row recurved. The outer ends of the anterior and posterior laterals are in contact with one another, the posterior row being strongly procurved. The median eyes are separated by about a diameter, forming a quadrangle which is more or less distinctly wider behind than in front, and about as long as it is wide.

Length of female about $2\frac{1}{2}$ mm.; male slightly smaller. I do not feel justified in giving a name to this minute spider without further material for comparison.

Suffucia cingulata, Simon.

Text-fig. 2d.

Suffucia cingulata, Simon, 1905, p. 174.

Both sexes of this minute spider were found running about among dead leaves and in the open after rain during August.

The Indian Museum collection includes specimens from Ross Island in the Andamans (females only, Mr. C. Paiva), Serampore near Calcutta (female only, Mrs. Drake) and Madras (male only, Prof. Ramuni Menon). The species was described from females from Pondicherry.

♀ The markings are very variable in extent and the posterior pair of transverse spots may be absent, as they appear to have been from Simon's specimens. The ground colour of the abdomen is black, and the markings pale ochraceous including the spot on which the anal papilla stands; but the papilla itself is of a snowy white.

♂ The male is slightly smaller than the female, being only about $2\frac{1}{2}$ mm. long, and has the dorsal surface of abdomen of a lustrous blue-black hue throughout, except for the minute white anal papilla.

Family HERSILIIDAE.

Hersilia savignyi, Lucas.

Hersilia savignyi, Pocock, 1900, p. 241.

Common on tree-trunks on the sandy shore of the northern end of the island.

Family PHOLCIDAE.

Artema atlanta, Walck.

Artema atlanta, Pocock, 1900, pp. 238-9, text-fig. 81.

One specimen found in the house.

Smeringopus sp.

A spider with small but somewhat elongate body and immensely long legs, which spins untidy cobwebs in hollow trees and sometimes among the lowest branches of Prickly Pears. It appears to form the chief article of diet of a remarkable Attid (*Linus* sp., see below, p. 419). It is very like *S. elongatus*, but differs in the structure of the vulva. The specimens in the Indian Museum collection suggest that it is a widely distributed jungle spider, while *S. elongatus* lives mainly in houses.

Family THERIDIIDAE.

Rhomphaea sp.

A single spider, apparently belonging to the genus *Rhomphaea*, was found in an irregular web together with a specimen of one of the species of *Theridon* referred to below. The latter was much the larger spider of the two, and doubtless the rightful owner of the web.

Argyrodes scintillulana, Cambridge.

Argyrodes scintillulana, Cambridge, 1880, pp. 332-3, pl. xxxi, fig. 10.

This species is occasionally found in webs of *Cyrtophora cicatrosa*, Stoliczka.

***Argyrodes argentata*, Cambridge.**

Argyrodes argentata, Cambridge, 1880, pp. 325-6, pl. xxviii, fig. 5.

This species also occurs on the island.

? *Theridion* spp.

One or more species of *Theridion*, varying considerably in colouration, spin irregular snares of the usual type among Prickly Pear and other bushes, living in these webs under a dead leaf or some such shelter.

Another species, closely resembling the European *Lithyphantes paykullianus* in colour, and possibly belonging to the same genus, lives on the ground.

Family ARGIOPIDAE.***Tetragnatha gracilis*, Stoliczka.**

Tetragnatha gracilis, Pocock, 1900, pp. 214.

This species, which is known to occur from India and Ceylon to Celebes and Amboina, usually spins its webs with a twig, on which it rests, across the centre.

***Tetragnatha mandibulata*, Walckenaer.**

Common on sedges at the edge of the tank, and on small bushes on the shore of the lake, where it rests by day, coming out to spin its webs at dusk. Recorded from numerous localities extending from Mauritius and the Seychelles to the Sandwich Islands.

***Tetragnatha viridorufa*, sp. nov.**

This is a jungle spider, rather than a frequenter of water. It spins its web among bushes, and spends the day on a leaf besides it, where its bright reddish brown back and legs and green flanks help to render it inconspicuous in spite of its large size.

The ocular quadrangle is practically square—if anything slightly longer than wide and wider in front than behind. The lateral eyes are much nearer to each other than are the medians. The chelicerae are much longer than the cephalothorax and are strongly divaricate. In the female the first tooth on the ventral margin of the fang groove is situated close to the base of the fang and is much stouter than the corresponding tooth on the dorsal margin, which is situated a little further back. The first five dorsal teeth and the first seven ventral extend over about two-thirds of the length of the basal segment, the remaining teeth being crowded into the remaining one-third. The fang is unarmed and almost straight.

In the male there is the usual strong sub-apical dorsal tooth, which is simply curved and pointed. The fang groove teeth are less numerous than in the female, and the first two of the dorsal

row are much larger than any of the others. The fang is armed on the inner side with a very characteristic truncate tooth set in the middle of the basal curve; it is very slightly curved in the middle and somewhat strongly at the tip.

Figures and comparisons with other species are given in another paper now in the press (Gravely, 1921).

***Leucauge decorata* (Blackwall).**

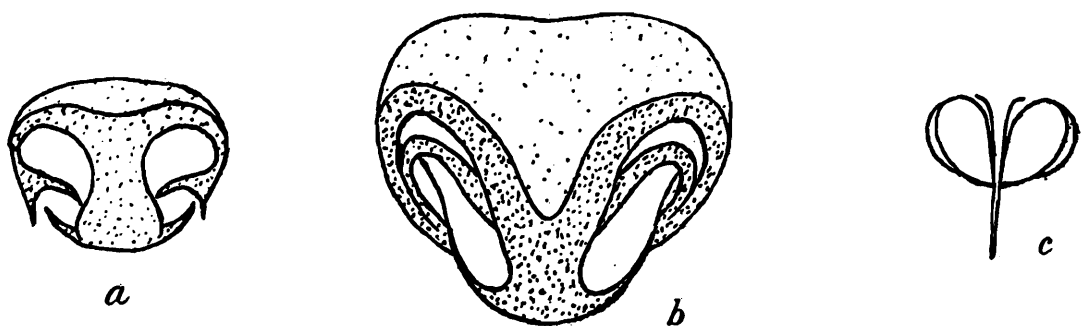
Argyropeira celebesiana, Pocock, 1900, p. 216.¹

A few specimens which probably belonged to this species were once seen on their horizontal webs among bushes.

***Leucauge fastigata* (Simon).**

Argyropeira fastigata, Pocock, 1900, p. 216.

Not uncommon in open spaces in shady jungle, across which the female spins large and more or less horizontal webs. The male



TEXT-FIG. 3.

- a. Vulva of *Argiope anasuja*.
- b. " " " *pulchella*.
- c. " " " *Araneus viridisoma*.

is minute and spins small webs among bushes, where it is very hard to find.

***Argiope anasuja*, Thorell and *A. pulchella*, Thorell.**

Text-fig. 3a, b.

Argiope anasuja, and *A. pulchella*, Pocock, 1900, p. 221-222.

The general shape of the vulva of the female of *A. pulchella* is extremely variable. The thickened margin and partition seem as a rule to approximate more nearly to a T- and less to a Y-shape in the Indian Peninsula than in Burma, but in Bengal the variation is such as to suggest at first sight that *A. anasuja* from India and *A. pulchella* from Burma are no more than local races of one species. They can, however, readily be distinguished

¹ See Simon, 1906, p. 282, for synonymy and an account of the differences between *L. decorata* and *L. celebesiana*; see also Gravely, 1921.

by the internal sclerite, which in *A. pulchella* is very large and situated beside the anterior wall of the aperture, and in *A. anasuja* is smaller and situated beside the posterior wall (see text-figs. 3a, b). The anterior median eyes are, moreover, much more prominent in *A. pulchella* than in *A. anasuja* in the female sex. But I have been unable to find any character by which to distinguish the males. Both species occur on Barkuda Island.

Cyrtophora cicatrosa, Stoliczka.

Araneus cicatrosus, Pocock, 1900, p. 226.

The dome-shaped webs of this spider are very abundant among Prickly Pear. They are frequented by the slender Reduviid bug *Eugubinus reticolus*, hitherto recorded only from Bengal, and also by *E. intrudens*, hitherto only recorded from Cochin. I have nothing to add to my previous record of the habits of these bugs, which appear to live mainly on the eggs of this spider (1915b, pp. 512-3). Single specimens of the larger and still more slender Reduviid *Ischnobaena henrici* have twice been found in the webs. I have not been able to make any definite observations on this association, but it is unlikely, I think, to have been accidental, both on account of the similarity of form between *Ischnobaena* and *Eugubinus* and because both seem equally at ease in the webs. The presence of cast skins, moreover, proved that the specimens had grown up in the webs from an early stage.

The association of a Uloborid and a Theridiid with *C. cicatrosa* has already been referred to above (pp. 405, 410).

Cyclosa insulana, Costa.

Cyclosa albisternis, Simon, 1888, pp. 285-6.

Cyclosa spirifera, Simon, 1889, pp. 337-8.

Cyclosa insulana, Workman, 1896, pl. 36.

This species is represented in the Indian Museum collection from many localities and proves to be extremely variable both in structure and in colour. The young may be brownish, but are frequently of a glistening metallic silver. The silver colouration may be more or less persistent in the adult, in which various shades of ochre, brown or black more or less marbled with fainter tints are, however, more usual.

The sternum is usually dark brown with a transverse yellow band between the first legs, a spot or radial streak of yellow opposite the bases of the second and third legs and a terminal spot or longitudinal streak between the fourth legs (as in types of *C. spirifera*). It may, however, be uniformly black or uniformly white (as in the type of *C. albisternus*) according to the extent and density of the different pigments.

I can find no constant structural difference between *C. albisternus* and *C. spirifera*. The anterior and posterior eyes of the latter do indeed at first sight appear to be more widely separated

from one another than are those of the former ; but this is I believe really due to the ground-colour of the carapace between them being darker in one than in the other.

The shape of the abdomen and the structure of the vulva are also variable. It is perhaps not unlikely that it may ultimately be possible to distinguish local races by means of the latter, whose median piece, though always variable, is inclined in Himalayan specimens to be markedly broader than in plains specimens and even obtusely triangular.

The shape of the abdomen, in spite of its variability in detail, is sufficiently constant to afford as a rule a ready means of distinguishing the present species from other common forms.

Araneus spp. nr. *nauticus*, Koch.

Pl. xix, 1-6.

All spiders of this series of Simon's third group of the genus appear to be more or less nocturnal, coming out to spin their webs at dusk and leaving them empty by day. Males not infrequently wander into houses in the late evening, presumably when searching for mates, and several were captured thus on Barkuda Island. Several immature specimens were found in their webs among bushes in the jungle after dark, but no adult females have yet been obtained. This is particularly unfortunate as the species are distinguished by the form of the vulva and I have been unable to find any certain means of identifying males or immature specimens. The commonest species in the plains seem to be *A. nauticus* and *A. rumphi*, and it is probable that the specimens all belong to one or both of these species.¹

The colouration of this series of spiders varies in a most interesting manner. Different species often appear to be characterized by different tints ; but closer study seems to indicate that these tints are of local or possibly climatic or even seasonal significance rather than truly specific. The pattern according to which the colours are arranged appears to be the same for *A. nauticus* and *A. rumphi* and for several Himalayan and probably other species also ; and the pattern of any one species seems as a rule (though probably not always) to be constant. The extent to which the different pigments are developed, however, may vary enormously, making different specimens of one species look far less like each other than like corresponding varieties of allied species. The majority of specimens in all species, except possibly *A. masoni* which seems always to be dark, are of a marbled greyish or brownish tint. Departures from this normal type are in three main directions: (a) a general reduction of pigmentation,

¹ Two mature females have since been obtained. One at least appears to be *A. rumphi*. Concerning the other I am more doubtful. A careful examination of large series of all species of the group seems to be needed for a full determination of specific characters.

resulting in paler forms, often more or less uniformly whitish; (b) a general increase of pigmentation resulting in darker forms, often more or less uniformly blackish; and (c) a general reduction of pigmentation throughout areas normally pale, combined with a general increase of pigmentation throughout areas normally dark, resulting in a contrast of black and white areas which, though entirely different in appearance to the fundamental pattern, appears in all cases to be based upon it and as a matter of fact to follow it somewhat closely. This variation is illustrated in the case of *A. rumphii* in pl. xix, figs. 1-6, the specimens shown being from various localities.

***Araneus melanocrania*, Thorell.**

Epeira melanocrania, Thorell, 1887, pp. 209-213.

This species is found chiefly among trees and bushes on the shores of the island. It spins a large orb-web in which it sits by night, but spends the day in a little silken retreat which it constructs close by in a curled leaf or some other suitable hiding place. Males were obtained in December.

***Araneus viridisoma*, sp. nov.**

Text-fig. 3c.

A medium-sized delicate-looking green spider, whitish above, which spins orb-webs in the jungle at night. It was very abundant in some places but was only found by searching with a lantern at night. I never saw it by day. In spirit the green colour disappears completely.

♀ Total length up to $7\frac{1}{2}$ mm. Carapace 3 mm. long by 2 mm. broad. This species belongs to Simon's fourth group of the genus, and its eyes bring it nearest to the series typified by *A. origena* from Java, the medians being arranged in a square, the anteriors slightly smaller than the posteriors, and the anterior line so strongly recurved that the medians appear to touch the edge of the clypeus. The abdomen, however, is short and oval instead of being elongate and is without shoulder projections. The lateral eyes are small and contiguous, together scarcely larger than the posterior medians, with which they form an approximately straight line. The legs are finely hairy, and bear a number of long slender blackish spines. The vulva is shown in text-fig. 3c.

♂ The male resembles the female in colour, but is much smaller. Total length about 5 mm., carapace barely 2 mm. long, and almost equally broad. The anterior median eyes are somewhat larger and more widely separated than the posteriors and are very strongly prominent. Laterals as in the female. The legs resemble those of the female, except the second pair in which the tibia bears a row of four or five stout spines on the basal two thirds of the ventral surface and a group of about four similar spines rather more than half way along the inner surface with a subapical

spine beyond them. There is also a ventral subapical spine, but this is little or no stouter than the other spines with which all the legs are armed.

***Araneus excelsus*, Simon.**

Glyptogona excelsa, Simon, 1889, p. 337.

Araneus excelsus, Simon, 1892 a, p. 820.

A common and widely distributed little spider originally described from the Himalayas. It is mostly found in shady glades.

***Gasteracantha hasseltii*, Koch.**

Gasteracantha hasseltii, Pocock, 1900, p. 233.

***Gasteracantha brevispina*, Doleschall.**

Pl. xix, 7-14.

Gasteracantha brevispina, Pocock, 1900, p. 235.

Both the above species of *Gasteracantha* are to be found seated in their orb-webs in the jungle.

The colour varies in the same way as it does in spiders of the *nauticus* group of *Araneus* (see above, p. 414). This is illustrated in pl. xix, figs. 7-14.

***Paraplectana maritata*, Cambridge.**

Paraplectana maritata, Cambridge, 1877, pp. 32-34, pl. vii, figs. 7 a-e.

„ *nigroanalis*, Van Hasselt, 1882, pp. 15-16, pl. i, fig. 3.

„ *maritata*, Thorell, 1895, p. 209.

A minute yellow and black spider with the dorsal surface of the abdomen much flattened.

Family THOMISIDÆ.

Several species occur on Barkuda Island, but there is nothing sufficiently noteworthy for record concerning them, and I am not at present able to identify them.

Family CLUBIONIDÆ.

***Sparassus lamarcki*, Latreille.**

Sparassus lamarcki, Pocock, 1900, p. 267.

A large spider of a somewhat rich brown colour, with densely scopulate tarsi and metatarsi. It lives among foliage, where it makes its lair by spinning loosely together the edges of one or two big leaves. A female was found in the clutches of a fossorial wasp much smaller than itself. Two males were found in the house in August; in neither of them is the black median area on the ventral surface of the abdomen as well developed as in the female, and in one it is practically non-existent. Its identity is,

however, established by the structure of its palps which differ from those of *S. impudicus*, to which, in the absence of this patch, the specimen would appear from Pocock's key (1900, p. 266) to belong.

Sparassus sp.

Two specimens, superficially very like *Palystes flavidus*, with which they were confused in life. Both have the red median band sometimes found on the lower surface of the abdomen of that species developed into a dark and broad reddish brown patch.

Heteropoda sp.

A species of *Heteropoda* is common among stones and dead leaves and on foliage and Prickly Pear. The same species is found in Madras. The male agrees closely with Pocock's brief description of *H. sexpunctata*, Simon, in the "Fauna of British India" series (1900); but the lobes of the vulva of the female, though different from those of *H. venatoria*, are in contact behind, instead of being separated throughout by a hammer-shaped median sclerite.

Palystes flavidus, Simon.

Palystes flavidus, Pocock, 1900, p. 266.

A moderately large Heteropodiform spider common among foliage, where it spins a few leaves loosely together to form its lair. The female is pale green in colour, the male more of a yellowish green with still more yellow legs. The lower surface of the abdomen sometimes bears a more or less broad longitudinal red band behind the genital aperture.

Clubiona spp.

Single specimens of two species apparently belonging to this genus have been found on the island. One, of a pale yellowish colour, was found among foliage. The other, which was much darker and of a browner tint, was dug up from among the underground galleries of a termite nest, round about which were numerous *Damarchus* burrows.

Gen. nov. ? near *Syrisca*.

A smaller and somewhat slenderer spider than the two last, of a moderately dark brownish colour, not uncommon among soil and under bark at the bases of trees. It appears to differ from *Syrisca* in having the posterior median eyes somewhat further from each other than from the posterior laterals instead of somewhat nearer together.

Sphingius sp.

A small spider found with *Corinnomma* and *Oedignatha* among loose soil. The same or a closely allied species occurs at Banga-

lore. In Madras it appears to be replaced by a larger species with transverse bands of whitish hairs on the abdomen, and a somewhat different vulva.

Corinnomma sp.

Two species are not uncommon. Both may readily be mistaken for ants when running about with them among dead leaves on open ground. In the larger species (about 10 mm. long) both sexes run about thus. The smaller species (about 5 mm. long) lives among fine soil and dead leaves at the bases of trees; but its males run about on the surface together with the larger species.

Oedignatha scrobiculata, Thorell.

Pl. xvii, fig. 1.

Oedignatha scrobiculata, Thorell, 1881, p. 209.

„ „ Simon, 1897, p. 14 and 1906, p. 302.

Also known from Ceylon, the Malabar Coast and Penang.

A spider of about the same general size and appearance as the smaller of the two species of *Corinnomma*, and found under the same conditions. It makes a lair for itself, however, by roofing over a small cavity in the ground with soil fastened together with silk, thus making an oval chamber with a tubular aperture directed upwards at each end. The nests are easily seen and can be recognized by the circular lips of the apertures projecting slightly above the surface of the soil (see pl. xvii, fig. 1).

Family LYCOSIDÆ.

Hipassa pantherina, Pocock.

Hipassa pantherina, Pocock, 1900, p. 250.

This is probably the commonest Lycosid on the island. I have already published a note on its habits, under the generic name *Pardosa*, which I have since found to be incorrect (1915 *b*, p. 539). It spins a silken platform with a tube leading back from it into a crevice, usually in a tree or among stones.

? **Lycosa** spp.

The remaining species of Lycosidae probably all belong to the genus *Lycosa*, but it seems impossible to name them without much more extensive work on the Indian species of the genus as a whole than I am yet in a position to undertake. The largest species (probably two in number) live in short holes in the ground, from which they emerge to run about among stones and dead leaves. A much smaller and more delicate looking species runs about among decaying debris on the sandy shores of the lake; and other still smaller species have been found in various open spaces.

Family OXYOPIDAE.

Peucettia viridana (Stoliczka).

Peucettia viridana, Pocock, 1900, pp. 255-6, fig. 86.

A large green Oxyopid, with the abdomen of young specimens and the legs of adults often reddish below, the upper surface of the abdomen ornamented with whitish lines, the legs covered with numerous large black spines.

Its colour and spiny legs make it most inconspicuous on plants bearing glandular hairs, such as *Jatropha gossypifolia*, in whose foliage it most frequently makes its home.

Peucettia and *Oxyopes* spp.

Several other Oxyopids occur among foliage, none of which I am at present able to determine. They are much less common and for the most part much smaller than *P. viridana*.

Family ATTIDAE.

Numbers of Attids, including some of the ant-mimicing species, are common on Barkuda Island; but it is impossible to deal with them satisfactorily without going much more fully into the Indian species generally than is possible in the present paper. One form, however, requires special mention on account of its habits. Its curious appearance makes it easy to identify generically.

Linus sp.

Pl. xiv, fig. 15.

A moderately large jumping-spider of mottled brown colour and normal form, but rendered peculiarly grotesque by projecting tufts of hair on the body and localized fringes on the legs (pl. xiv fig. 15). It lives in crevices of *Ficus* and other trees, from the bark of which it is not easily distinguishable until it moves. It feeds upon the Pholcid, *Smeringopus* sp. (see above, p. 410) into whose untidy webs it walks apparently without any difficulty till within striking distance, when it raises itself slowly on its hind legs and then springs like a flash upon its prey, which by this time is usually swinging rapidly to and fro on its long legs, as Pholcid spiders in common with Phalangids and Tipulid flies habitually do when alarmed.

I once found a young *Linus* in the web of *Cyrtophora cicatrosa*, whose obvious alarm had attracted my attention; but I have never known a *Cyrtophora* to be eaten even by an adult *Linus*. On the first occasion on which I tried the experiment the *Linus* made straight towards the spider into whose web I had introduced it; the *Cyrtophora* became greatly alarmed, rushed madly round inside its dome and eventually escaped. On a subsequent occasion, in another web, the *Cyrtophora* closely watched the move-

ments of the *Linus* and was evidently prepared to defend itself, but neither seemed anxious to take the initiative in a fight. Consequently I had to end the affair by recapturing the *Linus* before anything definite had happened.

Linus makes an irregular cocoon of silk mixed with earth round its eggs, which it hangs among the cobwebs in which it lives. The mother clings to the cocoon till the young are hatched.

The same or a closely allied species occurs in Madras.

LIST OF LITERATURE REFERRED TO.

1859. Doleschall, G. L. "Tweede Bijdrage tot de Kennis der Arachniden van den Indischen Archipel," 60 pp., 17 pl.
1877. Cambridge, O. Pickard. "On some new genera and species of Araneidae." *Ann. Mag. Nat. Hist.* (4) XIX, pp. 26-39, pl. vi, vii.
1880. Cambridge, O. P. "On some new and little known Spiders of the Genus *Argyrodes*, Sim." *Proc. Zool. Soc. London*, 1880, pp. 320-344, pl. xxviii-xxx.
1881. Thorell, T. "Studi sui Ragni Malesi e Papuani III." *Ann. Mus. Civ. Genova* XVII, pp. vii-xxvii and 1-720.
1882. Hasselt, A. W. M. van. "Araneae" in Veth's "Midden-Sumatra IV, Nat. Hist., I Fauna (2) 11A, 56 pp. 5 pl.
1887. Simon, E. "Etude sur les Arachnides de l'Asie méridional faisant partie des collections de l'Indian Museum (Calcutta)." *Journ. Asiatic Soc. Bengal* LVI (ii), pp. 101-116 and 282-287.
- Thorell, T. "Ragni Birmani" I. *Ann. Mus. Civ. Genova* (2) V (XXV), pp. 5-417.
1889. Simon, E. "Etude sur les Arachnides de l'Himalaya recueillis par MM. Oldham et Wood-Mason et faisant partie des collections de l'Indian Museum, 1^{re} Partie." *Journ. Asiatic Soc. Bengal* LXVIII (ii), pp. 334-344.
1891. Walsh, J. H. T. "A new Trapdoor Spider from Orissa," *Journ. Asiatic Soc. Bengal* LIX (ii), pp. 269-270.
1892. Simon, E. (a) "Histoire Naturelle des Araignées," Vol. I, Paris, 1892.
- (b) "Voyage de M. E. Simon en Venezuela; Arachnides." *Ann. Soc. Ent. Fr.* LXI, pp. 423-462, pl. ix.
1893. Simon, E. "Descriptions d'espèces et de genres nouveaux de l'ordre des Araneae." *Ann. Soc. Ent. Fr.* LXII, pp. 299-330.
1895. Thorell, T. "The Spiders of Burma" (London, 1895), 406 pp.
1896. Workman, T. "Malaysian Spiders" (Belfast, 1896), 96 pl.
1897. Simon, E. "Descriptions d'Arachnides Nouveaux." *Ann. Soc. Ent. Belg.* XLI, pp. 8-17.
1900. Pocock, R. I. "Arachnida" in the *Fauna of British India* series, 279 pp., 89 text-figs.

1905. Simon, E. "Voyage de M. Maurice Maindron dans l'Inde Méridional; Arachnides, 1^{re} partie." *Ann. Soc. Ent. Fr.* LXXIV, pp. 160-180, 3 text-figs.
1906. Simon, E. "Voyage de M. Maurice Maindron dans l'Inde Méridional; Arachnides, 2^e partie." *Ann. Soc. Ent. Fr.* LXXV, pp. 279-305, 4 text-figs.
1907. Strand, G. "Süd- und ostasiatische Spinnen." *Gorlitz Abh. natf. Ges.* XXV (1907) pp. 107-215, with 1 pl.
1909. Hirst, S. "On some new or little-known Mygalomorph Spiders from the Oriental Region and Australia." *Rec. Ind. Mus.* III, pp. 383-390, pl. xxiv.
1915. Gravelly, F. H. (a) "Notes on Indian Mygalomorph Spiders." *Rec. Ind. Mus.* XI, pp. 257-287, pl. xv.
(b) "Notes on the Habits of Indian Insects, Myriapods and Arachnids." *Rec. Ind. Mus.* XI, pp. 483-539, 1 text-fig. pl. xxii-xxv.
1919. Sherriffs, W. Rae. "A Contribution to the Study of South Indian Arachnology." *Ann. Mag. Hist. Nat.* (9) IV, pp. 220-252, pl. ii-vi.
1921. Gravelly, F. H. "Some Indian Spiders of the Subfamily Tetragnathinae." *Rec. Ind. Mus.* XXII pp. 423-459, 8 text-figs.

In the press. Annandale, N. "Introduction to the Biology of an Island in the Chilka Lake." *Mem. As. Soc. Beng.* VII, No. 4.

EXPLANATION OF PLATE XVII.

- FIG. 1.—Burrow of *Oedignatha scrobiculata*, from above, showing the two apertures, about twice natural size.
- „ 2.—Web of *Dictyna* sp. (green species) on leaflet of *Glycosmis*, a little before maturity of spider. Natural size.
- „ 3.—Web of *Dictyna* sp. (green species) on leaflet of *Glycosmis*, a little after maturity, with egg-cocoons. Natural size.
- „ 4.—Burrow of *Acanthodon barkudensis* exposed throughout. Reduced.
- „ 5.—Part of Termite mound containing two burrows of *Acanthodon barkudensis* with doors closed. Natural size, but burrows not of maximum size.
- „ 6.—Same with doors open.



1.



4.



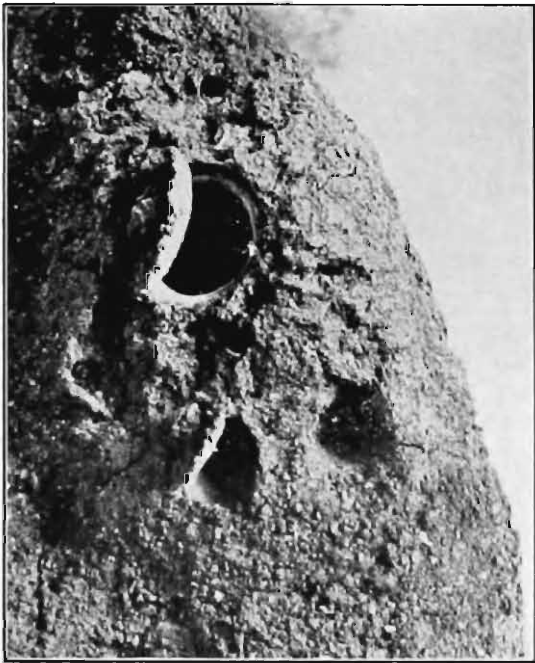
2.



3.



5.



6.

S. C. Mondul and D. Bacchi, photos.

BURROWS AND WEBS OF SPIDERS FROM BARKUDA I.

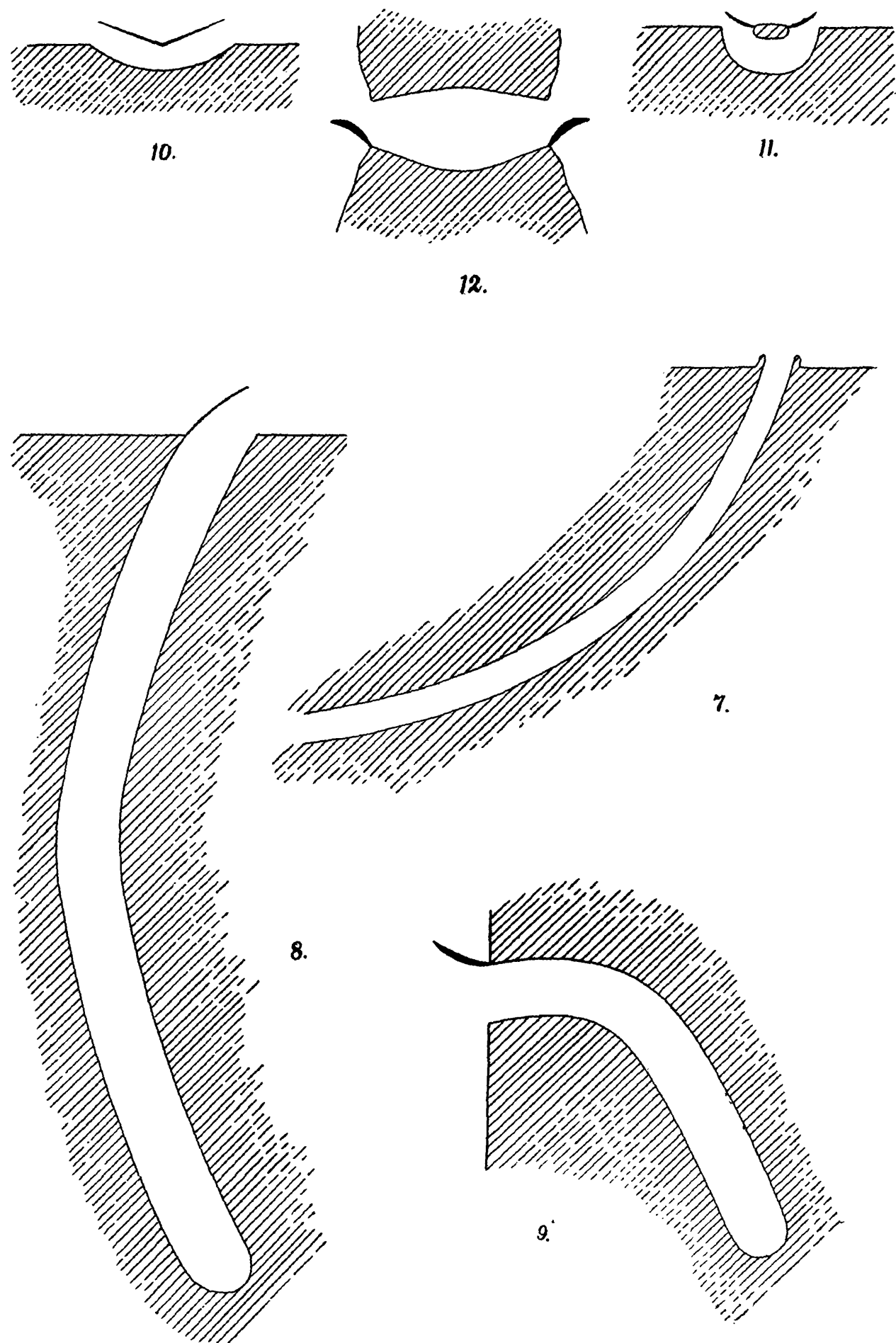
Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921.

EXPLANATION OF PLATE XVIII.

FIG. 7.—Diagrammatic section of burrow of *Damarchus excavatus*.

„ 8.	„	„	„	„	„ <i>Nemesiellus</i> sp.
„ 9.	„	„	„	„	„ <i>Acanthodon barku-</i> <i>densis</i> . ¹
„ 10.	„	„	„	„	„ <i>Sason</i> sp. from Cey- lon.
„ 11.	„	„	„	„	„ <i>Diplothele walshi</i> .
„ 12.	„	„	„	„	„ <i>Sasonichus arthropo-</i> <i>physis</i> .

¹ It is possible that the lower end of the burrow may be less simple than is indicated in this figure. See above, p. 402.



D. Bagchi del.

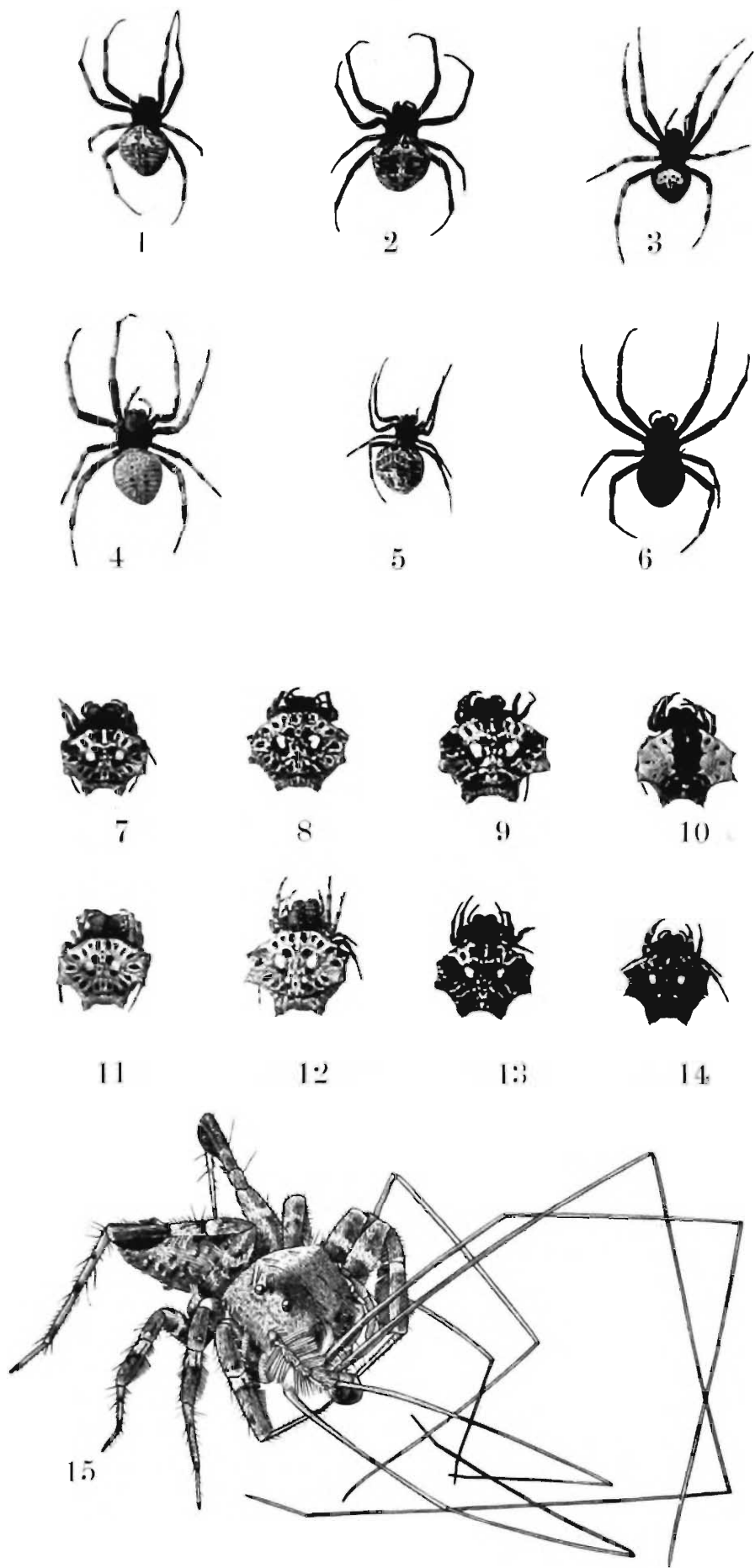
Burrows of Spiders on Barkuda I.

EXPLANATION OF PLATE XIX

FIGS. 1-6.—Colour variation in *Arañeus rumphi*.

„ 7 14.— „ „ „ *Gasteracantha brevispina*.

„ 15.—*Linus* sp. devouring *Smeringopus* sp.



S. C. Mondul, photo. and D. Bagchi, del.

SPIDERS FROM BARKUDA ISLAND.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

XXIV SOME INDIAN SPIDERS OF THE SUB-FAMILY TETRAGNATHINAE.

By F. H. GRAVELY, D.Sc., F.A.S.B., Superintendent, Government
Museum, Madras.

Spiders of the subfamily Tetragnathinae must be familiar to all field naturalists in India especially the curiously elongate species which comprise the large and widely distributed genus *Tetragnatha*, and the handsome silvery species which are among the commonest representatives of the genus *Leucauge* (= *Argyropeira*). Both are moisture-loving genera, most abundant in the rains, and often frequenters of vegetation bordering streams and tanks, among which they spin their circular and generally more or less horizontal webs. *Leucauge* is usually diurnal and sits in its web all day; but *Tetragnatha* is more nocturnal and commonly rests by day with its legs stretched straight out in front of and behind it on a twig, leaf or blade of grass near its web—or sometimes (e.g. *T. gracilis*) on a twig which passes through the centre of the web.

Eleven other genera of the subfamily are recorded from the Oriental Region in Simon's "Historie Naturelle des Araignées," namely *Atelidea*, *Atimiosa*, *Dolichognatha*, *Dyschiriognatha*, *Eucta*, *Meta*, *Mitoscelis*, *Orsinome*, *Pachygnatha*, *Timonoe* and *Tylorida*, and of these all except *Mitoscelis* and *Tylorida* are already known from India, Burma or Ceylon. Only two of them, however, namely *Eucta* and *Orsinome*, can be dealt with in the present paper as the others are not sufficiently represented in the collection before me. This collection belongs to the Zoological Survey of India, except for a few specimens belonging to the Madras Museum and a few belonging to Mr. Srinivasa Rao.¹

Eucta closely resembles *Tetragnatha* in form and lives in similar places, often in company with it. It is distinguished from *Tetragnatha* by having the posterior end of the abdomen produced beyond the spinnerettes into a sort of tail. *Orsinome* closely resembles *Leucauge*, but is less strikingly marked with silver than are the commoner species of that genus, and can be distinguished from all by the absence of *Leucauge*'s characteristic line of hair on the outer side of the femur of the fourth leg. It spins its webs among rocks in the beds of mountain streams, and lets itself down into the torrent below when disturbed, clinging to any rock against which it may be washed and hiding there an inch or two below the surface of the water till it feels safe to return to its native element.

¹ The types of all new species described are in the collection of the Zoological Survey of India, Indian Museum, Calcutta.

Genus *Tetragnatha*, Latreille.

In spite of the strong superficial resemblance that almost all species of this genus bear to one another, especially after the loss of their colour through soaking in spirit they may readily be distinguished by the structure of the chelicerae, and in some cases by the arrangement of the eyes.

In view of the considerable number of species already described by Thorell and others from the Oriental Region and neighbouring islands, and of the wide distribution of some of them, the very high proportion (seven out of ten) of new species in the collection before me is unexpected. All three of the known species represented have a very wide range and so apparently have three of the new ones, this extending from South India or Ceylon to the Eastern Himalayas in one case, the Southern Shan States in another, and Siam in the third. Of the remaining four new species two come from Assam and Burma respectively, localities where Thorell's species would certainly have been expected; and the other two from Southern India.

In view of the ease with which the species can be distinguished and the fullness of Thorell's descriptions I can only conclude that the number of species still awaiting discovery is very large; in which connection it should be remembered that most are unattractive looking spiders of somewhat crepuscular habits and therefore likely to be neglected by any one not specially looking out for them.

Before proceeding to deal with the material before me I propose to summarise as briefly as possible what is known of the species already recorded from or not unlikely to occur in the Oriental Region. For this purpose the species have been arranged in alphabetical order.

Tetragnatha anguilla, Thorell.

Tetragnatha anguilla, Thorell, 1877, pp. 443-445.

From Kandari in Celebes. Lateral eyes almost twice as widely separated as are anterior from posterior medians.

Female. Chelicerae half as long as carapace, with an inwardly directed broad, flattened and moderately strong tooth situated on the inner side much above the fang-groove a little before the middle; first of dorsal eight and ventral seven teeth apical, second dorsal widely separated from first. Fang about half as long as basal joint, unarmed.

Male unknown.

Tetragnatha biseriata, Thorell.

Tetragnatha biseriata, Thorell, 1881, pp. 139-141.

From Amboina. Lateral eyes somewhat nearer together than medians.

Female. Chelicerae about two-thirds as long as carapace, with two small obtuse subapical tubercles. First tooth of both series

situated at base of fang and slightly separated from remaining six. First and second dorsals of equal length, remainder diminishing, second opposite fourth and fifth ventrals. Second ventral larger than first, remainder diminishing. Fang with suggestion only of external tooth near base.

Male unknown.

***Tetragnatha chauliodus* (Thorell).**

Limoxera chauliodus, Thorell, 1890, pp. 292-295.

From Penang and Singapore. Laterals nearer together than medians.

Female. Chelicerae about half as long as carapace; about eight ventral teeth of diminishing size, the second about twice as far from the first as from the third; first of dorsal sixteen teeth moderately large, situated a little behind first ventral, second opposite fifth ventral, size diminishing proximally. Fang armed with small obtuse tooth on outer side of basal bend, and long inwardly and forwardly directed tooth further on below.

Male. Chelicerae about as long as carapace. Subapical spine bifid, with tubercle in front. First of dorsal five teeth a little larger than and situated a little behind first of ventral six; second nearly twice as long, situated far behind it, about opposite fourth ventral; remaining three smaller, diminishing proximally. Fang unarmed.

***Tetragnatha delumbis*, Thorell.**

Tetragnatha delumbis, Thorell, 1891, pp. 39-44.

From Little Nicobar. Laterals somewhat less widely separated than medians.

Female. Chelicerae slender, not much shorter than carapace, armed apically with a long compressed and narrowly acuminate spine, followed on the ventral margin by a diminishing series of about ten teeth of which the first is situated near the base of the fang, the first two are large, and the first four widely separated. First five of nine dorsal teeth large and somewhat widely separated. Fang armed externally with a dorsal tooth, below in middle with two minute granules.

Male unknown.

***Tetragnatha extensa* (Linn.).**

Aranea extensa, Linnaeus, 1761, p. 489.

Tetragnatha extensa, Blackwall, 1864, pp. 367-368, pl. xxvii, figs. 265a-h.

Tetragnatha extensa, Van Hasselt, 1882, p. 27.

A European species stated by Simon (1891, p. 722) to occur in Central and Eastern Asia and also in N. America, and briefly recorded by Van Hasselt from Padang in Sumatra. Lateral eyes not widely separated.

Female. Chelicerae with dorsal and ventral teeth more or less uniform. Fang unarmed.

Male. Chelicerae longer and slenderer than in female, with fine, prominent subapical process inflected at apex, and a short obtuse process likewise situated, penultimate tooth of dorsal surface much larger than rest. Fang unarmed.

***Tetragnatha fallax*, Thorell.**

Tetragnatha rubriventris ♂ nec ♀ Thorell, 1878, pp. 105-108.

Tetragnatha fallax, Thorell, 1881, pp. 134-135.

From Amboina. Lateral eyes equally or somewhat less widely separated than medians.

Female. Chelicerae shorter than carapace. First four of dorsal ten teeth subequal, moderately strong and conico-acuminate, the first situated at base of fang, slightly shorter than second, not much nearer to second than second is to fourth, remainder in diminishing series. First of ventral eight small teeth minute, situated at base of fang, the next two much larger and separated both from it and from each other by a space equal to about twice their own length. Third ventral slightly behind, fourth opposite corresponding dorsals. Fang unarmed.

Male. Chelicerae with first five (or six) of about ten upper teeth and all five ventral teeth long, acuminate and subequally spaced, the first of the latter row smaller than the rest; remaining dorsal teeth in diminishing series; fifth ventral tooth opposite fifth or sixth dorsal.

***Tetragnatha flagellens*, van Hasselt.**

T. flagelens, van Hasselt, 1882, pp. 27-28, pl. iv. fig. 11.

From Sumatra.

Female. Chelicerae about as long as carapace, armed with an acuminate subapical spine; fang-groove with only one row of teeth of which the first is widely separated from the remaining five or six. The fang is unarmed, long, bent as usual near the base, then straight for a distance about equal to the thickness of the basal joint, then bent inwards almost at right angles and straight for about two-thirds of the same distance, then abruptly bent outwards and somewhat wavy, straighter again and finely tapered distally.

Male unknown.

***Tetragnatha geniculata*, Karsch.**

Tetragnatha geniculata, Karsch, 1892, p. 286.

Tetragnatha geniculata, Thorell, 1895, pp. 140-142; 1898, p. 326.

Tetragnatha geniculata, Pocock, 1900, p. 215.

Tetragnatha geniculata, Sherriffs, 1919, p. 231.

From Ceylon, Uran, Poona Ghats, Nilgiris, Madras beach and Tharrawady. Lateral eyes approximate.

Female. Chelicerae somewhat shorter than carapace. Each side of fang-groove with about nine teeth of which the first is rather stout and situated at the base of the fang, widely separated from the second. Fang strongly geniculate, armed with a strong tooth on the outer side of the basal bend and another below, a little further on.

Male unknown.

***Tetragnatha gracilis* (Stoliczka).**

Meta gracilis, Stoliczka, 1869, p. 244, pl. xix, fig. 2.

Tetragnatha ceylonica, Cambridge, 1869, p. 394, pl. xiii, fig. 83.

Tetragnatha latifrons, Thorell, 1877, pp. 434-438; 1878, p. 109; 1881, p. 138.

Tetragnatha gracilis, Thorell, 1889, p. 133; 1890, p. 214; 1895, p. 140; 1898, p. 326.

Tetragnatha fronto, Thorell, 1890, pp. 214-217; 1895, p. 140.

Tetragnatha tridens, Thorell, 1898, pp. 328-330.

Tetragnatha gracilis, Pocock, 1900, pp. 214-215.

Tetragnatha gracilis, Sherriffs, 1919, p. 231.

Tetragnatha gracilis, Gravelly, 1921, p. 411.

From India and Ceylon to Celebes and Amboina. Differing from all other known Oriental species in having the anterior median eyes much nearer together than the posterior medians. The characters in which *T. fronto*, Thorell, differs do not appear to be constant (see below, p. 437) and Thorell's description of *T. tridens* agrees perfectly with the male of the present species.

***Tetragnatha gracillima* (Thorell).**

Limoxera gracillima, Thorell, 1890, pp. 227-230.

From Sumatra. Lateral eyes very slightly nearer together than medians.

Female. Chelicerae less than half as long as carapace. First of dorsal five teeth stouter but not longer than second, remainder diminishing; second widely separated from first, being opposite the fourth of the five ventrals all of which are small, first twice as long as second and narrowly separated from it. Fang scarcely half as long as basal joint, unarmed.

Male unknown.

***Tetragnatha hamata*, Thorell.**

Tetragnatha hamata, Thorell, 1898, pp. 326-328.

From Carennee.

Female unknown.

Male. Chelicerae a little shorter than carapace. Subapical spine acuminate but obliquely truncate and subemarginate at apex, with two strong teeth below and to the outer side of it. The ventral series consists of these two teeth and a diminishing series of about seven more, which commences some distance behind them. The dorsal series commences with two or three small teeth situated obliquely and close to the base of the fang, and very close to each

other, and to a large conical tooth which follows them; separated from these by a considerable distance is a diminishing series of six medium sized teeth.

Tetragnatha hasseltii, Thorell.

Tetragnatha hasseltii, Thorell, 1890, pp. 217-221.

do. var. *birmanica*, Thorell, 1895, pp. 142-143; 1898, p. 326.

? *Tetragnatha hasseltii*, var. *birmanica*,¹ Sheriffs, 1919, p. 231.

Typical form from Celebes, variety from Tharrawady, Bhamo. Lateral eyes nearer together than medians. Abdomen relatively short and stout.

Female. Chelicerae as long as carapace. Dorsal row of ten teeth extending almost throughout their length. First dorsal tooth small and situated a little behind apex, widely separated from large second tooth; second, third and fourth about equal, somewhat widely separated; remainder diminishing. Ventral row somewhat shorter than dorsal, with nine teeth; first long and somewhat sinuous, situated close to base of fang, second a little smaller, situated opposite and somewhat larger than second dorsal, remainder diminishing. Varietal form with teeth on either side of fang-groove smaller than in typical form and less space between the first and second teeth, especially in the ventral row, the second ventral tooth thus being in front of, instead of opposite the second dorsal. Fang unarmed in both forms.

Male known in varietal form only. Chelicerae slenderer than in female. Subapical spine slender and curved. First of dorsal seven teeth stouter than the rest and somewhat curved, nearer to second than are other dorsal teeth to each other. First of about ten ventral teeth small and nearer to second than second is to third. First tooth of both rows situated at base of fang, the dorsal slightly behind the ventral.

Tetragnatha irridescens, Stoliczka.

Tetragnatha irridescens, Stoliczka, 1869, pp. 246-247, pl. xviii, figs. 3-3b.

From the neighbourhood of Calcutta. Relatively short spiders having the general build of *T. hasseltii* and *T. mackenziei*. The two rows of eyes more or less parallel; laterals widely separated. The types of this species, both male and female, are immature as is clearly shown in Stoliczka's figure of the male palpal organ, though his description of it seems to imply maturity. Until mature specimens are obtained from the same locality it will be impossible to define the species.

In the collection before me there are two mature males and one possibly mature female, as well as several immature specimens,

¹ I suspect that the specimens recorded by Sheriffs from the Madras beach are really *T. mackenziei*, a species of similar form described below (p. 438) of which I have specimens from Villivaukam on the outskirts of Madras.

any of which may belong to this species. But as the two males clearly belong to two species it is obviously impossible to identify any of them till the identity of *T. irridescens* is settled.

The genital operculum is little if at all produced backwards between the spiracles, which suggests that these species may not belong to the genus *Tetragnatha* at all; but the material at my disposal does not justify a definite pronouncement on this point.

***Tetragnatha jejuna* (Thorell).**

Limoxera jejuna, Thorell, 1890c, pp. 5-7; 1897, p. 5; 1898, p. 330.

From Malewoon in Burma. Lateral eyes nearer together than medians.

Female unknown.

Male. Chelicerae slender, longer than carapace, with small tubercle at base of bifid subapical spine. First two of dorsal nine teeth large and curved, the second twice as long as the first, situated near together and much higher on the outer side than are the others. Third dorsal tooth small, twice as far from second as second is from first and still further from fourth which is longest, remainder in diminishing series. First of ventral eight teeth stout and long, situated at base of fang; second and third small, situated near third dorsal; remainder smaller, fifth situated opposite third dorsal; first ventral and third dorsal joined by an oblique ridge. Fang long, unarmed.

***Tetragnatha lineata* (Thorell).**

Limoxera lineata, Thorell, 1890, pp. 224-227.

From Tjibodas. Lateral eyes nearer together than medians.

Female. Chelicerae between a third and a half as long as carapace; first of dorsal five moderate-sized teeth scarcely twice as far from second as second is from third; ventral series consisting of only two or three teeth. Fang unarmed.

Male unknown.

***Tetragnatha mandibulata*, Walckenaer.**

Tetragnatha mandibulata, Walckenaer, 1837, p. 211.

Tetragnatha minax, Blackwall, 1877, p. 20, pl. ii, fig. 14.

Tetragnatha minatoria, Simon, 1877, pp. 83-84.

Tetragnatha leptognatha, Thorell, 1877, p. 441; 1878, pp. 109-111; 1881, p. 138.

Tetragnatha minatoria, nec mandibulata, Thorell, 1890, p. 221.

Tetragnatha minax, Simon, 1893, p. 206.

Tetragnatha mandibulata, Thorell, 1895, pp. 139-140; 1898, p. 326.

Tetragnatha mandibulata, Pocock, 1900, p. 215, text-fig. 67.

Tetragnatha mandibulata, Hirst, 1911, pp. 384-385.

Tetragnatha mandibulata, Sherriffs, 1919, p. 231.

Tetragnatha mandibulata, Gravelly, 1921, p. 411.¹

¹ Sherriffs' "*Tetragnatha* sp." in which each mandible has at its junction with the fang a large spine projecting straight in front, being in addition the

Recorded from an area extending from Mauritius and the Seychelles to the Sandwich Islands. Lateral eyes approximate.

Female. Chelicerae very long, with three very large spines close together at the commencement of the ventral row, of which the first extends directly forwards beside the base of the fang, these three teeth followed by about nine others of which the second is the largest and widely separated from those on either side of it. Dorsal row commencing with two moderately large teeth situated close together, the first being at the base of the fang and smaller than the second; the third tooth is situated much further back, about opposite the fourth ventral, the fourth opposite the fifth and the fifth a little behind the sixth; this fifth tooth is the first of a series of about six teeth situated close together making a total of ten teeth in the dorsal row. Fang somewhat as in *T. geniculata* but less strongly geniculate and with the teeth much smaller or almost rudimentary.

Male. Chelicerae very long, with acuminate subapical spine. Dorsal row of about ten teeth commencing with a very large tooth at the base of the fang, closely followed by a much smaller one and then at wider intervals by a diminishing series of about eight, of which the first is somewhat longer but narrower than the one preceding it (i.e. the second of the whole dorsal row). Ventral row of about thirteen teeth commencing with two rather small ones at base of fang, followed after an interval by four larger ones and then by a diminishing series of about seven very small ones. Fang unarmed.

***Tetragnatha marginata* (Thorell).**

Limoxera marginata, Thorell, 1890, pp. 230-232, 1895, p. 146.

From Mt. Singalang in Sumatra and Tonghoo in Burma. Lateral eyes almost as widely separated as medians.

Female. Chelicerae about half as long as carapace. Upper row of five, ventral of four or five teeth, space between first and second teeth of upper row not very great. Fang evenly curved, scarcely half as long as basal joint.

Male unknown.

***Tetragnatha maxillosa*, Thorell.**

Tetragnatha mandibulata, Thorell, 1890, pp. 221-223.

Tetragnatha maxillosa, Thorell, 1895, pp. 139-140, 1898, p. 326.

From Java, Singapore and Moulmein. Closely allied to *T. mandibulata*. Lateral eyes almost as widely separated as medians.

Female. Chelicerae a little shorter than carapace. First of dorsal five teeth long and thick, situated at base of fang, apex pointed and a little curved; second tooth widely separated from it, somewhat longer and slenderer, remainder diminishing both in size and distance from each other. First of ventral nine teeth at

commonest species he knew, must I think be *T. mandibulata*, which leads me to suppose that the species he calls *T. mandibulata* must in reality be something else.

right angles to fang-groove, and situated a little behind first dorsal, intermediate in size between first and second dorsals; following teeth only about half as big, series diminishing proximally. Fang unarmed, about two-thirds as long as basal joint.

Male. Chelicerae slender, with granule in front of subapical spine which is lightly bifid. First tooth of dorsal series moderately large, situated opposite first two ventrals; second about twice as long as first, widely separated both from it and from third, about opposite fifth ventral; remainder in diminishing series. First two of ventral fourteen teeth moderately small, situated close together, the smaller a little above and in front of the larger, widely separated from the remaining teeth (about twelve) which are rather small and close together.

***Tetragnatha modesta*, Hirst.**

Tetragnatha modesta, Hirst, 1911, p. 385, text-fig. 2.

From Silhouette and Mahè in the Seychelles. Space separating lateral eyes greater than diameter of posterior laterals.

Female closely allied to *T. geniculata*, but fang not geniculate and with both teeth situated nearer the base. Male unknown.

***Tetragnatha nepaeformis*, Doleschall.**

Tetragnatha nepaeformis, Doleschall, 1859, p. 46, pl. xvi, figs. 1-1b.

From Buitenzorg. Lateral eyes somewhat nearer to each other than are medians.

Female. Chelicerae with teeth on margin of fang-groove small; fang unarmed.

***Tetragnatha parvula*, Thorell.**

Tetragnatha parvula, Thorell, 1891, pp. 41-44.

From Kamorta. Lateral eyes nearer together than medians.

Female. Chelicerae half as long as carapace. First tooth of both series large and situated not much behind base of fang. Ventral teeth about nine in diminishing series, dorsal teeth fewer, first and second equal, nearly twice as far apart as second and third, remainder in diminishing series. Fang short, unarmed.

Male. Chelicerae little shorter than carapace, slender, with curved subapical spine, stout at base, equally bifid distally. First of eight dorsal teeth stout and long, further from still longer second tooth than from base of fang; second dorsal opposite fifth ventral, twice as long as third but nearer to it than to first; remainder in diminishing series. First of ventral nine teeth stout and situated below remainder a little behind base of fang, a little in front of first dorsal, twice as far from second as remainder are from one another. Fang shorter than basal joint, slender, unarmed.

***Tetragnatha puella*, Thorell.**

Tetragnatha puella, Thorell, 1895, pp. 143-146.

From Tharrawady. Lateral eyes about as widely separated as medians; abdomen unusually short, in female narrowly ovate, in male cylindrical.

Female. Chelicerae half as long as carapace; fang-groove armed on each side with five or six teeth in descending series. Fang about half as long as basal joint, unarmed.

Male. Chelicerae not much shorter than carapace. Subapical spine strong, curved and simply pointed, with a small obtuse tooth a little in front of and above it at base. First of dorsal seven teeth moderately large, situated at base of fang, and widely separated from second which is small and situated opposite the third or fourth ventral, third dorsal slightly larger than second and more widely separated from it than from fourth; remainder in diminishing series. First of ventral six teeth large and stout, armed with a minute denticle on its front margin, situated well below but not much behind base of fang; remaining five of medium size, subequally spaced and situated more on the inner side of the joint. Fang a little shorter than basal joint; armed with a small external tooth at base, raised into an obsolete tubercle on inner side between middle and base.

***Tetragnatha pulchella*, Thorell.**

Tetragnatha pulchella, Thorell, 1877, pp. 438-441; 1890, p. 217.

From Celebes and Sumatra. Lateral eyes nearer together than medians.

Female. Chelicerae about three quarters as long as carapace. First three of dorsal ten teeth widely separated. First tooth of ventral seven situated well back from apex, half way between first two dorsals, the next two between the second and third dorsals. Fang long, unarmed.

Male. Chelicerae as long as carapace, with acuminate and slightly curved subapical spine; eight dorsal and seven ventral teeth, of which the first dorsal is the largest. Fang rather short, with an obtuse tooth or tubercle on inner side near base.

***Tetragnatha rubriventris*, Doleschall.**

Tetragnatha rubriventris, Doleschall, 1857, p. 410.

Tetragnatha lupata, Koch, 1872, pp. 170 and 178, pl. xv, figs. 2-2c.

Tetragnatha rubriventris ♀, nec ♂, Thorell, 1878, pp. 105-108.

Tetragnatha rubriventris, Thorell, 1881, pp. 131-134.

From Amboina. Lateral eyes more widely separated than are medians.

Female. Chelicerae as long as carapace or nearly so. First of dorsal eleven or twelve teeth very long and thick, situated

about half its own length from base of fang; second dorsal about half as long as first and twice as far from first as from third; space between third and fourth nearly as great as between second and third, and about twice that separating remaining diminishing series. First of ventral twelve or thirteen teeth situated not far from base of fang, much shorter than first dorsal but much stouter than four following ventrals, which are subequal; space separating first and second ventrals about twice as great as the two following spaces; remainder in diminishing series. Third ventral situated slightly behind second dorsal. Fang shorter than basal joint, unarmed.

Male. Chelicerae longer than carapace, with inwardly curved and simply pointed subapical spine. At base of fang on inner side above, a strong acuminate tooth at right angles to chelicerae above and a little in front of first dorsal and of about equal size with it; behind this another tooth about twice as large, strongly curved forwards, above and a little behind second dorsal. First six (about) of dorsal ten teeth about equal in size and spacing, except that the first two are somewhat nearer together than the rest; posterior teeth in diminishing series. First of ventral diminishing series of six teeth as large as and situated slightly in front of first dorsal; space between first and second about half as great as subequal spaces between second and fifth; space between fifth and sixth much less. Second ventral situated between second and third dorsals. Fang unarmed.

Tetragnatha serra, Doleschall.

Tetragnatha serra, Doleschall, 1857, p. 409; 1859, pl. viii, fig. 5.

Tetragnatha serra, Thorell, 1878, pp. 111-115, 1881, p. 139.

From Amboina. Lateral eyes much closer together than medians.

Female. Chelicerae about as long as carapace, with a low obtuse tubercle on inner side near base below; a small tooth at its base on outer side; a subcylindrical, abruptly acuminate and subobtuse tooth at its apex on lower side. First of dorsal nine teeth strong and subsinuate, situated at base of fang. Second dorsal not much longer and scarcely stouter than first, twice as long as third, between twice and three times as far from first as from third; third nearly twice as far from second as from fourth, and opposite fifth or sixth ventrals. First six of ventral twelve teeth of about equal size and almost equally spaced, the remainder in diminishing series. Fang much as in *T. geniculata*.

Male. Chelicerae more slender than in female, with long strongly curved and simply acuminate dorsal subapical spine, also a small subapical ventral tooth, situated in front of the ventral series. First of nine dorsal teeth moderately long, slightly sinuate, directed forwards and inwards; second slightly longer but less strong than first and scarcely half as far from it as from third, though further than third is from fourth; remainder in diminishing series. First

of thirteen ventral teeth opposite and about equal to first dorsal; next four or five less than half as large as, and about as far from, first as from each other; remainder in diminishing series; seventh ventral about opposite third dorsal. Fang unarmed.

***Tetragnatha tonkina*, Simon.**

Tetragnatha tonkina, Simon, 1909, p. 102.

From Phu-lang'-Thuong.

Female unknown.

Male. Chelicerae shorter than carapace, with curved, slender and acutely pointed subapical spine. First dorsal tooth shorter but broader at base than subapical spine, curved and subacute distally; second dorsal long, straight and acute, situated a little in front of the middle and followed by four small teeth in the basal half. First ventral tooth moderately strong, perpendicular and lightly sinuate, the remaining five or six small, the first of them isolated, the rest crowded.

***Tetragnatha trichodes*, Thorell.**

Tetragnatha trichodes, Thorell, 1878, pp. 115-118; 1881, p. 141.

Limoxera trichodes, Thorell, 1890, p. 224.

From Amboina. Lateral eyes nearer together than are medians.

Female. Chelicerae three-fifths as long as carapace, with a small tooth near base of fang below. Teeth of fang-groove subequal in size, dorsal about seven and ventral about eight in number. First four dorsals larger than rest, the first a little shorter but stronger than the second, situated at base of fang and about four times as far from second as second is from third. First ventral about twice its own length from base of fang, much farther than from second tooth which is still nearer the smaller third; remainder minute and crowded; second dorsal opposite third ventral. Fang unarmed.

Male. Chelicerae with stout and strongly curved acuminate and unequally bifid subapical spine, with a small tooth between it and the apex almost opposite the first tooth of the dorsal series which, like that of the ventral series, is situated not far from the base of the fang. Dorsal teeth six to eight in number, ventral five to nine. First dorsal tooth small, second longest of all and nearly three times as far from first as from third; remainder in diminishing series. First and second ventrals moderately large and twice as far apart as are the smaller and diminishing remainder. Second dorsal opposite third ventral. Fang unarmed.

***Tetragnatha viridorufa*, Gravely.**

Tetragnatha viridorufa, Gravely, 1921, p. 411.

From Barkuda Island in the Chilka Lake. Lateral eyes approximate.

Female. Chelicerae very long and widely divergent in both sexes. First tooth of ventral row much the largest, two or three times as large as first tooth of dorsal row, which is not situated so close to the base of the fang; a semicircular depression between them. The second tooth of both rows very small, followed at rather long intervals by about five others of increasing size to near the base from where the remaining seven decrease in size and are more crowded. Fang unarmed.

Male. Subapical spine long and slender. First tooth of dorsal row slightly shorter and stouter than subapical spine; the second much smaller, the third smaller than the fourth; the first five widely spaced, the last six close together at the base. Ventral row of about eight spines shorter than dorsal, the third and the last two much smaller than rest. Fang with strong truncate tubercle on inner side of bend just above base.

The above diagnoses were drawn up in the first instance from published descriptions for my own convenience in dealing with the material before me. They have when possible and desirable been modified in the light of this material and have been placed on record here as a guide to others working on the group.

The species which I have myself been able to examine may be distinguished as follows:—

1	{	Ocular quadrangle very much narrower in front than behind (fig. 1a) ...	<i>T gracilis</i> , p. 436.
		Ocular quadrangle little or no narrower in front than behind ...	2.
	{	Lateral eyes somewhat more widely separated than medians (fig. 1g.) ¹ ...	3.
2		Lateral eyes not more widely separated than medians, usually more or less closely approximate or contiguous (fig. 1d) ...	4.
3	{	Abdomen much less slender than is usual in the genus, only about four times as long as broad, with more or less rounded sides; anterior and posterior rows of eyes slightly recurved, anterior laterals minute (fig. 1g) ...	<i>T mackenziei</i> , p. 438.
		Abdomen slender, parallel-sided; anterior and posterior rows of eyes strongly recurved, anterior laterals small ...	<i>T. moulmeinensis</i> , p. 439.
4	{	Females ...	5.
		Males ...	11.
5	{	Fang with a more or less distinct tooth situated ventrally on outer side of basal bend (figs. 2a, b and d) ...	6.
		Fang without any tooth in this position ...	8.
6	{	Fang unarmed except for above-mentioned tooth; first two teeth of ventral row situated at base of fang and not markedly larger than others (fig. 3a) ...	<i>T. fletcheri</i> , p. 440.
		Fang armed on inner side with a strong tooth about a third of the way from base to tip (fig. 3b) or first ventral tooth (or teeth) very large (figs. 3c-d) ...	7.

¹ *T. irridescens*, Stoliczka, belongs to this group if it is a true *Tetragnatha*, but its full characters have not been determined (see above, p. 428).

7	{	First ventral tooth small like others, directed inwards; fang strongly geniculate with teeth very well developed ...	<i>T geniculata</i> , p. 441.
		First ventral tooth very large, directed forwards below fang which is slightly geniculate with fully developed teeth ...	<i>T mandibulata</i> , p. 441.
8	{	Fang much swollen towards the middle, where it is armed dorsally with a stout and more or less rectangular tooth (fig. 4a); abdomen very slender ...	<i>T cochinensis</i> , p. 442.
		Fang unarmed; abdomen stouter ...	9.
9	{	Fang very stout in the basal half, then very slender; first dorsal tooth broad and obliquely truncate (fig. 4c) ...	<i>T listeri</i> , p. 443.
		Fang more evenly tapering; first dorsal tooth acuminate ...	10.
10	{	Chelicerae stout, first two ventral teeth very large, first two dorsals very small (fig. 5a) ...	<i>T sutherlandi</i> , p. 444.
		Chelicerae very long and slender; first tooth of both dorsal and ventral rows much larger than second (fig. 6a) ...	<i>T viridorufa</i> , p. 445.
11	{	First dorsal tooth triangular, wide at base, simply pointed at apex, much larger than any other tooth of either dorsal or ventral row no tooth on inner side of basal curve of fang (fig. 3e) ...	<i>T geniculata</i> , p. 441.
		First dorsal tooth not the largest; or a strong tooth on inner side of basal curve of fang ...	<i>T mandibulata</i> , p. 441.
12	{	First dorsal tooth not larger than second, sometimes much smaller; at most a rounded swelling on inner side of basal curve of fang (figs. 4b and d) ...	13.
		First dorsal tooth much larger than second; a strong tooth, truncate distally, present on inner side of basal curve of fang (figs. 5b and 6b) ...	14.
13	{	First dorsal tooth much smaller than second; subapical spine very slender distally, truncate at apex (fig. 4b) ...	<i>T cochinensis</i> , p. 442.
		First dorsal tooth about equal in size to second; subapical spine broader distally, more or less bifid at apex (fig. 4d) ...	<i>T listeri</i> , p. 443.
14	{	Subapical spine short and stout; first dorsal tooth acuminate, slightly smaller than second ventral (fig. 5b) ...	<i>T. sutherlandi</i> , p. 444.
		Subapical spine long and slender, first dorsal tooth almost equally long, but stouter; second ventral tooth small (fig. 6b) ...	<i>T. viridorufa</i> , p. 445.

Tetragnatha gracilis (Stoliczka)

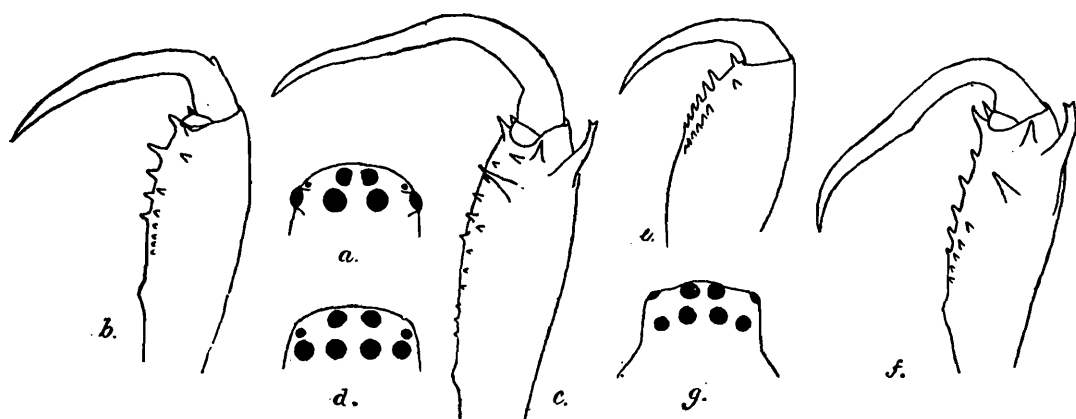
Figs. 1a-c.

Localities.—Parambikulam, 1700–3200 ft., Cochin State; Bangalore, ca. 3000 ft., S. India; Taloshi, ca. 2000 ft., Koyna Valley, Satara District, Bombay Presidency; Bandipur, ca. 3000 ft., Mysore; Villivaukam, Chingleput Dist. and Barkuda Island, Chilka Lake, Ganjam Dist., Madras Presidency; Bhubaneswar, Puri Dist., Orissa; Port Canning, Calcutta and Madhupur, Bengal; Pusa, Bihar; Kalimpong, 2000–4500 ft., Darjiling District.

This species differs from most in that it commonly (but not

invariably) spins its web on either side of a twig, which thus comes to extend across one diameter of it, and uses the part of the twig that crosses the centre of the web as its resting place.

It differs from all other oriental species of the genus in having the anterior median eyes much smaller and closer together than the posterior medians; and in the female the chelicerae do not become very prominent even in adult specimens. The posterior lateral eyes are very prominent, and the anterior laterals very small. In the female the dorsal margin of the fang-groove bears a row of about eight teeth in descending order of magnitude, of which the first is situated at the base of the fang, the second is situated some distance behind it and at a greater distance from the ventral margin, the third somewhat further from the second than the second is from the first, but nearer to the ventral margin than is the second, the rest being somewhat close



TEXT FIG. 1.

- a.—*Tetragnatha gracilis* ♀ eyes from above.
 b.—" " ♀ chelicera from above.
 c.—" " ♂ " " " " " "
 d.—*Tetragnatha mandibulata* ♀ " eyes from above.
 e.—*Tetragnatha mackenziei* ♀ chelicera from above.
 f.—" " ♂ " " " " "
 g.—" " ♀ eyes from above.

together. The ventral margin bears about six teeth, of which the second is situated further from the first than from the third and is commonly the largest. Above the first tooth there is usually a smaller tooth, likewise situated at the base of the fang; and the fang itself usually bears a distinct tooth on the outer side just above the base. Either or both of these last mentioned two teeth may, however, be absent; and the former of them may be larger than the first tooth of the ventral series, especially when the tooth on the fang is absent. It is to this form that Thorell has applied the name *fronto*. In view of the variability of these teeth, however, I think that *fronto* should be merged in *gracilis*. The fang is somewhat short and thick, abruptly curved close to the base, then lightly curved, not geniculate.

The chelicerae of the male are much longer and slenderer than are those of the female. The subapical spine is long and

slender, lightly curved, and imperfectly bifid distally; below and in front of it is a smaller conical spine directed forwards, and below this again and slightly behind it, about opposite the base of the subapical spine, is the first of the dorsal row of about seven small teeth, arranged in descending series with a very long gap between the first and second. Above the middle of this gap is a pointed inwardly directed spine somewhat variable in length but always well developed and, when large, often slightly geniculate. The ventral margin of the fang-groove bears a pair of teeth at the base of the fang, of which the second is the longest, followed after a short interval by a somewhat uniform series of about six teeth, all small, the middle of the interval being about opposite the first dorsal tooth.

***Tetragnatha mackenziei*, sp. nov.**

Figs. 1e-g.

Localities.—Kulattupuzha, W base of W Ghats, Travancore; Mahabaleshwar, 4200 ft., Satara Dist.; Seringapatam, *ca.* 2500 ft. and Bangalore, *ca.* 3000 ft., Mysore, Villivaukam, Chingleput Dist.; Barkul, Orissa; Pachmarhi, 3300–3500 ft. and Hoshangabad, Central Provinces; Siripur, Saran, Bihar; Calcutta; edge of Inlé Lake, Fort Stedman, Yawngkhwe State, S. Shan States. Type (female) from Salt Lakes near Calcutta.

Total length up to about 9 mm. (chelicerae excluded); length of carapace about 3 mm., maximum width of same fully 2 mm. in female, barely 2 mm. in male. The carapace and legs are yellowish, the abdomen greyish. The carapace is moderately narrow and almost parallel-sided in front, broadly rounded further back, relatively longer and narrower in the male than in the female. The abdomen is comparatively stout, as in *T. puella*, and much shorter and more rounded than is usual in the genus, being scarcely more than four times as long as it is thick.

The ocular quadrangle is practically square, but the posterior medians are separated by a very slightly wider space than the anterior medians, and are fully one and a half times as far from the anterior laterals as from each other. The anterior laterals are very small, and about equidistant from the anterior medians and posterior laterals, which latter are somewhat nearer to the posterior medians than these are to each other.

The chelicerae of the female are short and stout, between two and three times as long as they are thick and about two-thirds as long as the carapace. There are about seven teeth in each row, the first in each (occasionally the first two ventrals) somewhat widely separated from the rest, which are in diminishing series. First dorsal larger than second, situated behind base of fang. First ventral smaller than second, situated at base of fang. Second dorsal about opposite fourth ventral. Fang short and stout, unarmed.

The chelicerae of the male are much longer than those of the female and nearly as long as the carapace. The subapical spine is

broad at base, slender and slightly bifid distally. A stout conical tooth is situated just below its base and another some distance further back, much as in *T gracilis* but of more nearly equal size. The dorsal series of teeth contains about five only, all minute, situated much further back, the first of them being about opposite the fifth and sixth ventrals. The first two ventrals are situated close together at the base of the fang, the second larger than the first and nearly as large as the two large conical teeth on the dorsal surface; the remaining five are subequal, both in size and spacing, except the last one or two which are smaller than the rest but little if any closer.

It is possible that this may prove to be only a subspecies of *T puella* from Tharrawady, from which it is distinguished chiefly by having a bifid subapical spine in the male instead of an acuminate one. The only Burmese specimen I have seen is a female; but its eyes are as shown in fig. 19 with the laterals much more widely separated than the medians instead of equally so.

Tetragnatha moulmeinensis, sp. nov.

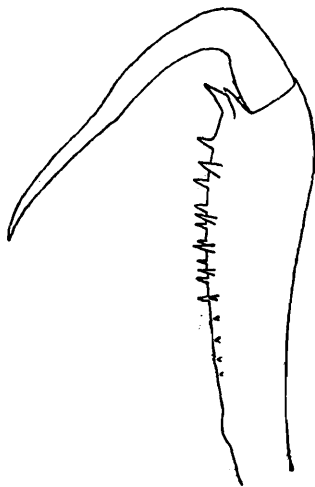
Fig. 2.

Locality.—Moulmein, a single female.

Much longer and slenderer than *T mackenziei*, with long divaricate chelicerae. Total length about 12 mm., carapace about 3 mm.

The carapace is more strongly rounded in front than in *T mackenziei*, and the two rows of eyes are more strongly curved in consequence. The ocular quadrangle is slightly wider in front than behind and slightly longer than wide. The posterior eyes are of about equal size and about equally distant (a little more than a diameter) from each other. The anterior eyes are widely separated from them, the small laterals even more so than the large medians.

The chelicerae are about as long as the carapace, with a minute denticle on a low obtuse swelling on the outer side below. The first dorsal tooth is slightly smaller than the first ventral; both these teeth are situated at the base of the fang and are followed after an interval, which is longer in the dorsal row than in the ventral, by other teeth in descending series, those of the dorsal row being larger than those of the ventral and also extending further back. The fang is simple and unarmed.



TEXT-FIG. 2.

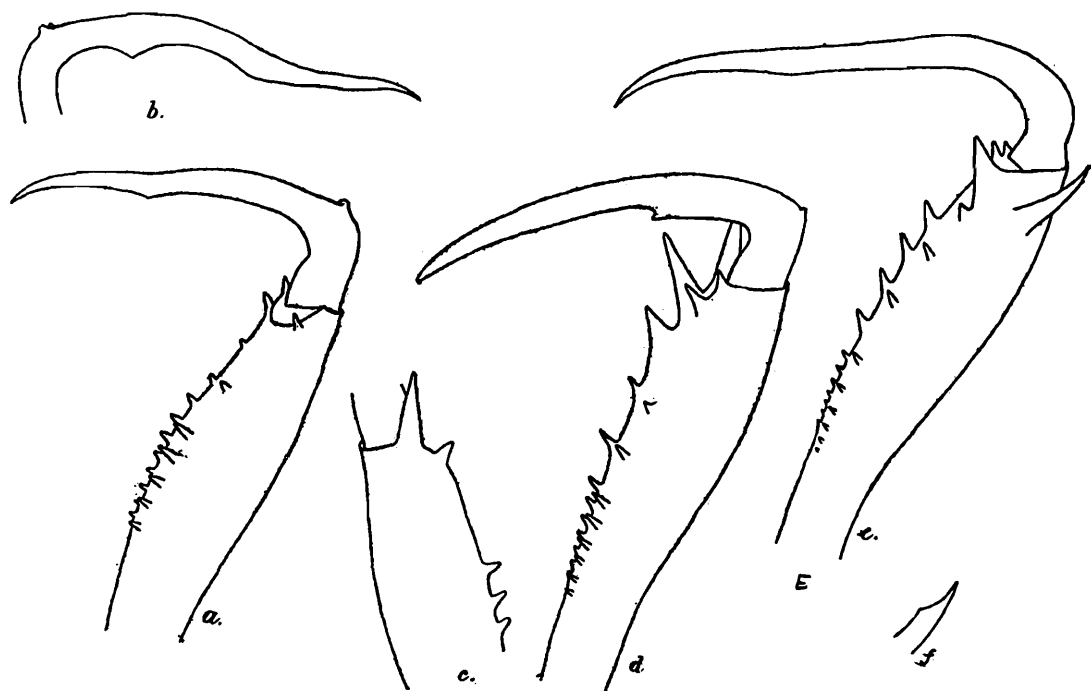
Tetragnatha moulmeinensis ♀
chelicera from above.

This species seems to be closely related to *T hasseltii*, Thorell, whose chelicerae appear to be somewhat variable, but is distinguished from it by having the lateral eyes more instead of less widely separated than the medians and by its longer and more slender abdomen.

***Tetragnatha fletcheri*, sp. nov.**

Fig. 3a.

Locality.—Shillong. Four females collected by Mr. T. Bainbrigg Fletcher and Mr. R. Senior White. Maximum length 11 mm., carapace $3\frac{1}{2}$ mm.



TEXT-FIG. 3.

- a.—*Tetragnatha fletcheri* ♀, chelicera from above.
 b.—*Tetragnatha geniculata* ♀, fang seen obliquely from in front below.
 c.—*Tetragnatha mandibulata* var. *bidentata* ♀, anterior ventral teeth of fang-groove.
 d.—*Tetragnatha mandibulata*, s. str. ♀, chelicera from above.
 e.—*Tetragnatha mandibulata*, s. str. ♂, chelicera from above.
 f.—*Tetragnatha mandibulata* var. *bidentata* ♂, subapical spine.

The anterior and posterior rows of eyes are very slightly recurved and as a rule approximately parallel, but the laterals appear almost contiguous in some specimens. The anterior laterals are somewhat smaller than the rest, the anterior medians may be slightly smaller than the posterior medians. The ocular quadrangle is very slightly narrower in front than behind and about as long as it is wide behind.

The chelicerae are nearly as long as the carapace and strongly divaricate. None of the teeth are very large. The first dorsal is situated near the base of the fang; the second is smaller than the first and situated about twice as far from the first as from

the third, which is about equal to the first, situated a little in front of the middle of the joint, and followed by a diminishing series of four other moderately large teeth. The first two ventral teeth are situated at the base of the fang, the first of them being directed forwards at the side of it; they are about equal in size to the first dorsal, the second slightly larger than the first. The third is very small, and situated about half way to the fourth which is about opposite or slightly further back than the second dorsal. The fourth is larger than the third and is somewhat closely followed by the remaining eight, of which the first three or four are larger than it is, though smaller than the dorsals opposite them; the rest in descending series.

Tetragnatha geniculata, Karsch.

Fig. 3*b*.

Localities.—Peradeniya, Ceylon; Coonoor, *ca.* 5700–6000 ft. and Coonoor Ghat, *ca.* 5500 ft., Nilgiris; Mahabaleshwar, *ca.* 4200 ft., Satara District, Bombay Presidency; Sanjai River, Chakadharpur, Chota Nagpur; Pegu, Burma.

This species, though widely distributed, does not appear to be very common. It is now nearly thirty years since the female was first described, but the male has still to be discovered.¹

The general build of the female is very slender and the chelicerae are strongly divaricate. The dentition somewhat resembles that of *T. viridorufa* (fig. 6*a*). None of the teeth are specially long; the first tooth of both rows is situated at the base of the fang, and is much more widely separated from the second than are the remaining teeth from each other, especially on the dorsal side, the second dorsal being about opposite the fourth ventral. The nine dorsal teeth are larger and more widely spaced than the more numerous ventrals. Both rows extend nearly to the base of the joint. The fang is strongly geniculate with a stout tooth, often double, on the outer side of the basal bend, and another on the inner side a little further on (fig. 3*b*).

Tetragnatha mandibulata, Walckenaer.

Figs. 1*d*; 3*d*, *e*.

Localities.—

Typical form.—Nuwara Eliya, Ceylon; Ernakulam and Chalakudi, Cochin State; Bangalore, Mysore; Ootacamund, 6700–8000

¹ I have since obtained a male from Coonoor. It is hardly distinguishable from that of *T. mandibulata* except for its greyish instead of reddish yellow general colour and its almost black sternum. These differences may, however, be due to the short time that the male of *T. geniculata* has yet been in spirit, or may prove to be variable even if real. The only structural difference that I can find is that the teeth on the mandibles are slightly more numerous (one or two more in each row) and therefore set somewhat closer together in *T. geniculata* than in *T. mandibulata*; but the material now before me does not admit of any certainty that even this character is really constant.

ft., Coonoor, 5700–6000 ft. and Coonoor Ghat, *ca.* 5500 ft., Nilgiris Villivaukam and Chingleput; Chingleput District, south end of Chilka Lake, Rambha, and Barkuda Island, Chilka Lake, Ganjam District of Madras; Barkul, Chilka Lake, Puri District of Orissa; pass between Chaibassa and Chakardharpur, Singbhum District and Purulia, Manbhum District, Chota Nagpur; Gmatia, Birbhumi District, Calcutta (including Salt Lakes area), Port Canning and Barisal in Bengal, Siripur, Saran and Kierpur, Purneah District, Bihar; Bijaura, Nepal Terai, Singla, 1500 ft., and Kalimpong, Darjiling District, Tezpur, Selai Kusi in Darrang District and Sibsagar, Assam; Than-taung, Yawnghwe State, S. Shan States, Lampam, Patalung, Siam

Var. *bidentata* (figs. 3c, f.)—Mauritius; Medha, Yenna Valley, Satara District; Datar Hill nr. Junagadh, Kathiawar; Nagpur, Pachmarhi, 3500 ft., and Hoshangabad, Central Provinces; Singla, 1500 ft., and Kurseong, 3200–4700 ft., Darjiling District; opening of gorge of Heho River, *ca.* 3000 ft., Yawnghwe State, S. Shan States.

This species is nocturnal, spinning large orb-webs at sundown among grasses and other foliage, usually beside a stream or tank, and resting by day with its legs stretched out before and behind on a blade of grass or a twig. It is readily distinguishable from others by the forwardly directed first ventral tooth of the female and by the large triangular first dorsal tooth of the male. The armature of the fang is never very strong and may be rudimentary or absent; apart from this it bears a close general resemblance to that of *T. geniculata*.

Two very distinct forms occur, the typical one and a variety which is described below under the name *bidentata*. For the most part these varieties seem to occur in different localities; but both are recorded from the Darjiling District and Southern Shan States.

T. mandibulata, s. str.—The first three ventral teeth of the female are very large and are followed without any long interval by a number of smaller ones. The subapical spine of the male is acuminate and simply pointed.

Var. *bidentata*, nov.—The first ventral tooth of the female is much the largest; it is closely followed by the second, after which there is a long interval without any teeth. The subapical spine of the male is obliquely truncate.

Tetragnatha cochinensis, sp. nov.

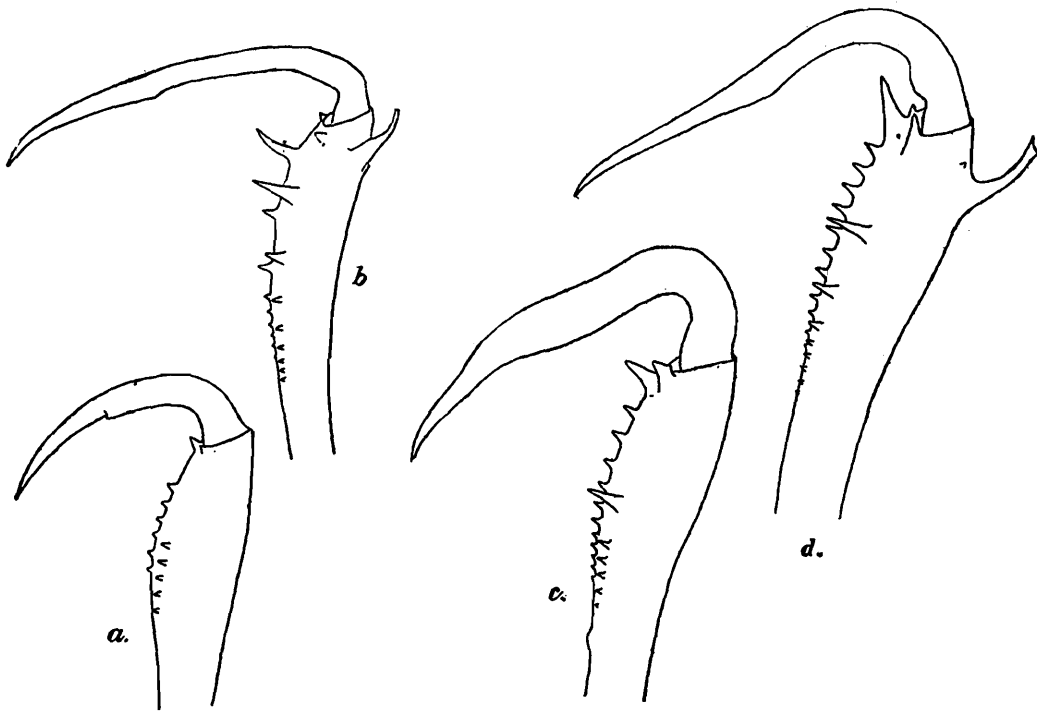
Figs. 4a, b.

Localities.—Parambikulam, 1700–3200 ft., Trichur, Chalakudi and Ernakulam, Cochin State; Bangalore, Mysore, Coonoor, 5700–6000 ft., Nilgiris. Types (male and female) from Parambikulam.

A very slender species. Total length about 11 mm.; carapace about 2 mm. long, less than 1 mm. wide. The anterior margin of

the carapace and two rows of eyes are somewhat strongly recurved. The ocular quadrangle is practically square; the anterior laterals are small and are situated very near to the posterior laterals.

The chelicerae of the female are slender, but are rather small and not very strongly divaricate. All the teeth are small and the first of each row is situated at the base of the fang with the second far behind, especially dorsally, as in *T. geniculata*. The second dorsal is opposite the fifth or sixth ventral. The fang of the female is somewhat geniculate, much swollen about the middle, where it bears dorsally a stout and more or less rectangular tooth. The chelicerae of the male are longer and more strongly divaricate than are those of the female. The subapical spine is



TEXT-FIG. 4.

a.—	<i>Tetragnatha cochinensis</i>	♀,	chelicera	from	above.
b.—	"	♂,	"	"	"
c.—	<i>Tetragnatha listeri</i>	♀,	"	"	"
d.—	"	♂,	"	"	"

very slender distally, with truncate apex. The first dorsal tooth is larger than the first ventral, which is minute; the latter is situated at, and the former slightly behind, the base of the fang. The second tooth of each row is much the largest, the ventral anterior to the dorsal. The remaining teeth of both rows are arranged in descending series. The fang is slender and unarmed.

***Tetragnatha listeri*, sp. nov.**

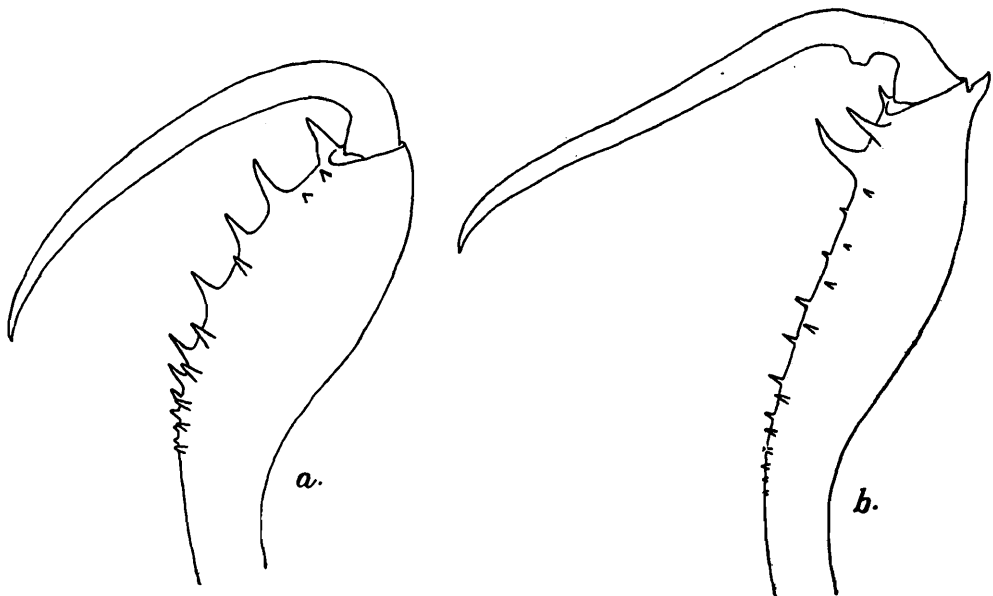
Figs. 4c, d.

Localities.—Peradeniya, Ceylon; Ernakulam and Chalakudi, Cochin State; Nara Ghat, Nepal; Singla, 1500 ft., Pashok, 3500

and 5000 ft., Kalimpong, 2000–4500 ft., Darjiling District; Chittagong; Man Ton, 4200 ft., Mongmit State, Ruby Mines District, Upper Burma, Telok Tikus, Penang; Lampam, Patalung and Singora, Talè Sap, Siam.

Total length of female about 11, of male about 8 mm., carapace about 2.5 mm. long by 1.5 mm. broad in both sexes. The anterior row of eyes is slightly recurved, the posterior almost straight; the ocular quadrangle is square and the small anterior lateral eyes are almost in contact with the posterior laterals.

The chelicerae are long and strongly divaricate. In the female the first dorsal tooth is broad and obliquely truncate, situated at the base of the fang, and succeeded after a long interval by the longer second tooth; the remaining four or five are in descending series. The first ventral tooth is situated slightly behind the base of the fang and is followed by three smaller ones



TEXT-FIG. 5.

Tetragnatha sutherlandi, chelicerae from above.

a.—Female

b.—Male.

somewhat widely spaced in the interval between the first and second dorsals; the remainder are in descending series. The fang is slightly geniculate, stout near the base, slightly swollen towards the middle, very slender distally.

The chelicerae of the male bear a long slender parallel-sided sub-apical spine, bifid at apex. The dorsal teeth are not unlike those of the female, except that the first of them is simply pointed. The first two ventral teeth are situated at the base of the fang, the first being minute and the second very large, the rest small. The fang is slender and unarmed.

***Tetragnatha sutherlandi*, n. sp.**

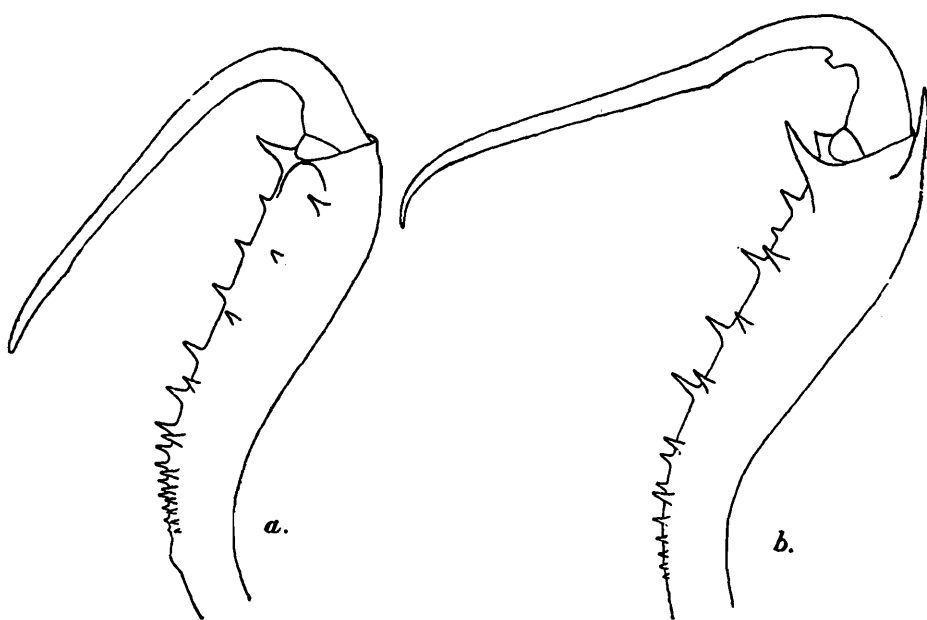
Figs. 5a, b.

Localities.—Trichur and Chalakudi, Cochin State; Siripur. Saran, Bihar; Serampore, Bengal, Kalimpong, Darjiling District,

Total length of female about 12 mm., of male about 9 mm., carapace about 3 mm. long in the female and about 2.5 in the male.

Both lines of eyes are distinctly recurved, the posterior more so than the anterior; the small anterior laterals are situated very near the posterior laterals.

The chelicerae are long and strongly divaricate in both sexes, but are much stouter in the female than in the male. In the female the first two dorsal teeth are short and stout and situated near together a little behind the base of the fang; the next two are larger and more widely separated, the remaining four in descending series. The first four ventral teeth are large and widely



TEXT-FIG. 6.

Tetragnatha viridorufa, chelicerae from above.
a.—Female b.—Male.

separated, the rest smaller, the first is situated at the base of the fang, and the first two are larger than the second two. The fang is unarmed.

The subapical spine of the male is short, broad and obliquely truncate. The first ventral tooth is minute, situated at the base of the fang; the first dorsal and second ventral are very large, situated a little further back, the former slightly in front of the latter; remaining teeth small. The fang is very long and slender with a distinct, broad, and more or less truncate tooth on the inner side of the basal bend.

***Tetragnatha viridorufa*, Gravelly.**

Fig. 6a, b.

Localities.—Ernakulam, Cochin State, Villivaukam, Chingleput District; Barkuda Island, Ganjam District and Balugaon,

Puri District, both on the Chilka Lake ; Balighai, further north in the Puri District.

Like *T. mandibulata* this species is nocturnal ; but instead of frequenting water it spins its webs among bushes in the jungle. The bright green of the sides of its abdomen tone with the reddish brown of its back and legs in such a way as to make it very inconspicuous on the leafy twigs of the bushes among which its web is spun, and where it rests by day.

In life it may readily be recognized by its bright colours and very long and strongly divaricate chelicerae ; but the characteristic colouration soon disappears in spirit. The female may, however, be recognized by a semicircular ridge that extends between the first spines of dorsal and ventral rows respectively, these spines being the largest, with the ventral much larger than the dorsal, the largest of the remaining spines are situated on the strong curve near the base of the joint instead of distally as is usual.

The male may be recognized by the fact that the first dorsal and the subapical spines are of about equal length, the former slightly shorter and thicker than the latter, and much longer than any of the other spines. The fang is armed with a strong truncate tooth on the inner side of the basal bend as in the preceding species.

Genus *Eucta*, Simon.

Three species, *E. caudicula*, Karsch (1879, pp. 66, 67, pl. i, figs. 4-4b), originally described from Japan, *E. isidis*, Simon (1880, p. 34), originally described from Egypt, and *E. javana*, Thorell (1889-90, pp. 236-239 ♂, 1895, pp. 146-147, ♀), originally described from Java are said to occur in India and Burma (see Simon, 1885, p. 450 and 1892, p. 722 ; Sheriffs, 1919, p. 232) ; and a fourth, *E. anguilla*, Thorell (1877, pp. 443-445) has been described from Celebes.

The specimens before me both male and female all agree with Thorell's description of *E. javana*, except that the teeth bordering the fang-groove of the female are somewhat variable in number and are usually slightly more numerous, as in *A. anguilla*. It seems possible, therefore, that these two species may prove to be identical ; but the male of *E. anguilla* has not yet been described.

E. caudicula is said by Sheriffs (1919, p. 232) to have been recorded by Simon from India.¹ The female differs from those of *E. anguilla* and *E. javana* in lacking the stout tubercle near the middle of the upper and inner side of the basal joint of the chelicerae. On the dorsal side of the fang-groove it has one large tooth at the base of the fang, one a little smaller at about the middle, followed by a row of about five small ones. On the ventral side there are three large teeth at the base of the fang, followed after an interval by a row of about nine small ones. The fang bears a small tubercle on the outer side just above the base,

¹ I have not, however, succeeded in tracing this record.

and is slightly constricted on the inner side at about the middle. The male appears to differ from that of *E. javana* chiefly in having the long apical tooth of the ventral row followed by about ten instead of five small teeth, this row consequently extending throughout the whole length of the joint.

E. isidis apparently also differs from *E. anguilla* and *E. javana* in the female sex, of which alone the description is known to me, in lacking the stout tubercle near the middle of the upper and inner side of the basal joint of the chelicerae, and it has only three strong teeth on the ventral margin of the fang-groove.

Eucta javana, Thorell.

Eucta javana, Thorell, 1889-90, pp. 236-239; 1895, pp. 146-147.

Localities.—Kulattupuzha at the western base of the Western Ghats in Travancore; Seringapatam, *ca.* 2500 ft., and Bangalore, *ca.* 3000 ft., Mysore; Ootacamund, *ca.* 6700-8000 ft., Nilgiris; Red Hills, Chingleput District and south end of Chilka Lake, Ganjam District in the Madras Presidency; Barkul and Balighai in the Puri District of Orissa, Charkardhapur, Singbhum District in Chota Nagpur; Siripur, Saran District and Katihar and Kierpur, Purnea Dist., in Bihar, Gmatia Birbhum and Calcutta in Bengal; Bulol in Nepal; Sukna, 1000 ft., Punkabari and Kalimpong, 2000-4500 ft., in the Darjiling Dist. of the E. Himalayas; Inlè Lake, Yawngkhwe State, S. Shan States.

In this species, as in the various species of *Tetragnatha*, the chelicerae are relatively short in young specimens, and the characteristic dentition is not developed. This develops, however, in specimens which I think can hardly be mature; and mature or apparently mature specimens of both sexes vary greatly in size (♂, 6-10 mm., ♀ 12-18 mm. long, excluding chelicerae). The size and general development of the teeth on the chelicerae also varies considerably, though their arrangement is approximately constant. In the female the first tooth on either side of the fang-groove is situated at the base of the fang; in the ventral row the second tooth is about twice as far from the first as from the third and the third is as a rule (but not invariably) distinctly further from the second than from the fourth; in the dorsal row the second is opposite the third ventral, the third opposite the fourth ventral and so on. Each row consists of from about six to eight teeth, usually one or two fewer in the dorsal row than in the ventral. In addition to these teeth there is a conical denticle at about the middle of the dorsal surface on the inner side. As a rule this is very large in well-developed specimens, but sometimes it is more indistinct. It is not developed in immature specimens. In mature specimens as a rule there is also a small but strongly chitinized conical denticle on the outer side close to the apex; this is, however, less constant and is likewise absent in immature forms. The fang is unarmed and slightly curved.

In the chelicerae of the male the basal joint is armed at

about three quarters of the way to the end of the dorso-lateral margin with an upwardly directed and forwardly curved spine, which is bifid distally. The fang-groove is oblique and somewhat curved. The ventral row of teeth consists of one large tooth at the base of the fang, followed at a little distance by a row of about five others, of which the anterior is the largest. In front of the dorsal row there is usually a pair of minute denticles situated transversely at the base of the fang. The dorsal row proper begins about a third of the way down the joint with a very long tooth situated somewhat high up on the dorsal surface and followed at a little distance by a row of about five others, normally of small size, the first of these being situated about opposite the last of the ventral row. The fang is lightly geniculate. The palps of the male are slender, with the patella about two-thirds as long as the tibia, and the tibia and tarsus together about two-thirds as long as the femur.

Genus *Orsinome*, Thorell.

The following Oriental species have been recorded :—

- O. armata*, Pocock, 1901, pp. 480, 481 (male only) from Shillong in Assam.
- O. marmorea*, Pocock, 1901, pp. 479, 480, from Ootacamund in the Nilgiri Hills and Ponmudi in Travancore.
- O. phrygiana*, Simon, 1901 a, pp. 56, 57 (male only) from Bukit Besar, Jalor, Malay Peninsula.
- O. vethi* (van Hasselt) 1882, pp. 32, 33 (damaged male only) from Java.

Little has yet been recorded of the habits of this genus. The two species that are known to me, *O. marmorea* and *O. listeri*, both spin their webs among boulders in mountain streams and the former at least drops into the water beneath when disturbed, clinging to the first rock against which it is swept by the current, an inch or two below the surface, till its alarm has subsided (see Gravely, 1915, p. 537).

A male and female are sometimes found together in one web with their heads in contact.

Orsinome marmorea, Pocock.

Fig. 7a, b.

O. marmorea, Pocock, 1901, pp. 480-481.

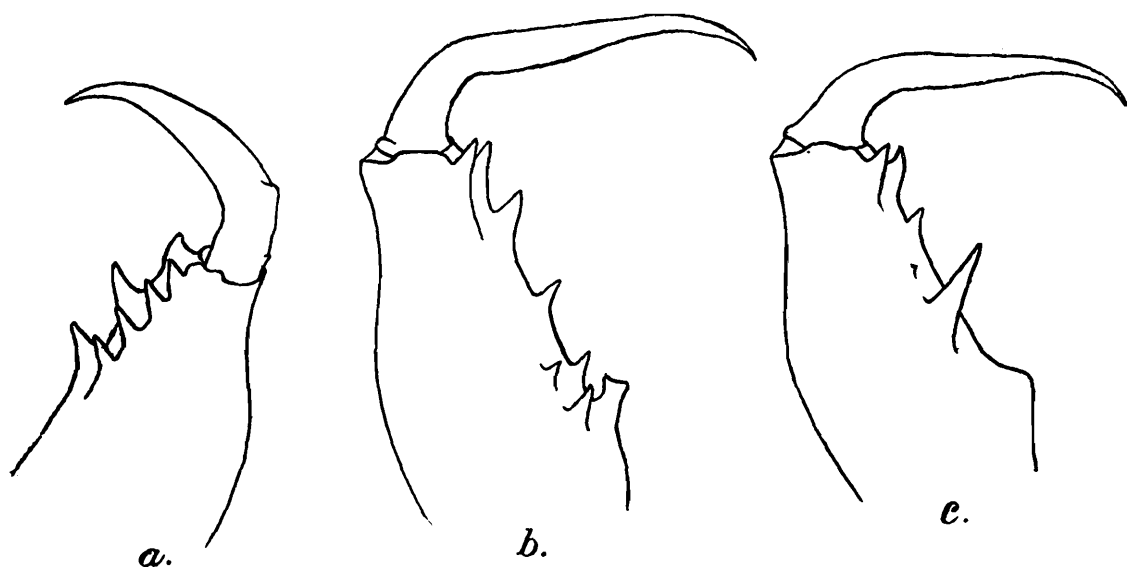
Localities.—Kavalai, 1300-3000 ft., and Forest Tramway 29-30th mile, 1600 ft., in Cochin; Talewadi near Castle Rock in N. Kanara; Coonoor, 5700-6000 ft., Nilgiri Hills, and Pachmarhi, 3000 ft., in the Satpura Hills of the Central Provinces.

Females of this species may be as much as 12 mm. long, with much more massive and rotund abdomen than the males.

The vulva of the female is a large smooth reddish brown chitinous plate, roughly circular in outline though with a slight posterior

prolongation; it is without the conspicuous anterior depression found in *O. listeri*.

The distal part of the chelicera of the female is shown in fig. 7a. The fang is very short, not more than half the length of the basal joint. The fang is longer in the male, and very slightly geniculate, otherwise similar. The ventral margin of the fang-groove of the male is armed with four acutely pointed conical teeth arranged at about equal distances from each other in descending order of magnitude and followed by a large abruptly truncate or slightly bifid tubercle. The dorsal margin bears one moderately large conical tooth at the base of the fang, i.e. opposite the first tooth of the ventral row, a very small one opposite the fourth and another moderately large one opposite the anterior margin of the truncate tubercle. The tip of the trochanter of the palp is unarmed beneath;



TEXT-FIG. 7.

- a.—*Orsinome marmorea* ♀ distal part of chelicera from below.
 b.—" " ♂, chelicera from above
 c.—*Orsinome listeri* ♂ " " "

the tibia is scarcely twice as long as the patella, shorter than the tarsus, and scarcely a quarter as long as the femur—characters in which it differs, according to Pocock, from *O. armata* from Shilong.

***Orsinome listeri*, sp. nov.**

Fig. 7c.

Localities.—Pashok, 1000 and 2500 ft., and Singla, 1500 ft., both in the Darjiling District of the E. Himalayas.

Total length of female about 10 mm.; length of carapace about 3.5 mm. Total length of male about 6 mm.; length of carapace about 2 mm. Colour, arrangement of eyes, etc., much as in *O. marmorea*, which the male further resembles in the structure and proportions of the palps and the female in the armature of the

chelicerae. The female, however, differs from that of *O. marmorea* in having the vulva neither redder nor smoother than the surrounding blackish matt integuments, and with a conspicuous longitudinal oval groove in front. The male differs in the armature of the chelicerae (see fig. 7c). There are two teeth on the ventral margin of the fang-groove, placed close together one behind the other at the base of the fang, the anterior being much larger than the posterior, and there is a large obtusely conical tubercle much nearer the base. The dorsal margin bears two widely separated teeth with a more or less obsolete denticle in front of the proximal one, much as in the male of *O. marmorea*.

Genus *Leucauge*, White.

Incl. *Argyropeira*, Emerton, and *Callinethis*, Thorell.

The following is a list of the principal descriptions of species recorded from the Oriental Region and of some of those found on its borders. Several of them have, however, already been relegated to the synonymy of common and widely distributed species (see synonymy of the species in the collections under consideration) and it is possible that others will have to follow them. On the other hand several species originally described as *Meta* or *Tetragnatha* have had to be transferred to *Leucauge*, and it is possible that others may have to follow these also, descriptions of a number of which from places bordering on the Oriental Region have been given by Thorell in his "Ragni di Selebes" (1877), "Ragni di Amboina" (1878) and "Ragni Austro-Malesi" (1881).

Argyropeira striata, Thorell (= *stellimicans* Simon, and *bigibba*, Thorell) has been made the type of a separate genus, *Tylorida*.

L. angustata (Stoliczka), 1869, pp. 241-242, pl. xx, fig. 7, ♀ from Calcutta and Sibsagar.

L. argentata (Cambridge), 1869, pp. 392, 393, pl. xiii, figs. 76-80, ♂ ♀ from Ceylon.

L. argentina (van Hasselt), 1882, p. 34, pl. ii, fig. 5, ♀ from Sumatra; (Thorell), 1889-90, pp. 199-200, ♀ from Sumatra; (Workman), 1896, pl. liv, ♀

L. argentina var. *nigriceps* (Thorell), 1890a, pp. 297-298, ♀ (? adult) from Penang.

L. auro-cincta (Thorell), 1887, pp. 418-422, ♂ ♀ from Celebes.

L. beata (Pocock), 1901, p. 481, ♀ from Shillong (Assam).

L. celebesiana (Walckenaer), 1837, pp. 222-223, *nec* Thorell, Workman, Pocock, etc. (see Simon, 1906).

L. culta (Cambridge), 1869, pp. 390-392, pl. xiii, figs. 69-75, ♂ ♀ from Ceylon.

L. decorata (Blackwall), 1864, pp. 44, 45, ♀ from East-India; (Cambridge), 1869, pp. 389, 390, pl. xiii, figs. 61-68, ♂ ♀ from Ceylon; Simon, 1906, pp. 282, 3, ♀ from Pondichery and Mahé.

L. ditissima (Thorell), 1887, pp. 143-146, ♀ from Bhamo (Burma).

L. elegans (Thorell), 1877, pp. 416-418, ♀ from Celebes; 1895,

pp. 156-159, ♂ ♀ from Tharrawady and Rangoon (Burma); (Workman), 1896, pl. xxii, ♀ from Singapore.

L. emtertoni (Thorell), 1890 a, pp. 22-24, ♀ from Nias.

L. fastigata (Simon), 1877, pp. 79, 80, ♀ from the Philippines.

L. fastuosa (Thorell), 1877, pp. 413-416, ♀ from Kandari (Celebes).

L. fibulata (Thorell), 1892, p. 16, ♀ from Singapore; (Workman), 1896, pl. liii, ♀

L. gemmea (van Hasselt), 1892, p. 26, pl. ii, fig. 4, ♀ from Sumatra; (Thorell), 1889-90, pp. 206, 207, ♀ from Sumatra; (Workman), 1896, pl. lvi, ♀

L. granulata (Walckenaer), 1837, p. 222, ♀ from New Guinea; (Thorell), 1889-90, pp. 198, 199, ♀ from Celebes, etc.

L. hasseltii (Thorell), 1889-90, pp. 194-196, ♀ from Sumatra.

L. lamperti. Strand, 1907, p. 157, fig. 8, from Ceylon.

L. leprosa (Thorell), 1895, pp. 133-5, ♀ from Tharrawaddy (Burma).

L. macrochaera, with var. *tenasserimensis* (Thorell), 1895, p. 152, ♀ from Tenasserim.

L. nicobarica (Thorell), 1891, pp. 44-46.

L. nigrotrivittata (Doleschall), 1859, p. 33, pl. xi, fig. 5, ♀ from Java.

L. pumila (Thorell), 1877, pp. 429-432, ♀ from Celebes; also recorded from Sumatra.

L. pusilla (Thorell), 1878, pp. 97-99, ♀ from Amboina; also recorded from Table Island.

L. quadrifasciata (Thorell), 1890a, pp. 18-21, ♂ from Penang, ♀ from Sumatra.

L. rubrotrivittata, Simon, 1906, p. 307, ♀ from the Lower Himalayas.

L. scalaris (Thorell), 1889-90, pp. 200-204, ♂ ♀ from Sumatra.

L. sexpustulata, Simon, 1906, pp. 307-8, ♀ from the Lower Himalayas.

L. stictopyga (Thorell), 1889-90, pp. 204-206, ♀ from Sumatra.

L. superba (Thorell), 1890a, pp. 15-18, ♀ from Nias.

L. tredecim-guttata (Simon), 1877, pp. 80, 81, ♀ from the Philippines.

L. tessellata (Thorell), 1887, pp. 135-138, ♀ from Shwegoomyo (Burma); 1895, pp. 155, 156, ♂ ♀ from Tenasserim.

L. tristicta (Thorell), 1891, pp. 46, 47.

L. ventralis (Thorell), 1877, pp. 423-427, ♂ ♀ from Celebes; (Workman), 1896, pl. lv, ♀ from Singapore.

L. vibrabunda (Simon), 1901b, p. 345, from Java.

The species in the collection before me may be distinguished from each other as follows :—

{	1	Carapace with a broad median brown band, or generally	
		infusate; abdomen in spirit (said to be greenish in life) brownish, finely speckled with silver; anterior median eyes unusually prominent, especially in the male; palpal organ of male dark brown	 <i>L. ventralis</i> p. 452.

- 1 { Carapace uniformly yellowish; abdomen silvery, especially in the female, with or without greyish or black markings; orange or yellow pigment often extensively present in living or freshly preserved specimens ... 2.
- 2 { Tibia of fourth leg of female not plumose; palpal organ of male smaller and paler, often yellowish... 3.
- 2 { Tibia of fourth leg of female plumose; palpal organ of male dark brown and very large ... 6.
- 3 { Black markings (apart from more or less obsolete mid-dorsal line) confined to a pair of spots beside the spinnerettes and two short rows (often absent) of spots on the posterior part of the dorsal surface, coalescing in a conspicuous black patch on the postero-dorsal hump, which is not otherwise very prominent (fig. 8a) ... *L. culta* p. 453.
- 3 { Black (or grey) markings linear and more extensive (fig. 8b) ... 4.
- 4 { Black mid-dorsal line of abdomen of female approximately uniform in width throughout, neither anterior nor posterior part of abdomen much produced (fig. 8b, c); male with relatively short palps and globular palpal organs with only the inner tarsal apophysis present ... 454.
L. celebesiana p.
- 4 { Black mid-dorsal line of abdomen of female more or less strongly expanded behind, dorsal portion of either anterior or posterior part of abdomen produced (fig. 8d-g); male with palps very long and slender, tibia not less than three times as long as patella, palpal organ less globular, both inner and outer tarsal apophyses present. 5.
- 5 { Female with posterior end of abdomen conically produced above spinnerettes, dorsal tubercles absent, dorso-lateral silver band more or less distinctly broadened and bifid behind (fig. 8d); abdomen of male much less strongly marked than that of female, oblique stripes absent ... *L. decorata* p. 454.
- 5 { Female with anterior end of abdomen produced above carapace, three pairs of more or less distinct dorsal tubercles present in anterior part of abdomen, all silver bands tapered and divergent behind (fig. 8g); abdomen of male as strongly marked as that of female, oblique black stripes present between the longitudinal ones dorsally ... [455.
L. bengalensis p.
- 6 { Abdomen of female not projecting far forwards above carapace; male moderately large with more or less parallel-sided abdomen, its chelicerae without strong spines ... *L. tessellata* p. 455.
- 6 { Abdomen of female projecting far forwards above carapace; male minute with more or less spherical abdomen and anterior surface of chelicerae thickly covered with large black spines ... *L. fastigata* p. 456.

Leucauge ventralis (Thorell)

Meta ventralis, Thorell, 1877, pp. 423-427.

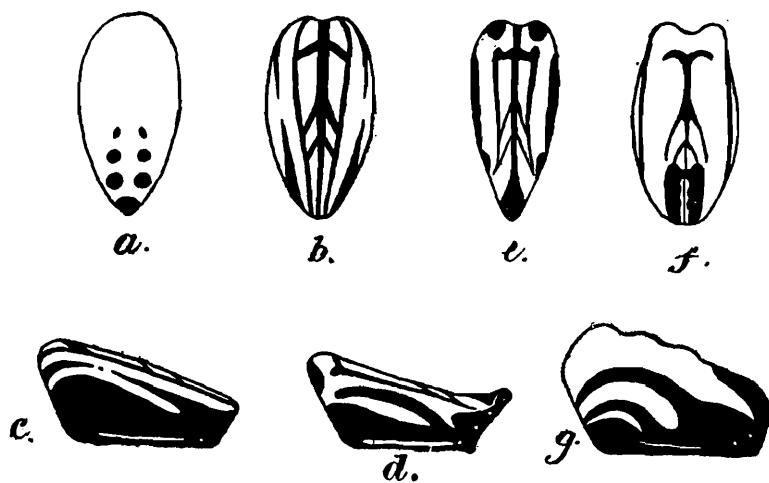
Argyropeira ventralis, Workman, 1896, pl. lv.

Argyropeira ventralis, Pocock, 1900, pp. 216, 217.

Localities.—Nirodumunai in the Trincomalee District (♂) and Kandy (♀) in Ceylon; Trichur, 0-300 ft. (♂ ♀), Chalakudi (juv.), Forest Tramway, 0-300 ft. (♂ ♀), and Parambikulam, 1700-3200 ft. in Cochin State, South India; Tollygunge near Calcutta in Bengal (♀).

This species, as already recorded by Sherriffs (1919, p. 233), rests with its legs stretched out on a twig beside its web. In this

it differs from all other species of the genus known to me, and resembles *Tetragnatha*. It further differs from all other species of *Leucauge* known to me in its dull colouration, more resembling that of *Orsinome*, and from all except the female of *L. bengalensis* in having the anterior median eyes much larger than the rest. From *L. bengalensis* it differs in that these eyes are equally large in both sexes, instead of being normal in the male. The trochanter and femur of the palps of the male are very long and slender, the former about half as long as the latter. The patella and tibia are short and stout, together shorter than the trochanter. The patella is scarcely any broader than it is long. The tibia is about twice as long as the patella and is thickened distally.



TEXT-FIG. 8.

- a.—*Leucauge culta* ♀ abdomen from above.
 b.—*Leucauge celebesiana* ♀ abdomen from above.
 c.—" " ♀, abdomen from the left side.
 d.—*Leucauge decorata* ♀ " " " "
 e.—" " ♀ abdomen from above.
 f.—*Leucauge bengalensis* ♀ " " "
 g.—" " ♀, abdomen from the left side.

There is the usual stout hook-like inner tarsal apophysis and in addition a stout and highly curved spiniform outer apophysis.

Leucauge culta (Cambridge).

Fig. 8a.

Tetragnatha culta, Cambridge, 1869, pp. 390–392, pl. xiii, figs. 69–75.

Leucauge sexpustulata, Simon, 1906, pp. 307, 308.

Originally described by Pickard-Cambridge from Ceylon and subsequently under another name by Simon from the lower levels of the Himalayas, where I have found it very abundant among low foliage during the rains and whence it is represented in the collection before me from Sureil, 5000 ft.; near Sureil, 6000 ft.; Soom, 4000–5000 ft.; Sitong, ca. 3500 ft.; Gopaldhara; Pashok, ca. 2000 and 3500 ft.—all in the Darjiling District. The Indian

Museum also possesses two specimens from Ceylon, a male from Pattipola and a female from Peradeniya.

The male resembles the female in colour, but is somewhat smaller, with relatively longer legs and narrower carapace. The palpi are of moderate length, the tibia is somewhat stouter than the patella, especially distally, but is about equal to it in length; the patella and tibia together are scarcely half as long as the femur. The palpal organ is more or less globular in form, yellowish in colour (in spirit) with both the inner and outer apophyses well developed, the former larger than the latter, both strongly curved. The adult male is further distinguished by the presence of a large downwardly directed tooth in the middle of the anterior surface of the basal joint of the chelicerae.

***Leucauge celebesiana* (Walckenaer).**

Fig. 8b, c.

Tetragnatha celebesiana Walckenaer, 1837, p. 222.

Epeira nigro-trivittata, Doleschall, 1859, p. 39, pl. xi, fig. 5.

Meta decorata, Koch, 1872, p. 14, pl. xi, fig. 5.

Meta nigro-trivittata, Thorell, 1881, pp. 126, 127.

Localities.—Sevook, 1000 ft.; Tindharia; Singla, 1500 ft.; Gopaldhara; Ghumti, 1500–5000 ft.; Kurseong, 4700–5000 ft.; Darjiling, 6000–7000 ft.; Darjiling to Soom, 7000–5000 ft.; Soom, 4000–5000 ft.; Lebong, 5500–6000 ft.; Pashok, 3500; 4500, 5000 and 5500 ft.; Kalimpong, 2000–4500 ft.; Monghoo, ca. 3000 ft.; Sureil, 5000 ft.—all in the Darjiling District of the E. Himalayas, where it is very abundant among herbage during the rains. Also one specimen from the Garo Hills and one each from Shillong and Cherrapunji (Khasi Hills) in Assam.

Concerning the synonymy and distinctive features of this species see under *L. decorata*, below.

***Leucauge decorata* (Blackwall).**

Fig. 8d, e.

Tetragnatha decorata, Blackwall, 1864, pp. 44, 45.

Nephila angustata, Stoliczka, 1869, pp. 241, 242, pl. xx, fig. 7.

Tetragnatha decorata, Cambridge, 1869, pp. 389, 390, pl. xiii, figs. 61–68.

Meta celebesiana, Thorell (*nec* Walckenaer) 1877, pp. 422, 423; 1881, pp. 126, 127.

Argyropeira celebesiana, Workman, 1896, pl. lii.

Argyropeira celebesiana, Pocock, 1900, p. 216.

Leucauge decorata, Simon, 1906, pp. 282, 283.

Localities.—Colombo and Peradeniya in Ceylon; Trichur, Chalakudi and Parambikulam (1700–3200 ft.) in Cochin; Yercaud, Shevaroy Hills; Bangalore, ca. 3000 ft., Mysore; Coonoor, ca. 5700–6000 ft., Nilgiris; Red Hills, Chingleput District, Madras; Rawal Pindi, Panjab; Barkul, 0–1000 ft., Orissa; Dehra Dun, W. Himalayas; Katihar and Kierpur (Purneah Dist.), Siripur (Saran Dist.), Calcutta and Serampore in Bengal; Darjiling ca. 7000 ft.:

Darjiling to Soom, 7000-5000 ft.; Soom, 3000-3500 ft.; Gopaldhara, Lebong, 5500-6000 ft.; Pashok, 3500 and 5000 ft.; Kalimpong, 2000-4500 ft. and Labdah, 3000 ft.—all in the Darjiling District of the E. Himalayas; Shillong and Sonarpur in Assam; Maymyo in Burma. This species is very common round Calcutta among long grass and low bushes, especially over water during the rains.

Simon (*loc. cit.*) has pointed out that the true *L. celebesiana* of Walckenaer is common throughout Malaysia and part of Australia, and that Blackwall's *nigrotrivittata* is identical with it, both being distinct from the Indian *decorata*. *L. decorata* is the species distinguished by Thorell (*loc. cit.*) from *nigrotrivittata* under the erroneous name *celebesiana*, an error in which he has been followed by Pocock in the "Fauna."

Females of *L. decorata* are somewhat smaller and slenderer than those of *L. celebesiana*, with the posterior end of the abdomen produced above the spinnerettes into a more acutely angular process. The markings on the abdomen, moreover, are usually somewhat better defined than in *L. celebesiana*, and the dorso-lateral silver band is bifid instead of simple behind.

In the male the inner tarsal apophysis of the palp is present in *L. decorata* and absent in *L. celebesiana*, and the palps as a whole are much more slender in the former than in the latter, the tibia—though varying greatly in different specimens—being not less than three times as long as the patella, whereas it is barely twice as long in *L. celebesiana*.

***Leucauge bengalensis*, sp. nov.**

Fig. 8f, g.

Localities.—Calcutta and its suburb Maniktolla, also Serampore on the Hughli a few miles north of Calcutta.

The female resembles *L. argentata* (Camb.) so closely that I took it to be identical with that species until I had examined the male. I can find no characters distinguishing the female from those mentioned in the description of *L. argentata*; but in this description there is no mention of the sizes of the eyes. In *L. bengalensis* the anterior medians are much larger than any of the others, so much so that I think the fact must have been noted by Cambridge in his description of *L. argentata* if it had existed there.

The male, however, differs greatly from that of *L. argentata*, both the palps and abdomen being very slender. In this it resembles *L. decorata*, except that the abdomen is perhaps a little longer and narrower, and is strongly marked with silver and black, much as in the female.

***Leucauge tessellata* (Thorell).**

Argyropeira tessellata, Thorell, 1887, pp. 135-138.

Argyropeira tessellata, Pocock, 1900, p. 216.

Localities.—Forest Tramway, 29-30th mile, 1600 ft. and Parambikulam, 1700-3200 ft., Cochin, Pollibetta, Coorg; Ghumti,

1500-5000 ft., Singla, 1500 ft., Gopaldhara, Soom, 4000-5000 ft., Pashok at various altitudes from 2000-4000 ft., Kalimpong, 600-4500 ft., and Argarra above Teesta nr. Kalimpong, 1000 ft., all in the Darjiling District; and above Tura (Garo Hills), 3500-3900 ft., Sonarpur, and the Assam-Bhutan Frontier (Darrang District) in Assam.

This species is often found in the Darjiling District during the rains together with *L. celebesiana*, which it resembles in general size, form and colour. The female may, however, readily be distinguished from that of this and all other species described above by the dense and somewhat long black hair covering the distal two-thirds of the tibiae of the fourth pair of legs. The male can be distinguished by its somewhat more prominent eyes and its large and dark coloured palpal organs armed with both inner and outer tarsal apophyses.

Leucauge fastigata (Simon).

Argyropeira fastigata, Simon, 1877 (July), p. 79, pl. iii, fig. 10.

Meta elegans, Thorell, 1877 (Oct.-Dec.), *Ann. Mus. Civ. Genova* X, pp. 416-418; 1895, pp. 156-159.

Argyropeira fastigata, Pocock, 1900, p. 216.

Localities.—Peradeniya in Ceylon; Trichur, 0-300 ft.; Forest Tramway, 10th-14th mile, 0-300 ft., and Parambikulam, 1700-3200 ft. in Cochin; Barkuda Island (Chilka Lake) in Ganjam; Hardwar and Saharanpur in the United Provinces, Tavoy and Arakan in Burma.

The webs of this species are mostly spread more or less horizontally in somewhat shady spaces among bushes or under trees. The webs are large, and are often attached to their supports by strands extending for a considerable distance. They are usually situated about on a level with one's eyes which makes them somewhat difficult to detect and I have frequently walked right into them without seeing them, even when searching for them. Males are very difficult to find, as both they and their webs are quite small, and they do not seem to associate themselves closely with females, though they live in similar situations.

The female resembles that of *L. tessellata* in having the hind tibiae clothed with long thick black hair, but differs in having the anterior end of the abdomen very strongly produced above the carapace. The male differs from those of all other species of the genus known to me, except *L. ventralis* and *L. tessellata*, in having large globular palpal organs of a very dark colour. From these two species it differs in its minute size (total length of body about 2 mm.), rotund abdomen and intensely spiny chelicerae. Both the inner and outer tarsal apophyses are present on the palps.

BIBLIOGRAPHY.

1761. Linnaeus, C. "Fauna Suecica," 2nd ed. (Stockholm, 1761).
1837. Walckenaer, M. le Baron. "Histoire Naturelles des Insectes Aptères" II (Paris, 1837).
1857. Doleschall, C. L. "Bijdrage tot de Kennis der Arachniden van den Indischen Archipel." *Natuurk. Tijdschr. Ned. Ind.* XIII, pp. 399-434, pl. i-ii.
1859. Doleschall, C. L. "Tweede Bijdrage tot de Kennis der Arachniden van den Indischen Archipel." *Kon. natuurk. Ver. Ned. Ind.* V (5), Batavia, 1859, 60 pp., 7 pl.
1864. Blackwall, J. (a) "Descriptions of Seven New Species of East Indian Spiders received from Rev. O. P. Cambridge." *Ann. Mag. Nat. Hist.* (3) XIV, pp. 36-45.
(b) "Spiders of Great Britain and Ireland," pt. II (Ray Society, London, 1864), pp. 175-384, pl. xiii-xxix.
1869. Cambridge, O. Pickard. "Part I of a Catalogue of a Collection of Ceylon Araneidea lately received from Mr. J. Nietner, with Descriptions of new Species and Characters of a new Genus." *Proc. Linn. Soc. London, Zool.* X, pp. 373-379, pl. xi-xiii.
Stoliczka, F. S. "Contribution towards the Knowledge of Indian Arachnoidea." *J. As. Soc. Bengal* XXXVIII (II), pp. 202-251, pl. xviii-xx.
1872. Koch, L. "Die Arachn. Austr." III.
1877. Blackwall, J. "A list of Spiders captured in the Seychelles Islands." *Proc. R. Irish Acad.* (2) III, pp. 1-22.
Simon, E. "Études Arachnologiques, 5^e Memoire, Arachnides recueillis aux îles Philippines par MM. G.A. Baer et Laglaise." *Ann. Soc. Ent. France* (5) VII, p. 53-96.
Thorell, T. "Studi sui Ragni Malesi e Papuani. I, Ragni de Selebes raccolti nel 1874 dal Dott. O. Beccari." *Ann. Mus. Civ. Genova* X, pp. 341-634.
1878. Thorell, T. "St. Rag. Mal. Pap. II, Ragni di Amboina raccolti dal Prof. O. Beccari." *Loc. cit.* XIII, pp. 5-317.
1879. Karsch, F. "Baustoffe zu einer Spinnenfauna von Japan." *Verh. Nat. Ver. Preuss. Rheinl.* XXXVI, pp. 57-105, pl. i.
1880. Simon, E. "Trois nouvelles espèces d'Arachnides d'Égypt, reçus de M. A. Letourneux." *Bull. Soc. Ent. France*, 1880, pp. xlvii-xlviii.
1881. Thorell, T. "St. Rag. Mal. Pap. III. Ragni dell' Austro-Malesia e del Capo York, conservati nel Museo Civico di Storia Naturale di Genova." *Loc. cit.* XVII, pp. viii-xxvii and 1-720.
1882. Hasselt, A. W. M. van. "Araneae" P. J. Veth's "Midden-Sumatra" IV (IIA) (Leiden, 1892), 56 pp., 5 pl.
1885. Simon, E. "Materiaux pour servir à la Faune Arachnologique de l'Asie Méridionale." *Bull. Soc. Ent. France*, 1885, I, pp. 1-26 (from Bellary); II, pp. 26-39 (from

- Ramnad); III, pp. 436-455 (from Malay Peninsula and Singapore), IV, pp. 456-462 (from Collegal, S. India).
1887. Thorell, T. "Viaggio di L. Fea in Birmani e Regioni vicine. II, Prima Saggio sui Ragni Birmani." *Ann. Mus. Civ. Genova* (2) V (=XXV), pp. 5-417.
- 1889-90. Thorell, T. "St. Rag. Mal. Pap. IV, Ragni dell' Indo-Malesia Raccolti da O. Beccari, G. Doria, H. Forbes, J. G. A. Kinberg ed altri," Pt. I. *Loc. cit.* (2) VIII (=XXVIII), pp. 5-419.
1890. Thorell, T. (a) "Aracnidi di Nias e di Sumatra raccolti nel 1886 dal Sig. E. Modigliani." *Loc. cit.* (2) X (=XXX) pp. 5-106.
 (b) "Aracnidi di Pinang raccolti nel 1889 dai sig.^{ri} L. Loria e L. Fea." *Loc. cit.* (2) X (=XXX), pp. 269-383.
1891. Thorell, T. "Spidlar från Nikobarerna och andra delar af Södra Asien, etc." *Sv. Ak. Handl.* XXIV (2), pp. 1-149.
1892. Karsch, F. "Arachniden von Ceylon und von Minikoy." *Berlin. Ent. Zeitschr.* XXXVI, pp. 267-310, taf. x-xii.
 Simon, E. "Histoire Naturelle des Araignées, 2nd ed., Vol. I (Paris, 1892) 1084 pp., 1098 text-figs.
 Thorell, T. (a) "Nova species Araneorum a cel. Th. Workman in ins. Singapore collectae." *Boll. Soc. Ent. Ital.* XXIV, pp. 211-282.
 (b) "On some Spiders from the Andaman Islands collected by E. W. Oates, Esq." *Ann Mag. Nat. Hist.* (6) IX, pp. 226-237.
1893. Simon, E. "Mission scientifique de M. Ch. Alluaud aux Iles Seychelles. Arachnides." *Bull. Soc. Zool. France* XVIII, pp. 204-210.
1895. Thorell, T. "Descriptive Catalogue of the Spiders of Burma, based upon the collection made by Eugene W. Oates and preserved in the British Museum" (London, 1895), 406 pp. [pl.
1896. Workman, T. "Malaysian Spiders" (Belfast, 1896), 96
1897. Simon, E. "Histoire Naturelle des Araignées, 2nd ed., Vol. II (Paris, 1897), 1080 pp., 1122 text-figs.
 Thorell, T. "Araneae paucae Asiae australis." *Bih. Svenska Ak.* XXII (4) 6, pp. 1-36.
1898. Cambridge, O. Pickard. "On a collection of Insects and Arachnids made by Mr. E. N. Bennett in Socotra, with Descriptions of new Species. IV, Arachnida." *Proc. Zool. Soc. London* 1898, pp. 387-391, pl. xxxi.
 Thorell, T. "Viaggio di Leonardo Fea in Birmanie e Regioni Vicine (LXXX). Secondo Saggio sui Ragni Birmani. II Retitelariae et Orbitelari." *Ann. Mus. Civ. Genova* (2) XIX (=XXXIX), pp. 271-378.
1900. Pocock, R. I. Arachnida in *Fauna of British India* (London, 1900), 279 pp., 89 text-figs.
1901. Pocock, R. I. "Descriptions of some new species of Spi-

- ders from British India." *Journ. Bombay Nat. Hist. Soc.* XIII, pp. 478-498.
- Simon, E. (a) "On the Arachnida collected during the 'Skeat Expedition' to the Malay Peninsula, 1899-1900." *Proc. Zool. Soc. London*, 1901 (2), pp. 45-84.
- (b) "Leste der Arachniden der Semon'schen Sammlung in Australien und dem Malayischen Archipel." *Semon's Zool. Forsch. Australien Malay Archip.* V, pp. 341-352.
1905. Simon, E. "Arachnides de Java." *Mitth. Mus. Hamburg* XXII, 1904 (1905), pp. 51-73, 5 text-figs.
1906. Simon, E. "Voyage de M. Maurice Maindron dans l'Inde Méridionale, Arachnides II. Appendice, Descriptions de quelques Arachnides des bas plateaux de l'Himalaya, communiqués par le R. P. Castets (de St. Joseph's College à Trichinopoly)." *Ann. Soc. Ent. Fr.* LXXV, pp. 279-314, 4 text-figs.
1907. Strand, E. "Süd- und ostasiatische Spinnen I." *Gorlitz Abh. natf. Ges.* XXV, 1907, pp. 107-215, 1 pl.
1909. Simon, E. "Étude sur les Arachnides du Tonkin." *Bull. Sci. Fr. Belg.* XLII, pp. 69-147.
1911. Hirst, S. "The Percy Sladen Trust Expedition to the Indian Ocean in 1905 under the leadership of Mr. J. Stanley Gardiner, M.A.—Araneae, Opiliones and Pseudoscorpiones." *Trans. Linn. Soc. London* (2) XIV, pp. 379-395, 10 text-figs.
1915. Gravelly, F. H. "Notes on the Habits of Indian Insects Myriapods and Arachnids." *Rec. Ind. Mus.* XI, pp. 483-539, pl. xxii-xxv.
1919. Sherriffs, W. Rae. "A Contribution to the Study of South Indian Arachnology." *Ann. Mag. Nat. Hist.* (9) IV, pp. 220-253, pl. i-vi.
1921. Gravelly, F. H. "The Spiders and Scorpions of Barkuda Island." *Rec. Ind. Mus.* XXII, pp. 399-421, 3 text-figs., pl. xvii-xix.

XXV REPORT ON A COLLECTION OF SUMA- TRAN MOLLUSCS FROM FRESH AND BRACKISH WATER

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(Plate XIV.)

INTRODUCTORY NOTE.

The collection on which this report has been based was made by Mr. J. E. A. den Doop and was submitted to me for examination. After a certain amount of preliminary work I was obliged by stress of official duties to hand it over to Dr. B. Prashad, who has worked it out in detail. The collection is very representative of the Molluscs of most types of fresh and brackish water in Sumatra. Only the true lacustrine forms and the bivalves of brackish water are poorly represented. The collection is particularly rich in Gastropoda from streams in the plains and mangrove-swamps on the coast. It has been of great assistance to us in working out similar elements in the fauna of the eastern districts of British India, and we may claim it as fortunate that it has been possible to consider the Molluscs of the two countries together.

The molluscan fauna of Sumatra is now at least as well known as that of any other similar area in the Eastern Tropics. It is very much better known, for example, than that of the Malay Peninsula or even that of many parts of Burma. The number of fresh- and brackish-water species that has been recorded from the island is two hundred and forty-six including sixty here recorded or described for the first time. Of the 246 species no less than 100 have been found in Mr. den Doop's collection. The thanks and congratulations of all malacologists are due to him, and we are particularly grateful in the Indian Museum for permission to retain a first set of the specimens. The remainder are to be sent to the Amsterdam Museum. The fact that a large proportion of the material is preserved in spirit with the soft parts intact is an interesting and important feature.

We have to thank Prof. Max Weber of Amsterdam not only for sending us in exchange specimens of a large proportion of the species described by the late Prof. E. von Martens from his own collections in the Malay Archipelago, but also for sending us on loan examples of the species of which no duplicates were available. This has not only rendered the report more authoritative but has greatly lessened the labour of its preparation. [N. ANNANDALE].

INTRODUCTION.

This report deals with a large collection of fresh- and brackish-water mollusca¹ made by Mr. J. E. A. den Doop in Sumatra² during the years 1916—1918. Details about it are included in the introductory note by Dr. N. Annandale at the beginning of the report

¹ The collection also includes large numbers of marine and land-molluscs, but these we are unable to deal with at present.

² The collections were made only in the northern part of the "Gouvernement Oostkust van Sumatra" and on the Isle of Sabang.

and need not be repeated here. I may note that the specimens in the collection had no locality-labels in the beginning, but their provenance was indicated by serial numbers, the details regarding their localities were later supplied to me by Mr. den Doop and these have been filled in the paper according to the list sent me. All available details regarding habitat and distribution of the various species have been included. Detailed synonymies are not given except in special cases; in others references to von Martens' paper (*Süss- und Brackwasser-Mollusken des Indischen Archipelago* in *Zool. Ergeb. Nieder. Ost-Indien* IV, and to papers published since that date only are necessary.

Owing to the little information available it is not possible for me to discuss in detail the geographical distribution and relationships of the species represented in the collection but a close connection between most of the freshwater species of Sumatra and continental Indian forms is quite apparent. This is particularly well marked in the families Planorbidae, Melaniidae and Vivipariidae. Indeed some of the forms from Sumatra are quite indistinguishable from the true Indian species.

In the case of the estuarine forms also we find the same relationships, but this probably has much less value in this case than for the freshwater forms, because a large proportion of the species have an extremely wide range.

The most useful summary of all that was known about the distribution of the fresh and brackish-water species of Sumatra was given by the late Prof. E. von Martens in the Zoological Results of Prof. Max Weber's collections in the Indo-Australian Archipelago. For comparison I give below von Martens' list together with a list of species described since his paper was published; and also a list of the species found in Mr. den Doop's collection. In addition to the references given in von Martens' paper the following more recent publications on Sumatran molluscs may be consulted.

- 1898. Aldrich, T. H. "Notes on some land and freshwater shells from Sumatra with descriptions of new species." *Nautilus*, XII, pp. 1-4, pl. i.
- 1899. Dautzenberg, P. "Contribution à La Faune Malacologique De Sumatra." *Ann. Soc. Roy. Malacol. Belgique*, XXXIV, pp. 1-26.
- 1900. Martens, E. von. "Ueber Land und Süsswasser Schnecken aus Sumatra." *Nachr. Deutsch. Malakozool. Ges.* XXXII, pp. 3-14.
- 1903. Martens, E. von. "Die beschaltten Gastropoden der deutschen Tiefsee expedition." *Valdivia Reports*, VII, pp. 1-146.
- 1906. Bullen, R. "On some land and fresh-water molluscs from Sumatra." *Proc. Malacol. Soc.* VII, pp. 12-16 and 126-130.
- 1908. Rolle, H. "Zur Fauna von West Sumatra." *Nachr. Deutsch. Malakozool. Ges.* XL, pp. 63-69.

I have not included references to the monographs in Martini and Chemnitz "Systematisches Conchylien Cabinet" published during the recent years.

I have also here to express my great indebtedness to Dr. N. Annandale for the great help he gave me while I was working out this collection and for his valuable advice given ungrudgingly at all times.

	von Martens' list (1897).	Species described or recorded since von Martens' paper in 1897.	Mr. den Doop's collection.
<i>GASTROPODA.</i>			
<i>PULMONATA.</i>			
<i>AURICULIDAE.</i>			
<i>Pythia</i> ...	<i>pantherina, undata</i>	<i>scarabeus, imperforata.</i>	<i>trigona plicata, undata.</i>
<i>Cassidula</i> ...	<i>auris-felis, multiplicata, mustelina.</i>	... ..	<i>auris-felis.</i>
<i>Auricula</i> ...	<i>midæ, judæ, scheepmakeri.</i>	... ..	<i>midæ, judæ, limnaeiformis</i> (sp. nov.).
<i>Melampus</i> ...	... ..	<i>fasciatus</i> ...	<i>percha</i> (sp. nov.).
<i>LIMNAEIDAE.</i>			
<i>Limnaea</i> ...	<i>javanica, brevispira</i> ¹	<i>javanica</i> var. <i>angustior, excavata, bongsonensis.</i>	<i>javanica</i> and vars. <i>intumescens, subteres, angustior, porrecta, costulata</i> and <i>turgidula.</i>
<i>PLANORBIDAE.</i>			
<i>Planorbis</i> (in part) = <i>Indoplanorbis.</i>	<i>indicus = exustus</i>...	... ..	<i>exustus.</i>
<i>Planorbis</i> (in part) = <i>Gyraulus.</i>	<i>sumatranus, proclivis.</i>	<i>sagoensis</i> (probably a <i>Gyraulus</i>).	<i>convexisculus, sumatranus, proclivis.</i>
<i>Segmentina</i> ...	... ..	<i>kennardi</i> ...	<i>calathus.</i>
<i>Isidora = Physastra</i>	<i>sumatrensis, stagnalis.</i>	... ..	<i>doopi</i> (sp. nov.).
<i>PROSOBRANCHIA.</i>			
<i>AMPULLARIIDAE.</i>			
<i>Ampullaria</i> (in part) = <i>Pachylabra.</i>	<i>ampullacea, involuta, scutata = conica.</i>	<i>ampullacea</i> var. <i>sumatrensis.</i>	<i>conica, ampullacea</i> vars. <i>typica</i> (= <i>celebensis</i>), <i>sumatrensis</i> and <i>magnifica.</i>
<i>VIVIPARIDAE.</i>			
<i>Vivipara</i> ...	<i>grassicosta, sumatrensis, hamiltoni, ingalsiana.</i>	<i>javanica, javanica</i> var. <i>sumatrana, sumatrensis, deliensis.</i>	<i>sumatrensis, hendrici</i> , (sp. nov.), <i>javanica</i> with vars. <i>laevior, saleyerica, moussoni, scalaris, borneensis.</i>

¹ Dr. Annandale and I have recently established (*Proc. As. Soc. Bengal*, XIV, pp. 460—462, pl. xii, figs. 4, 4a and text-fig. 2) the genus *Omia* for a Japanese species and we believe that the Sumatran *L. brevispira* also probably should be assigned to it.

	von. Martens' list (1897).	Species described or recorded since von Martens' paper in 1897.	Mr. den Doop's collection.
HYDROBIIDAE.			
<i>Bithynia</i> ...	...	...	<i>truncata.</i>
<i>Pachydrobia</i> ...	<i>lacustris.</i>		
<i>Stenothyra</i> ...	...	<i>weyersi.</i>	
ASSIMINEIDAE.			
<i>Assimineia</i> ...	...		
Subg. <i>Cyclotropis.</i>	<i>carinata, banka, lirata.</i>		
LITTORINIDAE.			
<i>Littorina.</i>			
Subg. <i>Littorinopsis.</i>	<i>scabra, intermedia, carinifera, undu- lata.</i>	...	<i>scabra, intermedia, rinifera, conica.</i>
Subg. <i>Nodilittorina</i>	<i>vilis.</i>		
Subg. <i>Melarraphe.</i>	<i>ventricosa</i> var. <i>sub- granosa, biangu- lata.</i>		
MELANIIDAE.			
<i>Protia</i> = <i>Acrostoma</i> ...	<i>sumatrensis, episco- palis, curvicosta, subplicata, verbec- ki, papillosa, stric- ticosta, zollingeri.</i> ¹	<i>indragirica, curvi- costa</i> var. <i>presto- niana.</i>	<i>variabile, vars. suma- trensis, infracostata, binodulifera, pseudo- spinosa and menke- ana.</i>
<i>Melania</i> (<i>Stenomela- nia, Melanoides, Plotia, Tarebia</i> and ? <i>Sermyla</i> , all = <i>Me- lanoides</i>).	<i>bisinuata, laeviga- ta?, crepidinata, tuberculata, pul- chella, scabra, gra- num, datura, spec- tabilis, granifera, lineata, flavida, dissimulans, ri- queti, pinguinun- cula.</i>	<i>mucronata, arcteca- va, javanica, rus- tica, perplicata, so- bria, rudis, pagoda</i> var. <i>costulata, savi- nieri, javanica, acanthica. distin- guenda, livata (=</i> <i>semigranosa), pa- lembangensis, da- tura, unifasciata, sykesi, kobelti.</i>	<i>aspirans, plicaria, acu- tissima, turris, mo- nile, crenulata, uni- formis, litigosa, tu- berculata, vars. se- minuda, virgulata, angularis and trun- catula; scabra, vars. nodosocostata, angu- lifera and mutica; semigranosa, sluiteri (sp. nov).</i>
<i>Melania</i> , s.s.	<i>cyhele (amara), seto- sa?, bocki, snell- mani.</i>	<i>setosa, mitra</i> (pro- bably same as <i>cy- bele</i>), <i>rudis, win- teri, berkoltzi.</i>	
<i>Faunus</i> ...	...	<i>ater.</i>	
<i>Paludomus</i> ?	<i>olivacea.</i>		
CERITHIIDAE.			
<i>Potamides</i> ...	...		
Subg. <i>Terebralia</i> ...	<i>palustris, sulcatus.</i>		
Subg. <i>Telescopium.</i>	...	...	<i>telescopium.</i>
Subg. <i>Tympanoto- nos.</i>	<i>cingulatus (fluvia- tilis).</i>	...	<i>cingulatus, micropte- rum.</i>
Subg. <i>Cerithidae</i> ...	<i>ornatus, charbonnieri</i>	<i>cornea, weyersi</i> ...	<i>obtusum, quadratum.</i>
NASSIDAE.			
<i>Canidia</i> ...	...	<i>theminckiana</i> ...	<i>helenae, theminckiana.</i>
<i>Clea</i> ...	<i>bocki</i> ...	...	<i>bocki.</i>

¹ I have given these names as they stand in von Martens' list, without attempting to give their correct names for want of sufficient material.

	von. Marten's list (1897).	Species described or recorded since von Marten's paper in 1897.	Mr. den Doop's collection.
NERITIDAE.			
<i>Neritina.</i>			
Subg. <i>Auriculatae</i> = <i>Neripteron</i> .	<i>auriculata</i> ...	...	<i>simoni</i> (sp. nov.).
Subg. <i>Mitrulae</i> = <i>Dostia</i> .	<i>crepidularia</i> ...	...	<i>crepidularia</i> with vars. <i>melanostoma</i> and <i>ex-</i> <i>altata</i> ; <i>weberi</i> (sp. nov.).
Subg. <i>Hemispheri-</i> <i>cae</i> = <i>Clypeolum</i> .	<i>iris, pennata</i> ...	<i>pulligera</i> .	
Subg. <i>Sulculosae</i> ...	<i>guerini</i> ,		
Subg. <i>Aculeatae</i> ...	<i>aculeata</i> .		
Subg. <i>Serratae</i> = <i>Neritae</i> .	<i>gagates?</i> , <i>variegata</i> , <i>zizac, communis?</i> , <i>turrita</i> .	<i>turrita</i> var. <i>semico-</i> <i>nica</i> .	<i>zizac, variegata</i> .
Subg. <i>Neritodryas</i>	<i>cornea</i> ...	...	<i>cornea</i> .
Subg. <i>Clithon</i> ...	<i>brevispira, subpunc-</i> <i>tata, solium, ualen-</i> <i>sis</i> .	<i>cliadema</i> ...	<i>brevispina, squarrosa</i> .
<i>Nerita</i> ...	<i>lineata, planospira</i>	...	<i>lineata, planospira</i> .
<i>Septaria</i> ...	<i>sculpta, suborbicu-</i> <i>laris, tessellata</i> .	<i>tessellata</i> with vars. <i>clypeolum, insignis,</i> <i>compressa, lineata</i> .	<i>tessellata</i> with vars. <i>clypeolum, compressa</i> and <i>lineata</i> .
PELECYPODA.			
OSTREIDAE.			
<i>Ostrea</i> s.s. ...	...	...	<i>gryphoides</i> .
Subg. <i>Alectryonia</i>	<i>cucullata</i> ...	...	<i>folium, cucullata</i> .
ARCIDAE.			
<i>Arca</i> ...	<i>granosa</i> .		
UNIONIDAE.			
<i>Unio</i> (genus doubt- ful).	<i>macropterus</i> ...	<i>stolatus</i> .	
<i>Schizocleithrium</i> ...	...	<i>hajakomboensis</i> .	
<i>Pilsbryoconcha</i> ...	...	<i>exilis, expressa</i> .	
<i>Contradens</i> ...	<i>hageni, dimotus</i> (= <i>Unio</i> <i>sumatrensis</i> , Lea), <i>verbecki</i> .	<i>laticeps</i> ...	<i>dimotus</i> var. <i>lugens</i> .
<i>Rectidens</i> ...	<i>sumatrensis</i> (= <i>Unio</i> <i>sumatrensis</i> , Dnkr.) <i>palembangensis</i> .	<i>gracilis, pressirostris</i> .	
<i>Physunio</i> ...	<i>superbus</i> .		
<i>Monodontina</i> ...	...	<i>vondembuschianus</i> ...	<i>vondembuschiana</i> , var. <i>chaperi</i> .
<i>Pseudodon</i> ...	...	<i>bicristatus</i> .	
<i>Trapezoides</i> ...	<i>peninsularis</i> (= <i>Unio</i> <i>sumatrensis</i> , Sow.)		
<i>Diplodon</i> ...	<i>novo-Hollandiae</i> (= <i>Unio</i> <i>cucumoides</i> , Lea).		
LUCINIDAE.			
<i>Lucina</i> (<i>Anodontia</i>)...	<i>phillipinarum</i> .		
CYRENIDAE.			
<i>Cyrnae</i> ...	<i>sumatrensis</i> ...	...	<i>sumatrensis</i> .
<i>Batissa</i> ...	<i>jayensis</i> ...	<i>sphaericula, violacea</i> var. <i>discoidea</i> .	

	von. Marten's list (1897).	Species described or recorded since von Marten's paper in 1897.	Mr. den Doop's collection.
<i>Corbicula</i> ...	<i>moltkeana, tumida, ducalis, trapezoida, angulifera, pullata, lacustris, gibba.</i>	<i>gustairana, tobae, sulcata, moussoni, subrostrata.</i>	<i>moltkeana, trapezoida, angulifera, pullata.</i>
<i>Sphaerium</i> ...	... ..	... ..	<i>ceciliae</i> (sp. nov.).
<i>Pisidium</i> ...	<i>sumatranum.</i>		
GLAUCOMYIIDAE.			
<i>Glaucomya</i> ...	<i>sumatrensis.</i>		
PSAMOBIIDAE.			
<i>Elizia</i> ...	<i>orbicularis.</i>		
<i>Psmamotellina</i> ...	<i>palleus.</i>		
<i>Asaphis</i> ...	<i>rugosa.</i>		
SOLENIDAE.			
<i>Siliqua</i> ...	<i>radiata, winteriana.</i>		
<i>Cultellus</i> , s.s. ...	<i>attenuatus.</i>		
Subg. <i>Pharella</i> ...	<i>javanicus</i> ...	... ..	<i>javanicus.</i>
PHOLADIDAE.			
<i>Teredo</i> ...	... ..		
Subg. <i>Cuphus</i> ...	<i>arenaria</i> ...	... ..	<i>arenaria.</i>

Family AURICULIDAE.

Genus *Pythia*, Link.

Specimens of three species of this genus are represented in the collection. Of these *P. undata* was the only form hitherto collected from Sumatra. The other two species *P. trigona* and *P. plicata*, though known from the adjacent islands, had never been taken in Sumatra. *P. pantherina* has also been recorded from Sumatra by von Martens, but is not represented in the present collection.

Pythia trigona (Troschel).

1897. *Pythia trigona*, von Martens, *op. cit.*, pp. 130, 131, pl. viii, fig. 1.

This widely distributed species had, as noted above, been never recorded from Sumatra before. It is represented in Mr. den Doop's collection by a few specimens collected in the mangrove-swamps at Belawan (Deli) and at a pematang¹ in the estate of Batang Kwis (Serdang) also near the mouth of the Soengei Batang Kwis (Serdang). All the specimens are quite typical.

¹ A pematang is an old sandy strand ridge along the coast formed by elevation of the land as yet situated in the mangrove-swamps or (older) fresh-water swamps near the coast. [den Doop].

***Pythia plicata* (Fer.).**

1897. *Pythia plicata*, v. Martens, *op. cit.*, pp. 131-133.

The only specimen of this species was collected in the mangrove-swamps at Belawan (Deli). I have no doubt as to its correct identification.

***Pythia undata* (Less.).**

1897. *Pythia undata*, v. Martens, *op. cit.*, pp. 139-140.

A single specimen of this species, collected in the mangrove-swamps at Belawan (Deli), is represented in the Sumatran collection.

Genus *Cassidula*, Fer.***Cassidula auris-felis* (Brug.).**

1897. *Cassidula auris-felis*, v. Martens, *op. cit.*, pp. 141, 142, pl. viii, figs. 12-14.

A large number of specimens of this variable species were collected in the mangrove-swamps at Belawan (Deli), from the mouth of the Soengei Batang Kwis (Serdang) and at Perbaoengan (Serdang). Most of these resemble fig. 13 of von Martens, but a few are like fig. 14 as regards the shape of the mouth.

Genus *Auricula*, Lam.

This genus is represented by four species, two of which are new. The descriptions of these new forms were drawn up by Dr. Annandale and are here included to make the account of Mr. den Doop's collection complete.

***Auricula midae* (Linn.).**

1897. *Auricula Midae*, v. Martens, *op. cit.*, pp. 150-152.

I have adopted with von Martens the name *A. midae* in preference to the name *A. auris-Midae* used in Küster's Monograph in Martini and Chemnitz *Conch. Cab.*

A fairly full account of the anatomy of the species is included in Quoy and Gaimard's work ¹ and the radular teeth are also figured.

In the Sumatran collection it is represented by a few specimens collected in the mangrove-swamps at Perbaoengan (Serdang) and at Belawan (Deli). A few were also collected on the sea-shore at Perbaoengan (Serdang).

***Auricula judae* (Linn.).**

1897. *Auricula Judae*, v. Martens, *op. cit.*, pp. 154-158, pl. vii, figs. 6-11.

Von Martens has treated the question of the various forms of this variable species in great detail, and published good figures.

In the Sumatran collection there are three specimens collected by Mr. den Doop along with those of *A. midae* in the mangrove-

¹ *Voy. Astrolabe Zool.* II, p. 156, pl. xiv, figs. 1-14 (1832).

swamps at Belawan (Deli) and on the sea-shore at Perbaoengen (Serdang). Two of the specimens resemble fig. 7 of v. Martens, and one is like his fig. 11.

Auricula limnaeiformis, Annandale (sp. nov.).

(Plate xiv, figs. 1, 2).

Shell of moderate size, imperforate, very thin, spindle-shaped, acuminate, with the anterior extremity bluntly pointed if examined microscopically; the greatest diameter about $\frac{3}{5}$ the height. Suture somewhat impressed, hardly oblique. Spire rather narrowly conical, $\frac{1}{2}$ the length of the body-whorl, with seven complete whorls; its whorls not at all swollen, increasing gradually and evenly. Body-whorl triangular, very little swollen, almost bilaterally symmetrical. Mouth long and narrow, sharply pointed posteriorly and bluntly pointed anteriorly; its main axis forming an acute angle with that of the shell; outer lip thin; columellar and parietal teeth rather feebly developed. Periostracum thin, bright olive-green, rather dull. Longitudinal sculpture obscure, irregular, spiral sculpture on the spire consisting of numerous guttate lines confined to the upper half of each whorl, similar lines covering the whole of the body-whorl but much stronger over the posterior region than over the greater part of its area. On this posterior region irregular longitudinal branching ridges can also be detected with the aid of a hand lens.

Measurements of shells (in millimetres).

	A (Type).	B.
Height	28.5	19.5
Maximum diameter	16	11.1
Height of mouth	19	13.2
Maximum diameter of mouth	7	5

The two shells of this interesting species were obtained by Mr. den Doop at Perbaoengan (Serdang).

The shell of this species is remarkable for its thinness and for the absence of any thickening of the lip. It is somewhat *Limnaea*-like in appearance. Nothing is known about its anatomy.

Auricula percha, Annandale (sp. nov.).

(Plate xiv, figs. 3, 4).

Shell of fair size, spindle-shaped, imperforate, moderately thin, slightly corroded at the posterior extremity but apparently blunt, with the anterior extremity bluntly pointed, the greatest diameter about $\frac{1}{2}$ the height. Five and a half whorls in all. Suture not impressed and slightly oblique. Spire broadly conoidal, contained about $3\frac{3}{4}$ times in the body-whorl; last whorl as high as the first two taken together. Body-whorl long, narrow and ovoid, not at all swollen, bluntly pointed anteriorly, bilaterally asymmetrical. Mouth long and narrow, sharply pointed pos-

teriorly and narrowly rounded anteriorly, its main axis forming an acute angle with that of the shell, the outer lip with a well defined internal ridge but sharp at the edge; columellar tooth obsolete, parietal of moderate size. Periostracum thin, bright chestnut, streaked on the body-whorl with irregular deep brown longitudinal stripes; longitudinal sculpture consisting of irregularly sinuate lines; the whole surface covered with minute tubercular spiral lines, which become gradually less well developed from behind forwards but never disappear altogether.

The single specimen of this shell, collected by Mr. den Doop in a mangrove-swamp at Batang Kwis (Serdang), measures 36.7 mm. by 18.2 mm., the mouth measures 26.7 mm. by 8.5 mm.

The shell resembles *A. morchi*, Menke, in outline and colour, but it is evidently thinner and has the suture less impressed and the parietal tooth much better developed. The mouth also is more elongate and the lip much thinner. The species is interesting as providing a link between the large thick-shelled forms of the genus and the small thin-shelled species.

Family LIMNAEIDAE.

Genus *Limnaea*, Lamarck.

Two species of this genus, *L. javanica* (Mouss.) and the highly peculiar *L. brevispira*, v. Martens, have been recorded from Sumatra,¹ but only the former is represented in the present collection.

Limnaea javanica (Mouss.).

1849. *Limnaeus succineus* var. *javanica*, Mousson, *Moll. Java*, pp. 42, 43, pl. v, fig. 1.
1897. *Limnaea javanica*, v. Martens, *op. cit.*, p. 3.
1899. *Limnaea javanica*, Dautzenberg, *Mem. Soc. Roy. Malacol. Belgique*, XXIV, p. 8.
1912-1913. *Limnaea javanica*, var., Schepmann, *Proc. Malacol. Soc. London*, X, pp. 235, 236.

Mousson described this species as a variety of *Limnaea succinea*, Desh., but as v. Martens and others have shown, the species, though allied to it, is quite distinct. It may also be noted here that *L. succinea*, Desh. is only a synonym or at the most a form of *L. luteola*, Lam.

In the Sumatran collection this variable species is represented by a large series of specimens from various localities. None of the specimens belong to the typical form, but specimens of the following six forms described by v. Martens are present:—*intumescens*, *subteres*, *angustior*, *porrecta*, *costulata* and *turgidula*. Besides the above there are a few individuals which it is not possible to assign to varietal rank.

¹ Prof. Max Weber collected especially in the western south half of Sumatra. These regions are geologically more related to Java, whereas the north half of Sumatra generally has more relations to the continent of Asia. [den Doop].

var. *intumescens*, v. Martens.

1881. *Limnaea Javanica* var. *intumescens*, v. Martens, *Conch. Mitth.* I, p. 88, pl. xvi, figs. 2-4.
 1897. *Limnaea javanica* var. *intumescens*, v. Martens, *op. cit.*, p. 3, pl. i, fig. 5.
 1898. *Limnaea javanica* var. *intumescens*, Sarasin, P. and F., *Süssw. Moll. Celebes*, p. 89.
 1900. *Limnaea javanica* var. *intumescens*, v. Martens, *Nachr. Malakozool. Ges.* XXXII, p. 10.
 1912-13. *Limnaea javanica* var. *intumescens*, Schepmann, *op. cit.*, pp. 235, 236.

This variety is one of the lake-forms of this species and shows the characters of the lake-forms.

Specimens closely agreeing with a specimen identified by the later Dr. E. von Martens and with his published figures are represented in the collection from freshwater areas at Mariendal (Deli), Poengei (Langkat), the Soengei Bohorok and Anak Laut (a freshwater lake in the isle of Sabang). Some young specimens from pools in the Lau Kling Valley and the Lau Goemba Valley (Karo-Batak High Plain) near Brastagei also seem to belong to this form. There are a few examples with the locality label 'Mangrove, Belawan (Deli).' Probably they had been carried into this area with the fresh-water flowing into it, if the labels have not got mixed.¹

This form is already recorded from Java, Sumatra and Celebes.

var. *subteres*, v. Martens.

1881. *Limnaea Javanica* var. *subteres*, v. Martens, *op. cit.*, p. 88, pl. xvi, figs. 6, 7.
 1897. *Limnaea javanica* var. *subteres*, v. Martens, *op. cit.*, p. 4.

This form appears from the shell-characters to be a stream-phase of *L. javanica*. It is represented in the collection by many specimens from the Valley of the Lau Kling (Karo Batak High Plain) and Soengei Landak (Upper Langkat). All the specimens, though rather small, are fully typical.

This form is also known from the Celebes.

var. *angustior*, v. Martens.

1881. *Limnaea Javanica* var. *angustior*, v. Martens, *op. cit.*, pp. 88, 89, pl. xvi, fig. 9.
 1897. *Limnaea javanica* var. *angustior*, v. Martens, *op. cit.*, pp. 4, 5, pl. I, fig. 7.
 1898. *Limnaea javanica* var. *angustior*, Sarasin, F. and P., *op. cit.*, p. 89.
 1900. *Limnaea javanica* var. *angustior*, v. Martens, *op. cit.*, p. 10.

L. javanica var. *angustior* appears to be a true stream-phase of the species in spite of the fact that v. Martens has recorded

¹ At many places the mangrove-swamps (mangrove-boschen) pass gradually into fresh-water swamps (moreas-boschen). At some places these two areas are only separated by a pematang. A sharp limit in plant growth does not exist. The shells mentioned are from such regions. [den Doop].

some specimens from ponds at Makassar. The elongate, slender form of the shells clearly points to their having had this habitat.

In the collection the specimens of this phase are from a streamlet next Timbang Langkat.

var. *porrecta*, v. Martens.

1881. *Limnaea Javanica* var. *porrecta*, v. Martens, *op. cit.*, p. 89, pl. xvi, figs. 9, 10.
 1897. *Limnaea javanica* var. *porrecta*, v. Martens, *op. cit.*, p. 5.
 1898. *Limnaea javanica* var. *porrecta*, Sarasin, P. and F., *op. cit.*, p. 89.

This form, which is still more elongate than the var. *angustior* and has a much longer and more regular spire, has been recorded from Sumatra by von Martens. It is also known from Java and the Kupang Islands, Timor.

The only specimens I assign to it were collected in a fresh-water area near Tandjong Djatti (Langkat). All the specimens are rather young, but I have no doubt as to their identification.

var. *costulata*, v. Martens.

1897. *Limnaea javanica* var. *costulata*, v. Martens, *op. cit.*, p. 2, figs. 3-7, pl. xii, figs. 2, 4.

This variety was described by von Martens from specimens collected by Prof. Max Weber in Tjipanas, Java, and I have, through the courtesy of Prof. Max Weber, had a chance of examining one of the co-types.

Mr. den Doop's specimens are from a streamlet near Timbang Langkat, and a few young specimens from near Medan. The costae on the shells are not so well developed as in the co-type, but there is no doubt that the shells belong to the variety.

var. *turgidula*, v. Martens.

1897. *Limnaea javanica* var. *turgidula*, v. Martens, *op. cit.*, p. 4, pl. i, fig. 6.

This elegant form is known only from Sumatra. My specimens closely agree with one of von Martens' co-types and his figure of the shell. They were collected in the Valley of the Lau Goemba¹ (Karo-Batak High-Plain) near Brastagei and from the stream Soengei Landak (Upper Langkat).

Family PLANORBIDAE.

Genus *Indoplanorbis*, Annandale and Prashad.

Recently Dr. Annandale² and I have found it necessary to separate the common Indian species hitherto known as *Planorbis*

¹ I remember that I collected here many specimens of a *Limnaea* among which there were some two per cent of left-handed shells. They were from a little rice-field in the valley beneath. [den Doop].

² *Ind. Journ. Med. Research*, VIII, p. 113 (1920).

exustus, Deshayes, as the type of a distinct genus on purely anatomical grounds. A full account of the animal and our reasons for adopting this course are given in a paper shortly to be published in the *Records of the Indian Museum*, but a few notes are included here to facilitate reference.

Indoplanorbis exustus (Deshayes).

- 1834. *Planorbis exustus*, Deshayes, *Voyage Belanger Indes-Orient. Zool.*, p. 417, pl. i, figs. 11-13.
- 1836. *Planorbis indicus*, Benson, *Fourn. As. Soc. Bengal* V, p. 743.
- 1856. *Planorbis Coromandelicus* and *P. zebrinus*, Dunker, in *Mart. Chemn. Conch.-Cab*, pp. 43, 57, pl. vi, figs. 14-16, 20, 22, and pl. vi, figs. 11-13.
- 1876. *Planorbis exustus*, ? *P. zebrinus* and *P. Merguiensis*, Hanley and Theobald, *Conch. Ind.*, pp. XVIII and 18, 60, pl. xl, fig. 1, pl. cli, figs. 5, 6.
- 1878. *Planorbis exustus* *P. Coromandelicus*, *P. eburneus*, *P. brunneus*, *P. Merguiensis* and *P. orientalis*, Sowerby in *Reeve's Conch. Icon.*, pl. iv, figs. 31, 34; pl. v, figs. 38 a-c, 40a, b; pl. xi, fig. 85 and fig. 89.
- 1897. *Planorbis exustus* (*Coromandelicus*, Beck, *Indicus*, Benson), v. Martens, *op. cit.*, p. 12.
- 1915. *Planorbis exustus* with vars. *eburneus*, *brunneus* and *zonatus*. *P. zebrinus*, *P. orientalis* and *P. Merguiensis*, Preston, *Faun. Brit. Ind. Freshw.-Moll.* pp. 115-118.

Dr. L. Germain of the Paris Museum, after a detailed examination of numerous shells of this species in the large collection of Planorbidae¹ in the Indian Museum has concluded that the various so-called species (with the exception of *P. orientalis*, Lamarck), included in the synonymy given above are all synonymous and should be known as *P. exustus*, Deshayes. I include *P. orientalis*, Lamarck, also in this synonymy as the differences noted by Lamarck² are of the same nature as the variations exhibited so commonly by this very variable species. The reasons that prompted Dr. Annandale and myself to create the new genus *Indoplanorbis* may be briefly stated as follows:—The branchial process is not a simple structure as in other members of the genus *Planorbis*, Geoff., but is distinctly lobed, the radula is rather large and broad and the penis is a long cylindrical tube without any stylet or retractor muscles.

Von Martens (*loc. cit.*) recorded the occurrence of this species from near Deli, Sumatra and in the present collection there are large numbers of specimens from various localities. Dr. L. Germain in his "Catalogue," referred to already, has discussed at length the variations exhibited by this species in the form of the spire, the mouth-aperture, the size of the shell, its colour and structure, and the sculpture on the various whorls. All these

¹ The results of Dr. Germain's work on the Indian Museum collection are being published as a special volume in the *Records of the Indian Museum*, and I have had the advantage of consulting the original manuscript and drawings of this valuable work.

² *His. Nat. Anim. Vertebres*, 2nd edition, p. 385 (1838).

points are beautifully illustrated by the large Sumatran collection before me and I include below a few notes regarding the shells of different types from the various localities.

Most of the shells are from fresh-water areas on the outskirts of Deli. They consist of many lots collected at different times by Mr. den Doop and Mr. J. B. Corporaal at Medan, Medan Estate, Padang Boelan and Mariëndal Soengei. These lots include shells of different types, varying in colour from pale yellow to dark brown and even black. The last are of this colour owing to a black deposit on their surface. The sculpture also is variable, some of the shells are quite smooth, others have delicate oblique striae more marked on the body-whorl than elsewhere, while in some cases the striae are so prominent as to look like low ridges. The shape of the aperture is also different, in some shells it is nearly subcircular, not much higher than broad, in others it has a distinct campanulate appearance, while others still show a distinct angulation, making the curvature much less regular but more prominent and the upper side rather straight. Young *Physa*-like shells in the earlier stages of development as recorded by Annandale¹ and Germain among Indian specimens are also present. A few shells resemble the *coromandelicus* form, others are identical with *zebrinus*, and a few others resemble the figures of *brunneus* and *eburneus* in Sowerby's monograph.

Other Sumatran localities from which the species was collected are rice-fields at Perbaoengan (Serdang), Serdang Estate; Batang Kwis; in a fresh-water lake near Perbaoengan; Anak Laut (in the isle of Sabang); and a streamlet near Timbang Lankat. These shells are also of the same types as the ones from Deli, except those collected from the Timbang Langkat streamlet, which are rather smaller, have a smaller mouth and have the striae on the surface much coarser.

The following are the measurements (in millimetres) of some shells from various localities :—

Locality.	Maximum diameter.	Minimum diameter.	Total Height.	Diameter of aperture.	Height of aperture.
1. Medan Estate ...	12	10	5	5.8	6
2. Near Medan ...	15.7	13	6.8	6.9	7.8
3. Rice-fields (Serdang) ...	14.6	12.2	6.3	6.4	7.7
4. Padang Boelan ...	15.5	13.2	6	6.8	8.6
5. Near Perbaoengan.	11.5	9.5	5.5	6	6.8
6. Streamlet at Timbang Langkat ...	10.1	8.4	5.6	4.6	6.5

Genus *Gyraulus*, Agassiz.

Gyraulus convexiusculus (Hutton).

1897. *Planorbis compressus*, v. Martens, *op. cit.*, pp. 13, 14, pl. i, figs. 17-21; pl. xii, figs. 7, 10.

¹ *Rec. Ind. Mus.* XIV, pp. 111, 112, figs. 1, 1a (1918).

1919. *Gyraulus convexiusculus*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 52-54, figs. 6c, 7b, 8b.
 1920. *Gyraulus convexiusculus*, Annandale, *Rec. Ind. Mus.* XVIII, p. 148.

As has been recently shown by Dr. Annandale and myself the correct name for the species identified as *Planorbis compressus* by von Martens is *G. convexiusculus*. In the same paper we have published figures of the shell, the radula and the genitalia. I have now compared a shell from Makassar, Celebes, identified by the late Dr. E. von Martens as *P. compressus* with Indian and Mesopotamian specimens and have no doubt that they are identical.

The specimens before me are from freshwater areas at Padang Boelan and from Anak Laut (a fresh-water lake) at Sabang.

***Gyraulus sumatranus* (v. Martens).**

1897. *Planorbis sumatranus*. v. Martens, *op. cit.*, p. 12, pl. i, figs. 8-10; pl. xii, figs. 6-9.

An examination of one of von Martens' co types from Danau di bawah, Sumatra, has confirmed my impression that this species also belongs to the genus *Gyraulus* and not to *Planorbis*, as von Martens believed.

In the present collection the species is represented by a number of small specimens from Anak Laut (Sabang), collected along with those of *P. convexiusculus* and *G. proclivis*.

***Gyraulus proclivis* (v. Martens).**

1897. *Planorbis proclivis*, v. Martens, *op. cit.*, pp. 12, 13, pl. i, figs. 11-16.

This species also belongs to the genus *Gyraulus*. The few specimens of it were collected along with those of the other two species of the genus in the freshwater lake Anak Laut (Sabang).

Genus *Segmentina*, Fleming.

***Segmentina calathus* (Benson).**

1897. *Planorbis (Segmentina) calathus*, v. Martens, *op. cit.*, p. 15.
 1917. *Segmentina calathus*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 56, 57, figs. 5D (not F) and 8C.

A few dry shells of this widely distributed species are represented in the collection from near Medan. The specimens are all rather small in size, and are of a shining amber colour.

Genus *Physastra*, Tapparone-Canefri.

In a recent paper Annandale¹ has discussed the question of the synonymy of the genus *Bullinus*. Shortly before this Hedley²

¹ *Rec. Ind. Mus.* XV, pp. 167, 168 (1918).

² *Rec. Aust. Mus.* XII, p. 18, pls. i, ii (1917).

had published critical notes of the Victorian species of *Bullinus* but his conclusions do not seem to be quite correct. He separated, with Tate,¹ a group of species in which the columella has no fold (*Isidora* with *Isidorella* as a synonym) from others with a distinct columellar fold (*Bullinus*). The name *Isidora*, however, as Cook² and Annandale have shown is strictly synonymous with *Bullinus*, and Hedley's conclusions, therefore, are inaccurate so far as it is concerned. The position, so far as can be judged from the available literature and the material at my disposal, is as follows:—The name *Bullinus*³ under the circumstances should be reserved for the more globose type of shells without any or with a poorly developed columellar fold; this will include the genus *Isidorella*, Tate, or what Hedley designated as *Isidora*; while the more elongate shells with *Limnaea*-like facies and with a distinctly produced spire and with the characteristic columellar fold may be separated as *Physastra*, Tapparone-Canefri.⁴ It is possible that this name may be synonymous with the much earlier name *Pyrgophysa*, Crosse,⁵ but there is much uncertainty as to the structure of the type-species *P. mariei*. So far as the form of the shell is concerned *Physastra* seems to bear the same relation to *Bullinus* as *Aplecta* does to *Physa*, but there is clearly less anatomical difference.

I regard *Physastra* as a genus rather than a subgenus of *Bullinus* as the difference between the two genera are, in my opinion, of sufficient importance to separate them as such. They are, however, very closely related. As understood by me the genus *Physastra* would include *P. vestita*, Tapparone-Canefri, from New Guinea, the species *sumatrana*, *ovalina*, *minahassae*, *timorensis*, *celebensis* and *stagnalis* from the Dutch East Indies referred to the genus *Isidora* by v. Martens (*loc. cit.*, pp. 6–11), Bollinger's *badae* and doubtfully *sarsinorum*⁶ and probably most of the long-spined forms known from Australia and the adjoining islands and catalogued by Tate and Brazier,⁷ Smith,⁸ Cocke, Hedley and Suter.⁹ It is not, however, possible for me with the limited material at my disposal to go into the question in greater detail.

The only specimens of this genus collected by Mr. den Doop belong to a new species which I have described as *P. doopi*.

¹ *Rep. Horn-Exped. Zool.* II, p. 212 (1896).

² *Proc. Zool. Soc. London*, pp. 136–143 (1889).

³ I agree with Dr. Annandale in adopting the generic name *Bullinus* instead of *Isidora* in spite of what Kennard and Woodward have said [*Proc. Malacol. Soc. London* XIV, pp. 86–88 (1920)] because of the wide usage of this name in medical nomenclature. See also *Nature* Vol. 106, p. 251 (October 1920).

⁴ *Ann. Mus. Civ. Stor. Nat. Genova*, XIX, p. 245 (1883).

⁵ *Fourn. Conchyliol.* 3rd ser. XIX, pp. 208, 209 (1879) and XX, pp. 141, 142, pl. iv, fig. 5 (1880).

⁶ *Rev. Suiss. Zool.* XXII, pp. 570–572, pl. xviii, figs. 7 (a, b) and 8 (a, b) 1914).

⁷ *Proc. Linn. Soc. N. S. Wales*, VI, pp. 552–569 (1881).

⁸ *Fourn. Linn. Soc. London (Zool.)*, XVI, p. 275 (1882).

⁹ *Man. New Zealand Moll.* pp. 610–615 (1913).

Physastra doopi, Prashad (sp. nov.).

(Plate xiv, figs. 5, 6).

The shell is elongate-ovate, subrimate, nearly smooth or with very fine striae; in the last part of the body-whorl these longitudinal and somewhat curved striae are more prominent. There are $5\frac{1}{2}$ — $6\frac{1}{2}$ somewhat swollen whorls. The suture is very oblique and moderately impressed. The body-whorl is narrowly heart-shaped, with the outer outline markedly sinuate and somewhat emarginate towards the anterior extremity, its antero-external angle is rounded; the inner outline is evenly but not strongly curved. The mouth is elongate elliptical, extending backwards for more than $\frac{4}{5}$ of the body-whorl and is two and a half times as long as broad. It is narrowly pointed posteriorly, but, owing to the slight recurving of the outer lip in this region, the angulation is quite distinctly visible. The outer lip is sharp and not at all thickened; it is, as noted already, slightly recurved in the upper region. The peristome is continuous; the callus is rather narrow and only slightly thickened; the columella shows a distinct but rather faint fold near its posterior end. The shell is of a dull brownish colour and the apex is black.

In some of the specimens the mouth is rather broader and the spire a little shorter.

Measurement of shells (in millimetres).

	1 (Type)	2	3	4
Length ...	16	14.6	14.5	14.3
Maximum breadth ...	8.3	8	7.6	8.4
Length of spire ...	6	5.4	5.5	4.9
Height of aperture ...	10	8.8	9	9.4
Breadth of aperture ...	4.4	4.3	4.4	4.2

Locality.—The eight specimens of this species in the collection were obtained by Mr. den Doop in the valley of the Lau Kling stream (Karo-Batak High Plain near Brastagei).

Remarks.—The species is allied to *P. sumatrana* (v. Martens), but has the shell comparatively shorter and broader, the spire less elongate, the mouth much less broad and the outer lip thin and only slightly retroverted. The fold of the columella is less deep.

I have great pleasure in naming this species after Mr. den Doop, to whose careful collecting and keenness is due the great advance in our knowledge of the aquatic fauna of Sumatra.

Family AMPULLARIIDAE.

Genus **Pachylabra**, Swainson.

1911. *Pachylabra*, Kobelt, *Martini and Chemnitz Conch.-Cab., Ampullariidae*, pp. 44-46.

I have adopted with Kobelt the generic name *Pachylabra*, Swainson, for the Oriental and African species of the family Ampullariidae. The genus is distinguished from the American *Am-*

pullaria, Lam., by the structure of the operculum and the inhalent siphon. In *Pachylabra* the operculum is a massive calcareous structure with a coarse external horny covering, while the siphon, when expanded, is a funnel-shaped structure considerably broader than long, when contracted it is a prominent fold on the left side of the head forming an incomplete tube not much longer than its transverse diameter.

Pachylabra conica (Gray).

- 1828. *Ampullaria conica*, Gray, *Supp. Wood's Index Test.*, pl. vii, fig. 22.
- 1848. *Ampullaria orientalis*, Philippi, *Zeitschr. Malakozool.*, p. 192.
- 1849. *Ampullaria scutata*, Mousson, *Moll. Java*, p. 60, pl. vii, fig. 2.
- 1851. *Ampullaria scutata*, Philippi, *Mart. Chem. Conch. Cab.*, p. 9, pl. i, figs. 4, 5.
- 1854. *Ampullaria conica*, Hanley, *Conch. Miscell.*, pl. iii, fig. 13.
- 1854. *Ampullaria conica*, and *A. Javanica*, Reeve, *Conch. Icon.*, pl. ii, fig. 10; pl. xx, fig. 26.
- 1857. *Ampullaria scutata*, v. Martens, *Malakozool. Blatt.*, p. 186.
- 1877. *Ampullaria conica* near type form, var. *orientalis* and ? *borneensis*, Nevill, *Cat. Moll. Ind. Mus. Fas. E.*, pp. 7-10.
- 1885. *Ampullaria conica* typical form, vars. *orientalis* and ? *borneensis*, Nevill, *Hand-List Moll. Ind. Mus.* II, p. 5.
- 1890. *Ampullaria conica* var. *Javanica*, Boettger, *Ber. Senckenb. Naturg. Ges.*, p. 156.
- 1897. *Ampullaria scutata* v. Martens, *op. cit.*, pp. 18, 19.
- 1898. *Ampullaria scutata*, Sarasin, P. and F., *Moll. Celebes*, I, p. 69.
- 1910. *Ampullaria conica*, and vars. *borneensis*, *Javanica*, *orientalis* and *scutata*, Sowerby, *Proc. Malacol. Soc. London*, IX, pp. 57, 58.
- 1911. *Pachylabra conica*, and *P. javanica*, Kobelt, *op. cit.*, pp. 93, 94, 83, 84, pl. XI, figs. 1-5, 8, 9, and pl. xxxv, figs. 5, 6.
- 1913. *Ampullaria scutata*, Schepmann, *Proc. Malacol. Soc. London*, X, p. 236.
- 1915. *Pila conica* and var. *orientalis*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, pp. 100, 101.
- 1920. *Pachylabra conica*, Annandale, *Fourn. Nat. Hist. Soc. Siam*, IV pp. 9, 10, pl. i, fig. 3 and pl. ii, fig. 2.

The above fairly complete synonymy is given in view of the great differences of opinion that have existed regarding the form named *Ampullaria conica* by Gray. Von Martens considered the name *conica*, as used in Wood's Index, as being too doubtful to apply to the Javanese species. There remains no doubt, however, if we take Hanley's figure, which is a delineation of Gray's type, as representing *conica*. I have, therefore, with Sowerby adopted Gray's name in preference to Mousson's *scutata*, though I do not agree with Sowerby in considering *lubrica*, *stoliczkana*¹ and *turbinoides* as varieties of this species. The forms *orientalis*, *borneensis* and *javanica* certainly belong to it. Philippi and Kobelt regard the latter two as distinct species, but an examination of the collections in the Indian Museum does not uphold their conclusions. The specimens of these forms show a clear gradation towards *conica*, and must be assigned to it. Owing to the paucity of material

¹ Most authors seem to have missed Nevill's paper (*Fourn. As. Soc. Bengal*, L. pt. ii, p. 155, pl. vi, figs. II, IIA) in which he gives good figures of this interesting species.

at my disposal I am, however, unable to definitely decide as to whether they should be considered as distinct varieties.

Schepmann has referred to the peculiar vermiculations round the pad on the inner surface of the operculum of *P. conica*. This character which was also pointed out by Mousson in his description of *scutata* and is well shown in his figure, is a constant character of the species.

The Sumatran specimens are from fresh-water areas near Poengei and Talang Koeda, and from the Soengei Minahol.

***Pachylabra ampullacea* (Linn.).**

- 1885. *Ampullaria ampullacea* and var. *javaensis*, Nevill, *op. cit.*, pp. 5, 6.
- 1890. *Ampullaria ampullacea*, Boettger, *op. cit.*, p. 155.
- 1896. *Ampullaria ampullacea*, Schepmann, *Notes Leyden Mus.* XVII, p. 159.
- 1897. *Ampullaria ampullacea*, v. Martens, *op. cit.*, p. 18.
- 1898. *Ampullaria ampullacea*, Sarasin, P. and F., *op. cit.*, p. 68.
- 1899. *Ampullaria ampullacea*, Dautzenberg, *Ann. Soc. Malakol. Belgique*, XXXIV p. 17.
- 1900. *Ampullaria ampullacea* var. *sumatrensis*, v. Martens, *Nachr.-Bl. Deut. Malakozool. Ges.* XXXII, p. 10.
- 1910. *Ampullaria ampullacea*, Sowerby, *op. cit.*, p. 66.
- 1911. *Pachylabra ampullacea*, Kobelt, *op. cit.*, pp. 76-78.
- 1913. *Ampullaria ampullacea*, Kruiemel, *Bijdr. Dierkunde Amsterdam*, p. 226.
- 1915. *Ampullaria ampullacea*, Bollinger, *Rev. Suisse. Zool.* XXII, pp. 507, 568.

Authors have experienced great difficulty in ascertaining the exact species, which was named *Helix ampullacea* by Linnaeus. His description in the "Museum Ulricae" is unfortunately incomplete, and, as has been pointed out by Hanley,¹ contradictory. In the Linnaean collection, however, Hanley found a marked shell, which probably Linnaeus meant to be the type of the species described in his "Systema," but Philippi to whom Hanley sent a sketch of this specimen considered it to belong to a distinct species, which he named *A. linnaei*. Philippi, in his monograph² doubtfully considered *A. ampullacea* as synonymous with *A. celebensis* and considered the various species, which later Reeve rightly considered as synonymous, as distinct. Reeve³ appears to have been the first author who correctly understood the species named *Helix ampullacea* by Linnaeus. He included in this species *A. magnifica*, Dunker, *A. sumatrensis*, Philippi and *A. celebensis*, Quoy and Gaimard, but considered *A. linnaei*, Philippi, as distinct. Nevill followed von Martens and possibly Reeve as regards the synonymy of the species, but considered *A. celebensis*, Mousson⁴ (not Quoy and Gaimard⁵) as a distinct variety, which he

¹ Hanley, *Ipsa Linnaei Conchylia*, pp. 368, 369 (London, 1855).

² *Ampullaria* in *Martini and Chemnitz Conch.-Cab.*, p. 58 (1851).

³ *Conchologia Iconica*, pl. x, fig. 48 (1854).

⁴ *Moll. Fava*, p. 60, pl. ix, fig. 2 (1849).

⁵ *Voy. Astrolabe Zool.* III, pp. 167-169 (1834).

named *javensis*. The latter, as Boettger has shown, is the same as *magnifica*, Dunker. The other authors, cited in the references above, have followed v. Martens who agreed with Reeve's conclusions in his first paper but in 1910 considered *sumatrensis* as worthy of varietal rank. Kobelt in his recent work included *A. linnaei* with others in the synonym of *P. ampullacea*, but was doubtfully inclined to consider the forms *sumatrensis*, *celebensis* and *magnifica* as worthy of varietal ranks, a conclusion with which I agree. Of these var. *celebensis* represents the *forma typica*. These three forms may be distinguished as follows:—

1. Shell globose-ovate, scarcely rimate, spire more than $\frac{1}{3}$ of the total length with the whorls increasing evenly in size, aperture narrower than in the var. *sumatrensis* ... *forma typica* (= *celebensis*).
2. Shell globose, narrowly umbilicate, spire about $\frac{1}{3}$ of the total length but with the whorls rapidly increasing in size, aperture rather broad ... var. *sumatrensis*.
3. Shell subglobose, comparatively larger than in the other two forms, very narrowly umbilicate, spire short, less than $\frac{1}{3}$ of the total length, whorls rapidly increasing in size but less pronounced than in the other two forms, aperture oblong, about twice as long as broad ... var. *magnifica*.

Specimens of the *forma typica* (= *celebensis*) are represented from fresh-water areas near Perbaoengan and from rice-fields near the same place, also from the Kroeeng Seunara (Sabang). A few dry shells from Perbaoengan are labelled as coming from the mangrove-swamp region near Perbaoengan, where they were probably carried with the current.

Specimens of the *sumatrensis* form were all collected in fresh-water areas near Medan.

There are three specimens from Talang Koeda which I assign doubtfully to the var. *magnifica*. It is impossible to identify these specimens definitely as all of them are young, and have not developed the characters of the fully-grown adults.

Family VIVIPARIDAE.

Genus *Vivipara*, Lam.

This genus is represented in the collection by three species, *V. sumatrensis*, *V. javanica* and the new species described here as *V. hendrici*.

Vivipara sumatrensis (Dunker).

1852. *Paludina sumatrensis*, Dunker, *Zeitschr. Malakozool.* p. 128.
 1864. *Paludina sumatrensis*, Reeve, *Conch. Icon.* XIV, pl. x, sp. 65a, b.
 1875. *Paludina sumatrensis* (in part), Morelet, *Ser. Conchyliol.* IV pp. 304-306.
 1885. *Paludina bengalensis* subsp. *polygramma* (in part), Nevill, *Hand-List Moll. Ind. Mus.* II, p. 22.
 1896. *Paludina sumatrensis*, Schepmann, *Notes Leyden Mus.* XVII, p. 159.
 1897. *Vivipara sumatrensis*, v. Martens, *op. cit.*, p. 24, pl. x.

1900. *Vivipara sumatrensis*, v. Martens, *Nachr. Malakozool. Ges.* XXXII, p. 10.
 1909. *Vivipara sumatrensis*, Kobelt, *Martini and Chemnitz Conch.-Cab.* (ed. Kuster), pp. 276, 277, pl. lvi, figs. 9-12.

There has been some difference of opinion as to whether *V. sumatrensis* should be considered a species distinct from *V. lineolata* (Mousson) v. Martens, *V. polygramma* (v. Martens) and *V. bengalensis* (Lam.). Morelet summed up the situation as follows: "En résumé, les *Pal. Sumatrensis* et *polygramma* ne sont, à mon avis, qu'une même espèce; le nom de *lineolata* est un double emploi; toutes ces formes, enfin, se rattachent étroitement à la *P. Bengalensis* et n'en sont probablement que des variétés." Nevill, following Morelet, considered the forms *polygramma*, *lineolata* and *sumatrensis* as synonymous, and for this form, which he considered to be a subspecies of *P. bengalensis*, he wrongly selected the name *polygramma*. Von Martens, however, after carefully considering the whole situation, concluded that *V. sumatrensis* is quite distinct from *V. polygramma*, and that Mousson's *V. lineolata* should be considered as synonymous with it. Reeve's *P. lineolata*, however, he considered to be a distinct species and so also, though with some doubt, Frauenfeld's description of the same species. Kobelt, agreeing with von Martens, has described *V. lineolata* and *V. polygramma* as distinct from both *V. sumatrensis* and *V. bengalensis*.

The largest specimen in the collection measures 21 mm. in length. The keel on the body-whorl is well marked in young individuals but becomes less distinct in older specimens. The specimens are mostly yellowish or even of an olive colour, but a few have a reddish-brown tinge owing to a deposit on the surface. In all cases the black bands on the yellow or brown back-ground are quite distinct.

Most of the specimens are from areas of fresh water near Medan and near Bohorok, but a few dead shells were also collected on dry land. A few specimens are from the east coast of Sumatra (exact locality not stated).

***Vivipara javanica* (v. d. Busch).**

1897. *Vivipara javanica*, v. Martens, *op. cit.*, pp. 21, 22.
 1909. *Vivipara javanica*, Kobelt, *op. cit.*, pp. 251, 252, pl. lii, figs. 1-7.

A number of forms of this species were described as distinct varieties by von Martens, and Kobelt has since included some more. The identification of these varieties, in spite of the careful descriptions and excellent figures published by the two authors, is not an easy task owing to the very great individual variation exhibited in large series of shells, and I would have been obliged to identify some of the specimens before me as varieties of Busch's form without assigning them to their exact varietal rank, but for the valuable named material that I have received from Prof. Max Weber for examination and in exchange.

None of the specimens in the collection belong to the typical

form, but in the large series the following five varieties can be distinguished:—*saleyerica*, *scalaris*, *laevior*, *borneensis* and *moussoni*.

var. *laevior* (v. Martens).

1897. *Vivipara costata* var. *laevior*, v. Martens, *op. cit.*, p. 21, pl. ii, figs. 5, 6.
 1909. *Vivipara javanica laevior*, Kobelt, *op. cit.*, p. 253, pl. xlviii, figs. 3-6.

The form as the Sarasins¹ and Kobelt have shown is a variety of *V. javanica* and not of *V. costata* as von Martens considered it to be. I have one of von Marten's co-types before me and agree with the opinion of these authors.

Most of the Sumatran specimens agree closely with von Martens' co-type and his figures, except that they are a little broader and less elongate. The operculum agrees with Kobelt's fig. 3 (*loc. cit.*). The specimens are mostly olive brown in colour, but some of them are much darker owing to a deposit on the surface. The largest specimen is smaller than the largest of von Martens'; it measures 28.2 mm. in length by 20 mm. in breadth, and the aperture is 14.8 mm. by 11.6 mm.

The specimens before me are from fresh-water areas at Medan and Mariëndal (Deli); also from the Soengei Krah (Medan); and the Soengei Minahol.

This variety was hitherto known from Java and South Celebes only.

var. *saleyerica*, v. Martens.

1897. *Vivipara javanica* var. *Saleyerica*, v. Martens, *op. cit.*, p. 24, pl. ii, fig. 3.
 1909. *Vivipara javanica saleyerica*, Kobelt, *op. cit.*, p. 235, pl. xlviii, fig. 16.

The only adult specimen of this variety in the collection is from the Soengei Minahol. It agrees closely with one of v. Martens' co-types before me. The specimen is of a yellowish brown colour with dark transverse bands on the first three whorls, and measures 17.4 mm. by 12.5 mm., the aperture is 10.5 mm. by 8.3 mm.

I also assign to this form, with some doubt, two young shells from a fresh-water area at Padang Boelan (Deli). These specimens are not larger than 12 mm. in length, have a fairly prominent keel on the body-whorl and are narrowly umbilicate. They are of an amber-brown colour.

This record greatly extends the range of this form, which was only known from Saleyer.

var. *moussoni*, v. Martens.

1849. *Paludina angularis* (nec Müll.), Mousson, *Moll. Java*, p. 62, p. viii, fig. 5.

¹ *Moll. Celebes*, p. 64 (Wiesbaden, 1898).

1897. *Vivipara javanica* var. *moussoni*, von Martens, *op. cit.*, p. 22.

1909. *Vivipara javanica moussoni*, Kobelt, *op. cit.*, p. 256, pl. lii, figs. 10, 11.

This interesting variety is represented by two lots of specimens. Of the first lot collected by Mr. den Doop at Medah (Deli), the specimens are mostly brownish in colour. A few however, have a darkish colour owing to a clayey deposit on the surface. The apex of the shells is, in most cases, eroded, and many show rather low varices in the regions of growth. A very low but distinct keel is present near the lower edge of the body-whorl; it is better marked in some specimens than in others. The operculum resembles Kobelt's figure. The largest specimen of this lot measures 29.1 mm. by 22.5 mm., the aperture being 14.6 mm. by 12 mm.

The second lot of specimens was collected near Medan by Mr. J. B. Corporaal. The shells are rather smaller and much lighter in colour than those in the other lot.

var. *scalaris*, Mousson.

1909. *Vivipara javanica scalaris*, Kobelt, *op. cit.*, p. 257, pl. liii, figs. 1, 2, pl. lv, figs. 8, 9.

This beautiful variety has a highly evolved type of shell. It is represented in the collection by a few young shells and some adults collected from the fresh-water lake, Anak Laut (Sabang).

The shells are of an olive brown colour with a few vertical stripes of a darker shade more marked on the body-whorl than on the rest of the shell. The adult shell consists of 6-6½ somewhat inflated whorls, with a deeply impressed and oblique suture, and with a large body-whorl; the keel on the body-whorl is more distinct in young than in fully-grown adults, in which it becomes even quite obsolete. The shells are broadly rimate and perforate. The largest specimen measures 33.4 mm. by 22.6 mm., and the aperture is 18 mm. by 15.5 mm. in size.

The variety was hitherto known from Java only.

var. *borneensis*, Kobelt.

1909. *Vivipara javanica borneensis*, Kobelt, *op. cit.*, p. 257, pl. liii, figs. 3, 4, 19, 20.

Kobelt in the paper cited above has given a very complete description of this form and pointed out its distinguishing characters very well. The shell is rather small, nearly smooth, ovato-conical in form with an acute apex; the whorls are very little swollen and the suture is oblique and faintly impressed.

The two shells that I identify with *borneensis* are from near Medan. They agree closely with figs. 3, 4 of the Bornean shells in Kobelt's Monograph.

***Vivipara hendrici*, Prashad (sp. nov.).**

(Plate xiv, figs. 7-10).

This new species, though closely allied to *V javanica*, appears to be quite distinct, and is here described under the name *V hendrici* after the name of Mr. den Doop's father.

The shell is of a large size and rather thick in texture. It is narrowly rimate, with the spire elongate and the body-whorl somewhat swollen. The whorls of the spire are a little oblique and only moderately swollen, they increase gradually in size. The suture is oblique, rather narrow, but fairly impressed. The body-whorl, as seen in dorsal view, is band-shaped, increasing gradually but not very greatly towards the end; near the periphery there is no angulation in the adult shells, but traces of it are to be seen in shells of moderate size; it is not very much swollen. The mouth is fairly large, subcircular, bluntly pointed above and broadly rounded below. The outer lip is thin and irregularly arched. The columella is narrow and slightly curved but without any fold. The peristome is complete. The colour of the shell is uniform dark olive-green in fresh shells, but rather brownish in those covered with a deposit. The first three whorls, in some specimens, also show 2-3 transverse bands of a darker colour. The margin of the mouth is blackish, while the interior of the shell is light blue. The sculpture consists of fairly coarse longitudinal curved striae crossed by a few transverse ones; the latter are all more conspicuous on the body-whorl than on the rest of the shell.

The operculum is dark brownish or even black; it is large ovoidal, thick but somewhat brittle. Externally only a few concentric striae can be made out, but the nucleus is excentrically situated. There is on the inner surface a well marked muscular scar with raised subcircular boss lying near the left margin, the scar shows thick vermicular ridges on its surface.

Measurements of shells (in millimetres).

	1 (Type)	2	3	4	5
Length of shell	31	26.7	25.8	24	24.2
Maximum breadth	20.8	20.1	18.4	16.5	17.3
Height of spire (dorsal view)	14	12.3	11.2	11.3	10.7
Height of mouth	16	14.9	14.7	13.4	13
Breadth of mouth	13.2	13	11.6	11.1	11.3

Locality.—A few adults of this species were collected in the Bah Endah (streamlet) by Mr. den Doop.

Family HYDROBIIDAE.

Genus *Bithynia*, Leach.

Only a single representative of the family Hydrobiidae is represented in the collection. This might to some extent be due to the minute size of the shells of the members of this family.

***Bithynia truncata*, Eyd. and Soul.**

1897. *Bithynia truncata*, v. Martens, *op. cit.*, pp. 25, 26, pl. ix, figs. 11, 11b.

B. truncata had not hitherto been recorded from Sumatra but was known only from Java and Celebes. In Mr. den Doop's collection there are a fair number of specimens from fresh-water areas at Medan and near Padang Boelan. The specimens are typical and agree fairly well with the detailed description in von Martens' paper.

Family LITTORINIDAE.

Genus *Littorina*, Fer.

Subgenus *Littorinopsis*, Morch.

The four species of this subgenus from Sumatra all belong to the subgenus *Littorinopsis*, Morch. All these species are rather thin-shelled forms not exceeding 25 mm. in length.

***Littorina scabra* (Linn.).**

1897. *Littorina scabra*, v. Martens, *op. cit.*, pp. 194-196.

There are eight specimens of this species collected from a mangrove-swamp at Belawan (Deli). All the specimens are fairly typical, showing only slight variation in colour.

Some features of the gross anatomy of this species are shown in Quoy and Gaimard's figures¹ and the radula has been figured by Troschel.²

***Littorina intermedia*, Phil.**

1897. *Littorina intermedia*, v. Martens, *op. cit.*, p. 197.

In the paper cited above von Martens has given the complete synonymy, and discussed the distribution of this widely distributed species.

In the Sumatran collection it is represented by a large number of specimens from the sea-shore at Perbaoengan (Sardang), and a few from the Soengei Belawan (Deli), not far from the sea. All these specimens closely agree with the large series of this species in the Indian Museum collection from various localities.

***Littorina carinifera* (Menke).**

1897. *Littorina carinifera*, v. Martens, *op. cit.*, p. 198.

This widely distributed species is represented in the collection by a few individuals from the mouth of the Soengei Batang Kwis (Serdang) and from a mangrove-swamp at Belawan (Deli).

The specimens closely agree with Menke's and von Martens' descriptions, but show a slight variation in colour.

¹ *Op. cit.*, p. 770, pl. xxxiii, figs. 1-3. The species is referred to as *Littorina angulifera* (Lam.).

² *Das Gebiss der Schnecken*, I, sp. 133, pl. x, fig. 18.

Littorina conica, Phil.

1897. *Littorina conica*, v. Martens, *op. cit.*, p. 198.

All the specimens of this species are from a mangrove-swamp at Belawan (Deli). Some of the specimens are much darker than others, while two are nearly creamy in colour. In shape and sculpture, however, they are all alike.

Family MELANIIDÆ.

Genus *Acrostoma*, Brot.

1920. *Acrostoma*, Annandale, *Rec. Ind. Mus.* XIX, pp. 109, 110.

In the paper cited above Annandale has fully discussed the reasons for adopting the name *Acrostoma*, Brot, for the species which had hitherto been classed as belonging to *Melanoides*, H. and A. Adams (*nec* Olivier), *Brotia*, v. Martens and "Paleome-lanien," P and F. Sarasin. The only species of this genus in the Sumatran collection comprises a number of forms of the common *Acrostoma variabile* (Benson). In the Sumatran forms I can find no differences of sufficient importance to consider them as belonging to a distinct species. They show an identically similar variation as regards shape and shell-sculpture as the Indian forms, and many of them seem to be quite identical. I have, therefore, after a careful comparison of the large series of Sumatran shells with the very large collections of Indian specimens in the Indian Museum, Calcutta, decided to consider them as varieties of *A. variabile*, even though none of them are identical with the typical form.

Acrostoma variabile (Benson).

1836. *Melania variabilis*, Benson, *Journ. As. Soc. Bengal*, V, pp. 746, 747.
 1874. *Melania variabilis*, Brot, *Melanidae in Mart. and Chemn. Conch.-Cab.*, pp. 85-87, pl. x, figs. 1a-d.
 1915. *Tiara (Melanoides) variabilis*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 23.

This species was originally described from the Goomty River, Jaunpur in the United Provinces of India, and was later found by Benson in Tolly's Nullah near Calcutta. It has since been found to be widely distributed, and is, as its name indicates, a very variable species both as regards the shape and sculpture of the shell. The Indo-Burmese forms of this species are in need of a thorough revision.

None of the Sumatran specimens belong to the typical form but the five varieties considered further on are represented. There are besides a few specimens from some localities, which it is not possible to assign to their exact varietal rank, owing to their imperfect condition and to the fact that the sculpture is quite eroded.

var. *sumatrensis* (Brot).

1874. *Melania sumatrensis*, Brot, *op. cit.*, pp. 87, 88.
 1885. *Melania* (*Melanoides*) *variabilis*, Nevill, *Hand-List Moll. Ind. Mus.* II, pp. 251, 252.
 1897. *Melania* (*Brotia*) *sumatrensis*, v. Martens, *op. cit.*, pp. 34-36.
 1900. ? *Melania* (*Brotia*) *episcopalis*, v. Martens, *Nachr. Deut. Malakozool. Ges.*, XXXII, p. 10.

In spite of what von Martens has said regarding the validity of this species, I do not think that it is possible to separate it from *A. variabile*. Nevill interpreted its relationships correctly, but was mistaken in considering Brot's species as a mere synonym of Benson's. Probably he was led to this conclusion by the very different forms figured by Brot as representing his species. It might have been a better course to have dropped Brot's name *sumatrensis* and adopted the earlier *varicosa*, Troschel, for the Sumatran form, but as Troschel's original specimens came from the River Ganges, India, this form was probably the *forma typica* or one of the various Indian varieties of the true *variabile*. The Sumatran shell recorded by v. Martens as *M. episcopalis*, in the paper cited above, appears from the short note appended to have probably been this form. I have no doubt, however, regarding the one he described as *M. sumatrensis* in his first paper, for I have seen one of the specimens named by him.

The form I consider as Brot's *sumatrensis* is widely distributed in Sumatra. It is well represented by Brot's figure 1a (pl. xiii). The shell of this form is fairly massive, pyramidal, with 6-9 persistent whorls increasing more or less evenly in size, the suture is oblique and moderately impressed and the whorls have well developed oblique varices or rather ribs. The ribs, though feeble on the upper whorls, are quite distinct on all of them; the body-whorl has at least ten distinct ribs. The aperture is ovate, somewhat pointed posteriorly and produced but rounded anteriorly. The shells are uniformly coloured, being chestnut-brown or even black. The aperture has a black margin though the mouth further inwards is bluish or even whitish.

The following are the measurements (in millimetres) of six specimens from different localities:—

Localities.	Height.	Maximum breadth.	Height of aperture.	Breadth of aperture.	Number of persistent whorls.
Soengei Kalau ...	48.5	20	18.2	12.3	5—7
Timbang Langkat	52.6	18.4	17.8	11.2	8 $\frac{1}{2}$
Bah Endah ...	45.2	20.8	17.6	11.5	6 $\frac{1}{2}$
Soengei Bohorok...	46.8	18.2	18	11	6—7
Soengei Minahol ...	56.5	23.8	21.1	13.1	7 $\frac{1}{2}$
Soengei Lapan ...	22.4	9.3	9	4.8	5 $\frac{1}{2}$

This is a true stream form, and in Mr. den Doop's collection is represented by a large series of specimens of all ages from the following streams:—Soengei Kalau (near Bohorok), streamlet at Timbang Langkat, Bah Endah, Soengei Lapan (Langkat), Soengei Minahol and Soengei Bohorok (Langkat).

var. *infracostata* (Mousson).

1849. *Melania infracostata*, Mousson, *Moll. Java*, pp. 65, 66, pl. x, fig. 3.
 1874. *Melania infracostata*, Brot, *op. cit.*, pp. 98, 99, pl. xii, fig. 3.
 1885. *Melania* (*Melanoides*) *variabilis* var. *infracostata*, Nevill, *op. cit.*, p. 253.

I agree with Nevill in considering this as only a variety of *A. variabile*. The shell is similar to that of the var. *sumatrensis*, but is distinguished by the ribs being obsolete on the last whorl. A few spiral striae are, however, to be distinguished below the suture in some specimens, and these often decussate as in Mousson's figure. The ribs are more distinct in the young than in fully-grown adults.

I do not think that fig. 3a (pl. xii) of Brot's represents this form. His figure 3 is not very good, but resembles some of the specimens in the Sumatran collection.

The following are the measurements (in millimetres) of some specimens from two localities :—

Locality.		Height.	Maximum breadth.	Height of aperture.	Breadth of aperture.	Number of persistent whorls.
Soengei } 1.	...	60.2	22.9	21.3	14.4	6½
Deli } 2.	...	51	18.2	17.6	10	8
Medan } 3.	...	49	17.9	17.1	9.8	7½
Soengei } 1.	...	36	14.1	14	8.4	6½
Kalau } 2.	...	32.3	12.8	12.2	6.7	6½

This form, like the var. *sumatrensis*, is a true stream form. Large number of specimens of it were collected from the streams Soengei Deli (Medan) and Soengei Kalau (near Bohorok).

var. *binodulifera* (Nevill).

1885. *Melania* (*Melanoides*) *variabilis* subsp. *episcopalis* var. *binodulifera*, Nevill, *op. cit.*, p. 259.

Nevill has discussed the mistakes committed by both Brot and Hanley and Theobald (*Conch. Indica*) in the identification of the form *episcopalis*, Lea. He was, I think, justified in giving a new name to the variety with a double row of nodules in the region corresponding to the ribs on the whorls in *A. variabile* and var. *sumatrensis*. His specimens of the variety were collected in various places in Assam in the north-east of India.

The Sumatran specimens I assign to this form all resemble the Indian specimens. They are dull yellowish-brown in colour with a few darker vertical bands. They are rather smaller than those of the var. *sumatrensis* and have two distinct rows of small nodules on the last 2½–3 whorls. On the upper whorls the nodules are more or less obsolete. In younger shells, however, the nodules are present on the upper whorls also.

In the Sumatran collection the variety is represented by specimens of all ages from the Soengei Deli (Medan), from Deli (without precise habitat) and from the Soengei Kalau (a streamlet near Bohorok).

var. *pseudospinosa* (Nevill).

1885. *Melania (Melanoides) variabilis* subsp. *episcopalis* var. *pseudospinosa*, Nevill, *op. cit.*, pp. 258, 259.

As Nevill has pointed out this variety appears to be intermediate between Brot's *M. sumatrensis* and *M. spinosa*. The type-specimens were from Assam, but Nevill found it hard to distinguish some Perak and Malacca specimens from them. I can find no difference between the Sumatran shells I assign to this form and those from Assam, Perak and Malacca.

This variety leads on to the form *menkeana* (Lea), but differs from the latter in the suture being less impressed, the spines much smaller and less protruding, and the shell being much smaller.

The Sumatran specimens were collected along with those of the vars. *infracostata* and *binodulijera*.

var *menkeana* (Lea) Nevill.

1885. *Melania (Melanoides) variabilis* subsp. *menkeana*, Nevill, *op. cit.* pp. 260, 261.

Nevill fully discussed the confusion introduced by Brot and by Hanley and Theobald (*Conch. Indica*) regarding this form. He gave a full synonymy and emended the description of the species. The form, as stated already, is closely allied to the var. *pseudospinosa*, but differs in colouration, in the whorls being more convex, the suture sharply and more deeply impressed, and in the spines being better developed.

I can detect no differences between the Assamese and the Sumatran specimens.

All the Sumatran specimens are from the Soengei Lapan in Langkat. The measurements (in millimetres) of a few specimens are as follows :—

Height.	Maximum breadth.	Height of aperture.	Breadth of aperture.	Number of persistent whorls.	
33	14·1	13·3	7·8	5½	Apex greatly eroded.
30	13·3	12·4	7·2	4½	
27	13·8	12·2	6·8	5	

Genus *Melanoides*, Olivier (*nec* H. and A. Adams).

1920. *Melanoides*, Annandale, *Rec. Ind. Mus.* XIX, pp. 108, 109.

In the paper cited above Annandale has given reasons for accepting the generic name *Melanoides* for the species of the type of *M. tuberculata* (Müller), and not in the sense it was used by H. and A. Adams. He has also given a complete synonymy of the genus. My examination of the large Sumatran collection completely upholds his views, except that I adopt, for the sake of convenience, some of the subgeneric names used by von Martens for the various groups of species.

Subgenus *Stenomelania*, Fischer.*Melanoides aspirans* (Hinds).

1874. *Melania aspirans*, Brot, *op. cit.*, pp. 140, 142, pl. xvii, figs. 4a-d.
 1885. *Melania fuscata* var. *aspirans*, Nevill, *op. cit.*, p. 222.

Nevill considered this species to be only a variety of the Nicobarese *M. fuscata*, but I think it to be distinct. In the Sumatran collection there is a single specimen from a streamlet along the road to Anak Laut (Sabang), which resembles Fijian specimens of this species in the Indian Museum collection.

The specimen is fairly large, measuring 36.5 mm. by 11 mm., and the aperture is 12.5 mm. by 6.7 mm. It has five persistent whorls; the apex is greatly eroded and at least 3 more whorls must have been present in the complete specimen. The whorls increase regularly in size and are only moderately swollen. The sculpture consists of very faint vertical ridges irregularly disposed on the various whorls, on the uppermost whorl transverse ridges are also to be seen a few such ridges are also present on the base of the body-whorl. The suture is very oblique and moderately impressed. The aperture is ovoidal, drawn out to an acute angle posteriorly. The shell is dark brownish.

Melanoides plicaria (Born).

1897. *Melania plicaria*, v. Martens, *op. cit.*, pp. 41, 42.

This species has a wide range in the Malay Archipelago, but had not hitherto been recorded from Sumatra. In Mr. den Doop's collection there are three adult specimens, collected from a streamlet along the road to Anak Laut (Sabang). Another specimen collected at Sabang by Mr. J. B. Corporaal also probably belongs to the species.

Melanoides acutissima (Busch).

1874. *Melania acutissima*, Brot, *op. cit.*, p. 129, pl. xvi, figs. 2, 2a.
 1885. *Melania acutissima*, Nevill, *op. cit.*, pp. 226, 227.
 1897. *Melania acutissima*, v. Martens, *op. cit.*, pp. 42, 43.

The specimens I assign to this species are from a streamlet along the road to Anak Laut (Sabang). They are of all ages and show the specific characters distinctly.

M. acutissima was hitherto known from Java, Bali and Luzon.

Melanoides turris (Brot).

1874. *Melania turris*, Brot, *op. cit.*, pp. 146, 147, pl. xviii, figs. 5, 5a.

I assign to this species 3 adult and 3 medium-sized specimens from a streamlet along the road to Anak Laut (Sabang). The specimens were collected along with those of *M. plicaria*, *M. acutissima* and *M. monile*. They agree closely with Brot's description and figures of the species.

Brot gives the locality of his specimens as doubtfully from Borneo, and von Martens states that the species is found in the Malaccas, Bali and Flores.

Melanoides monile (Mouss.).

1874. *Melania monile*, Brot, *op. cit.*, p. 173, pl. xx, fig. 7.

1897. *Melania monile*, v. Martens, *op. cit.*, pp. 44, 45.

In a tubeful of specimens of *M. acutissima* I found three specimens of this species. They had been collected in a streamlet along the road to Anak Laut (Sabang).

The exact localities of the original specimens are rather doubtful, they are stated to have come from Java and the Moluccas. Von Martens' specimens were collected by Prof. Wichmann at Kupang in Timor.

Melanoides crenulata (Chemn.).

1874. *Melania crenulata*, Brot, *op. cit.*, pp. 114-117, pl. xiv, a fig. 9a.

1897. *Melania crenulata*, v. Martens, *op. cit.*, pp. 45, 46.

I have compared the specimens I assign to this species with a specimen named by the late Prof. E. von Martens, and can find no differences in the form of the shell or the shape of the mouth. These specimens, however, have vertical striae on the first 3-4 whorls, while von Martens' is nearly smooth. The difference is probably due to age, von Martens' specimen being an adult in which the striae have probably become obsolete. The difference, however, is not of much importance in this variable species.

The Sumatran specimens are from near the Prise d'eau of Sabang.

Melanoides uniformis (Quoy and Gaim.)

1874. *Melania uniformis*, Brot, *op. cit.*, pp. 124, 125, pl. xv, figs. 3, 3a, pl. xvi, fig. 1.

1897. *Melania uniformis* with vars. *crispulata*, *aequisulcata* and *plicatula*, v. Martens, *op. cit.*, pp. 46-48; pl. iii, figs. 3-6.

The typical form of this interesting species is not represented in the Sumatran collection but specimens of the vars. *crispulata*, *aequisulcata* and *plicatula* of v. Martens are present. The specimens of the first variety are from the Soengei Minahol, while those of the other two were collected in a streamlet along the road to Anak Laut (Sabang).

The present record of the occurrence of the various varieties of this species in Sumatra is interesting as the species was hitherto known from the North Celebes, Molucca, Bali, Flores and Timor only.

Melanoides sluiteri, Prashad (sp. nov.).

(Plate xiv, figs. 11, 12).

At Mr. den Doop's request I have associated this new species with the name of Prof. Ph. Sluiter of Amsterdam.

The shell is elongate, acuminate, somewhat conical, about three times as long as broad. The whorls, of which there are at least 7 in complete shells, increase very gradually and regularly,

and are very little swollen. The suture is oblique and moderately impressed. The body-whorl is broadly ovoidal, narrow above, gradually widening to the region of the mouth, where, owing to the greater part of the mouth lying outside the median axis, it is broadest. In dorsal view the outer profile of the body-whorl is slightly arched in the upper half and then suddenly curves downwards and inwards, and has a somewhat sinuate course. The inner profile is regularly curved. The mouth is of fair size, being a little more than half the size of the body-whorl; it is ovoid in outline with the basal margin regularly curved and drawn to an acute angle at the apex. The outer lip is only slightly thickened; seen from the side it shows a distinctly sinuate outline. The columella is narrow and slightly bent. The surface of the shell in young shells on the first 4-5 whorls shows regular transverse ridges, these become obsolete in adult shells, and are quite absent on the penultimate and the body-whorl; on these two whorls fine longitudinal striae are always present. The shells are blackish in colour, but the whole or a part of the body-whorl along the outer lip in the region of growth is dull olivaceous or yellowish; in this region a few vertical brownish stripes are also present.

The type-specimen measures 22.2 mm. in length by 8.1 mm. in maximum breadth, the aperture measures 8 mm. by 4.7 mm.

Locality.—A large number of specimens of this species were collected by Mr. den Doop in the Kroeëng Seunara (Sabang); streamlet from the Prise d'eau of Sabang, and in fresh-water areas near Boelan and Padang Boelan.

Remarks.—The species is nearly allied to *M. uniformis* but is distinguished by its shape, position and form of the mouth and by its sculpture.

Melanodies litigosa (Brot).

1874. *Melania litigosa*, Brot, *op. cit.*, pp. 170, 171, pl. xx, fig. 5, 5a, b.
1897. *Melania litigosa*, v. Martens, *op. cit.*, pp. 48, 49.

A single specimen from a streamlet along the road to Anak Laut (Sabang) agrees well with Brot's description and figures.

Subgenus **Plotia**, A. Adams = **Melanoides**, s.s.

Melanoides tuberculata (Müll.).

1897. *Melania tuberculata*, v. Martens, *op. cit.*, p. 56.
1919. *Melanoides tuberculata*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 31, 32, pl. iv, fig. 1.

Although *A. tuberculata*, as Dr. Annandale and I stated in the above-cited paper, has a wide range from the Mediterranean to Australia and China, there is no evidence of its occurrence in Baluchistan or Southern Persia. There are no specimens of the typical form in the Sumatran collection, but specimens of four varieties are present.

var. seminuda, v. Martens.

1897. *Melania tuberculata* var. *seminuda*, v. Martens, *op. cit.*, p. 58, pl. iv, fig. 1.

Von Martens recorded this variety from a number of localities in Sumatra and in the present collection it is represented from the following sources:—Fresh-water areas at Medan and Toentengan, streamlets at Sabang and Timbang Langkat, the Soengei Landak and Soengei Bohorok (both near Bohorok).

Some of the specimens, owing to a deposit on the surface, appear much darker than others.

var. virgulata (Quoy and Gaim.).

1897. *Melania tuberculata* var. *virgulata*, v. Martens, *op. cit.*, pp. 57, 58.

This variety is widely distributed in the Malay Archipelago, and has been recorded from various localities in Sumatra. In the present collection there are specimens from a fresh-water area at Medan and Padang Boelan and from the Soengei Bohorok.

var. angularis, v. Martens.

1867. *Melania tuberculata* var. *angularis*, v. Martens, *op. cit.*, p. 59, pl. iv, figs. 2, 3.

This form is only known from Sumatra. I have compared my specimens with one of von Martens' co-types and have no doubt as to their identity.

The specimens are from near Medan, from a streamlet on the Medan Estate, from the Soengei Bohorok and Anak Laut (Sabang).

var. truncatula (Lam.).

1897. *Melania tuberculata* var. *truncatula*, v. Martens, *op. cit.*, p. 59, pl. iv, fig. 4.

Large series of specimens of this interesting form are represented in the Sumatran collection from Padang Boelan, Poengei, Medan and Timbang Langkat, and from the Soengei Bohorok and Soengei Minahol.

The ribs in fully adult specimens become greatly reduced and are not so clear as they are on young shells.

Melanoides scabra (Müll.).

1897. *Melania scabra*, v. Martens, *op. cit.*, p. 62.

The groups or subgenera *Plotia* and *Striatella* as defined by Brot in his monograph, as has been pointed out by Dr. Annandale and myself,¹ fade imperceptibly into one another and we have, therefore, adopted the older name *Plotia* for the subgenus.

The complete synonymy of *M. scabra* and its allies has still to be worked out,² but there is no doubt regarding the Sumatran

¹ *Rec. Ind. Mus.* XVII, p. 28 (1919), see also Vol. XIV p. 147 (1919).

² *Rec. Ind. Mus.* XVIII, p. 37 (1919).

forms dealt with here. None of the specimens belong to the typical form.

var. *nodosocostata* (Mousson).

The specimens of this variety are from a pool in the valley of the Lau Kling (a stream) near Brastagei and from the Soengei Bohorok. The costae on young individuals are rather faint and the body-whorl is nearly smooth.

var. *angulifera*, v. Martens.

The only specimens of this form were collected in the streamlet Soengei Kalau (near Bohorok). They agree in all respects with one of von Martens' co-types from Rotti, river Oilelao, near Bilba, in the Indian Museum collection.

var. *mutica*, v. Martens.

This form is represented in the Sumatran collection by a fair number of specimens from a streamlet near Anak Laut (Sambang).

Subgenus *Tarebia*, H. and A. Adams

Melanoides semigranosa (Busch).

- 1842. *Melania semigranosa*, V. D. Busch, *Philippi Abbild.* 1, p. 2, pl. i, fig. 13.
- 1874. *Melania lirata* var. 2, Brot, *op. cit.*, p. 329, pl. xxxiii, figs. 6, 6a.
- 1885. *Melania lineata* var. *semigranosa*, Nevill, *op. cit.*, p. 277.
- 1897. *Melania lineata* var. *semigranosa*, v. Martens, *op. cit.*, p. 72.
- 1899. *Melania (Tarebia) semigranosa*, Dautzenberg, *Ann. Soc. Roy. Malacol. Belgique.* XXXIV, p. 14, pl. ii, figs. 9, 9a-c.

I agree with Dautzenberg in considering this form as a distinct species rather than as a variety of *M. lineata*. The specific characters as defined by Mousson are, as was also found by Dautzenberg, quite constant in a large series of specimens.

The specimens in the Sumatran collection are from the Soengei Lapan, the Soengei Kalau and from Medan.

Family CERITHIIDAE.

Genus *Potamides*, Defr.

This genus is represented in the collection by specimens of the three subgenera, *Telescopium*, Montf., *Tympanotonos* (Morch) Adams, and *Cerithidea*, Swains. There are no specimens of the subgenus *Pyrasmus*, Montf., which is also known from Sumatra.

Subgenus *Telescopium*, Montf.

Potamides telescopium (Linn.).

- 1855. *Cerithium telescopium*, Sowerby, *Theasaurus Conchyliorum*, 11, p. 895, pl. clxxxv, fig. 269.
- 1866. *Telescopium fuscum*, Reeve, *Conch. Icon.* XV, pl. i, sp. 1, a b.

1897. *Potamides (Telescopium) telescopium*, v. Martens, *Suss. und Brackw.-Moll.* in Weber's *Zool. Ergebn. Nederl. Ost.-Indien* IV, pp. 180-182.
 1898. *Cerithium (Telescopium) telescopium*, Kobelt, *Cerithium in Martini and Chemnitz Conch.-Cab.* (ed. Kuster), pp. 57, 58, pl. xii, fig. 1.
 1916. *Potamides (Telescopium) fuscum*, Annandale and Kemp, *Mem. Ind. Mus.* V, pp. 344, 345.

Von Martens has given a fairly complete synonymy and the exact distribution of the species, and a few of the important references only are given above.

A fairly complete account of the anatomy of this species was published by Berkley¹ in 1835, while Quoy and Gaimard had given good figures of the animal in the previous year.² The radula has the formula 3.1.3.

The specimens in the collection are from mangrove-swamps at Belawan (Deli); and at Perbaoengan (Serdang). They were collected at different times and are of various sizes ranging from 30 mm to 110 mm. in length.

Subgenus *Tympanotonos* (Morch) Adams.

Potamides cingulatus (Gmelin).

1788. *Murex cingulatus*, Gmelin, *Linn. Syst. Nat.* ed. XIII, p. 3561.
 1838. *Cerithium fluviatile*, Potiez and Michaud, *Gal. de Moll.* I, p. 363, pl. xxxi, figs. 19, 20.
 1866. *Tympanotonos fluviatilis*, Reeve, *Conch. Iconica*, XV, pl. ii, sp. 9, figs. a, b.
 1897. *Potamides (Tympanotonos) cingulatus*, v. Martens, *op. cit.*, pp. 183, 184.
 1916. *Potamides (Tympanotonos) fluviatilis*, Annandale and Kemp, *op. cit.*, p. 344.

Kobelt in his monograph of the genus *Cerithium* (*loc. cit.*) does not mention this species, but the references given above and those given in the above references should be quite enough to identify the species. It may also be noted that the species is not the same as *Murex fluviatilis*, Gmelin, which is a synonym of *P. radula* (Linn.).

There are a few specimens in the collection from the mangrove-swamps at Belawan (Deli) and Perbaoengan (Serdang), two specimens from the mouth of the Soengei Batang Kwis (Serdang), and two from a rice-field at Perbaoengan (Serdang). The species is essentially a brackish-water form and the two specimens from a rice-field at Serdang were probably carried there during floods.³ Only two of the specimens are perfect, in all others the greater part of the outer lip is broken. The radula of the species is described and figured by Troschel.⁴

¹ *Zoological Journal*, V, pp. 431-439, pls. xx, xxxi (1835).

² 'Astrolabe' *Zoology*, III, p. 125, pl. lv, figs. 4-6 (1834).

³ I think this is not possible. Perhaps there is a label-error. I remember that once I collected in these rice-fields and also near the sea on the same day and that I did not possess good boxes for keeping separate the collected material. [den Doop].

⁴ *Das Gebiss der Schnecken*, I, pp. 145-146, pl. xii, fig. 2.

The species was originally described from the Malabar Coast of Peninsular India, but has since been found to be widely distributed in the Indian Ocean and the western parts of the Pacific.

Potamides micropterus (Kiener).

1866. *Tympanotonos microptera*, Reeve, *Conch. Iconica*, XV pl. ii, sp. 7, figs. a, b.
 1897. *Potamides* (*Tympanotonos*) *micropterus*, v. Martens, *op. cit.*, p. 185.
 1898. *Cerithium* (*Tympanotonos*) *microptera*, Kobelt, *op. cit.*, p. 74, pl. xiv, figs. 5, 6.

I assign, with some doubt, a single specimen from the East Coast of Sumatra to this species. The entire outer lip is broken and the shape of the mouth cannot, therefore, be made out. In form, sculpture and colouration the specimen quite resembles some of the authentic specimens of the species in the Indian Museum collection, though the suture is a little less excavated.

The species was hitherto known from the Phillipines and Borneo.

Subgenus Cerithidea, Swains.

Potamides obtusum (Lam.).

1897. *Potamides* (*Cerithidea*) *obtusum*, v. Martens, *op. cit.*, pp. 186, 187, pl. ix, fig. 22.
 1898. *Cerithium* (*Cerithidea*) *obtusum*, Kobelt, *op. cit.*, pp. 42, 43, pl. ix, figs. 3-5.

This species should be assigned to Lamarck and not Wood, as Kobelt has done. The form figured and described by Quoy and Gaimard (*loc. cit.*, pp. 126, 127, figs. 18-21) under this name is not this species but *P. quadratum* (Sow.¹); the shells of the two are quite different and the animal also in the two species, as was pointed out by Eydoux and Souleyet,² has a different colouration. The figure of these authors is a very good representation of the colouration of the animal of the true *P. obtusum*.

There are a large number of specimens of this species in the collection from the mangrove-swamps at Belawan (Deli) collected at different times, and from the mouth of the Soengei Batang Kwis (Serdang). Some of the Deli specimens are apparently subfossil, being very much worn and rather chalky in consistency.

This is a widely distributed species and von Martens has given a fairly detailed list of the localities from which it has been recorded.

Potamides quadratum (Sow.).

1897. *Potamides* (*Cerithidea*) *quadratus*, v. Martens, *op. cit.*, pp. 187, 188, pl. ix, fig. 23.
 1898. *Cerithium* (*Cerithidea*) *quadratum*, Kobelt, *op. cit.*, pp. 45, 46, pl. ix, fig. 8.

¹ Kobelt in his monograph (*loc. cit.*, p. 42) does not seem to have detected this mistake, but von Martens had come to the same conclusions as myself; his figure references, however, are incorrectly cited as 19-24 instead of 18-21, pl. lv.

² *Voyage Bonite, Zoology*, III, p. 600, pl. xxxix, figs. 1, 2 (1852).

Good figures of this species are given by Reeve, von Martens and Kobelt and all these closely resemble Quoy and Gaimard's fig. 18 (*loc. cit.*) of "*P. obtusum*." The species is easily distinguished from *P. obtusum* by the shape of the shell, the mouth and the much more delicate sculpture.

There are only four specimens of this species in the collection. These were collected along with those of *P. obtusum* from the mangrove-swamps at Belawan (Deli).

Family NASSIDAE.

Genus *Canidia*, Adams.

- 1861. *Canidia*, Adams, *Proc. Zool. Soc. London*, p. 383.
- 1876. *Canidia*, Brot, *Fourn. Conchyliol.* XXIV, p. 343.
- 1897. *Canidia*, v. Martens, *op. cit.*, p. 75.

No specimens of this genus were obtained by Prof. Weber in Sumatra and the genus was described by von Martens as being unrepresented there. In 1900, however, he recorded the occurrence of *C. themenckiana* from Lake Toba, Sumatra. In Mr. den Doop's collection there are two specimens, one of which is referable to *C. themenckiana*, while the other is a specimen of *C. helena*, which has hitherto been recorded from Java and Timor. These two records greatly extent the known range of the species.

Canidia helena (Phil.).

- 1897. *Canidia Helena*, v. Martens, *op. cit.*, pp. 75, 76.
- 1912-13. *Canidia Helena*, Schepmann, *op. cit.*, p. 236.

The species was originally described as a *Melania*, and later referred to the genus *Melanopsis* by Mousson, but Brot¹ from an examination of the radula and operculum referred it to its true position amongst the Nassidae.

There is a single specimen of the species in the Sumatran collection from a fresh-water area near Medan (Deli).

Canidia theminckiana (Petit).

- 1853. *Melania Theminckiana*, Petit, *Fourn. Conchyliol.* IV, pp. 255, 256, pl. vii, fig. 11.
- 1876. *Canidia Theminckiana*, Brot, *Fourn. Conchyliol.* XXIV, p. 347.
- 1900. *Canidia Temminckiana*, von Martens, *Nachr. Deutsch. Malakozool. Ges.* XXXII, p. 12.

A single specimen collected along with that of *C. helena* is referred to this species. It is quite like the figure of the species and agrees well with Petit's description.

Genus *Clea*, Adams.

- 1855. *Clea*, Adams, *Proc. Zool. Soc. London*, p. 119.
- 1876. *Clea*, Brot, *op. cit.*, pp. 348-353.

¹ *Fourn. Conchyliol.* XXIV, pp. 343-351, pl. xii (1876).

There is a single specimen in the Sumatran collection which is referable to this genus. Brot described it from Sumatra and it has not been found anywhere else.

***Clea bocki*, Brot.**

1881. *Clea Bockii*, Brot, *Journ. Conchyliol.* XXIX, pp. 159, 160, pl. vi, fig. 5.

1895. *Clea Bockii*, Smith, *Proc. Malacol. Soc. London*, L, p. 253.

I assign to this species a single specimen obtained in the mangrove-swamps at Belawan, Deli. The mouth is slightly broader and the body-whorl a little larger than in Brot's figure, but these differences are probably of the nature of individual variations. The entire spire except for the penultimate whorl has disappeared and the specimen is in poor condition, but the characteristic sculpture on the shell is well preserved.

The occurrence of a member of the genus *Clea* in estuarine areas is worthy of note, as the genus is essentially a fresh-water one.

Family NERITIDAE.

Genus *Neritina*, Lam.

Subgenus *Neripteron*, Recluz (= *Auriculatae*, v. Martens).

The only species in the Sumatran collection I assign to this subgenus is the new form described below as *N. simoni*. It is a very interesting species, in that it shows definite relationships between the subgenera *Neripteron* and *Dostia*, but clearly belongs to the first sub-genus.

***Neritina simoni*, Prashad (sp. nov.).**

(Plate xiv, figs. 13, 14).

The shell of this species is suborbiculate-ovate, with the posterior margin regularly curved. Its lateral profile is somewhat semicircular, much more arched on the anterior than near the posterior margin. The spire is short and distinctly lateral, but obliquely turned inwards; only a small part of it is visible in ventral view. The columellar area is provided with a short auricle on the upper side; on the lower side the auricle is not well developed. The columellar plate is very broad, extending to a little more than half way across the ventral surface; it is greatly depressed inwards towards the true mouth. The free margin of the columellar plate is slightly but regularly curved, and is finely crenulate. The periostracum is dull black, and has fine concentric striations on its surface; the columellar plate is dull olivaceous with a tinge of orange in some places; the mouth is rather dusky and the operculum is dark brownish with a light orange border.

Measurements of shells (in millimetres).

		A (Type).	B.
Maximum diameter	...	14.3	13.7
Height	...	6	5.9
Height of aperture	...	10	9.8
Columellar plate	...	7.4	6.5

Locality.—The two specimens of this species were collected by Mr. den Doop from near the mouth of the Soengei Batang Kwis (Serdang), in the mangrove-swamp region.

Remarks.—The species is closely allied to *N. auriculata*, Lam., but differs from it in the shell being more elongate, the auricles much less developed and in the comparatively greater width of the columellar plate. The species is interesting in that it affords a connecting link between the subgenera *Neripteron* and *Dostia*.

I have associated the name of this species with that of Mssrs. Simon (Managers of the Estates Batang Kwis and Loeboe Pakam) who greatly assisted Mr. den Doop in making collections on their estates.

Subgenus *Dostia*, Gray.

1879. *Dostia*, v. Martens, *Neritina* in *Mart. and Chemn. Conch.-Cab.*, pp. 16, 37.
 1883. *Dostia*, Tapparone-Canefri, *Ann. Mus. Civ. Stor. Nat. Genova*, XIX, p. 63.
 1919. *Dostia*, Annandale and Prashad, *Rec. Ind. Mus.* XVI, pp. 241, 242.

In the paper cited above Dr. Annandale and I considered *Dostia* to be sufficiently well characterized to deserve generic rank. Having since examined the large collections in the Indian Museum, some Mesopotamian shells, and the large Sumatran collection I find that there are various intermediate forms between it and the subgenus *Neripteron*. *Dostia*, therefore, cannot stand as a separate genus but must be considered as a subgenus of *Neritina*. Von Martens' name "*Neritae Mitrulae*" must, however, give way to Gray's older name *Dostia*.

Neritina crepidularia, Lam.

1879. *Neritina crepidularia*, v. Martens, *op. cit.*, pp. 37-45, pl. vii, figs. 1-4.
 1897. *Neritina crepidularia* with var. *melanostoma*, v. Martens, *op. cit.*, p. 218.

This widely distributed species is represented in the Sumatran collection by two varieties, which are separately considered below.

var. *melanostoma* (Troschel).

1837. *Neritina melanostoma*, Troschel, *Arch. Naturgesch.*, p. 179.

This variety was described from specimens collected in the River Ganges, probably from the deltaic region. It is represented from Sumatra by a large number of specimens of all ages collected in the mangrove-swamps at Belawan (Deli). The Sumatran specimens are exactly like the Indian shells.

var. *exaltata* (Recluz).

1850. *Neritina exaltata*, Recluz, *Fourn. Conchyliol.* I, p. 65, pl. iii, fig. 3.

Recluz's type-specimens of this form were collected in the Negros Island, Philippines. There are a few named specimens in the Indian Museum with which I have compared the Sumatran specimens I assign to this variety. All these specimens agree fairly with the description and figure of Recluz.

The Sumatran specimens were collected in the mangrove-swamps at Belawan (Deli) along with those of the var. *melanostoma*.

Neritina weberi, Prashad (sp. nov.).

(Plate xiv, figs. 15, 16).

The shell is very thin, subcircular in outline in the ventral view, regularly curved anteriorly and broadly truncated posteriorly. In the lateral view it forms an arch much less than a semicircle, greatly depressed anteriorly, and only slightly raised a little behind the middle. The spire is very minute, lateral, recurved inwards and just visible from below. The columellar plate is broad, greatly inclined forwards and downwards, and with a distinct depression near the margin; the margin is entire or very slightly crenulate, and is distinctly curved. The dorsal surface is strongly marked with concentric transverse striae. The periostracum is dark olivaceous in the region of the spire, but over the rest of the shell has a marked tessellated pattern formed by the crossing of dark olive bars over a dark yellowish background; the columellar plate is bluish, the shell on the inner surface is greyish but the tessellated pattern of the outer surface is visible through the translucent shell; the operculum is black.

Measurements of shells (in millimetres).

			A (Type).	B.
Maximum diameter	...	...	8.2	8.5
Height	...	...	3.3	3.4
Height of aperture	...	...	7.2	7.9
Columellar plate	...	...	3.6	3.8

Locality.—The two specimens of this interesting species were obtained from the mouth of the Soengei Batang Kwis (Serdang) in the mangrove-swamp region along with those of *N. simoni*.

Remarks.—The species is distinguished by its very depressed type of shell, its outline and the distinctly tessellated colouration.

I have great pleasure in associating the name of this species with that of Prof. Max Weber, who has been kind enough to send me a large proportion of the collection of fresh-water and brackish-water species made by him in the Dutch East Indies, and identified by the late Prof. E. von Martens.

Subgenus **Neritaea**, Roth (= **Serratae**, Recluz).

Neritina ziczac, Lam.

1897. *Neritina ziczac*, v. Martens, *op. cit.*, p. 79.

1899. *Neritina ziczac*, Dautzenberg, *Ann. Soc. Malacol. Belgique*, XXXIV, p. 19, pl. i, figs. 7, 7a.

I refer to this species two specimens of a characteristic colour. The colouration of these specimens resembles fig. 29, pl. vii in Reeve's *Conch. Iconica*. The spire of one of the specimens is very much eroded.

The two specimens were collected from the mouth of the Soengei Batang Kwis (Serdang), in the mangrove-swamp region.

Neritina variegata, Lesson.

1897. *Neritina variegata*, v. Martens, *op. cit.*, pp. 78, 79, pl. x, fig. 14.

Nine specimens collected from a streamlet along the road to Anak Laut (Sabang) closely agree with Lesson's description and with a specimen named by the late Prof. E. von Martens. The colour-pattern is, however, slightly variable.

Subgenus **Neritodryas**, v. Martens.

Neritina cornea (Linn.).

1879. *Neritina cornea*, v. Martens, *op. cit.*, pp. 140-142, pl. xii, figs. 14-18.

1899. *Neritina (Neritodryas) cornea*, Dautzenberg, *op. cit.*, pp. 21, 22, pl. i, figs. 11, 11a and b.

This species is widely distributed in the Dutch East Indies, and is represented in the Sumatran collection by a large number of variously coloured specimens collected along with those of *N. variegata* from a streamlet along the road to Anak Laut (Sabang) at various times.

Subgenus **Clithon**, Recluz.

Neritina brevispina, Lam.

1879. *Neritina brevispina*, v. Martens, *op. cit.*, p. 28.

A very large series of this species was collected by Mr. den Doop at different times in the streamlet along the road to Anak Laut (Sabang). The specimens are variously coloured, and either have well-developed spines or are nearly smooth, there being only rugosities in the regions of the spines.

Neritina squarrosa (Recluz).

1897. *Neritina squarrosa*, v. Martens, *op. cit.*, p. 80.

The specimens of this species are also from the streamlet along the road to Anak Laut (Sabang). The banding on the shell is very like that figured on pl. xii in Reeve's *Conch. Iconica*.

Genus *Nerita*, Linn.

This genus is represented by two widely distributed species *N lineata* and *N planospira*.

Nerita lineata, Chemn.

1897. *Nerita lineata*, v. Martens, *op. cit.*, p. 219.

A large series of specimens of all ages collected from the mangrove-swamps at Belawan (Deli), and a few from the Soengei Belawan (Deli) not far from the sea, are represented in the collection. Some of the empty shells contain hermit-crabs.

Nerita lineata, Anton.

1897. *Nerita planospira*, v. Martens, *op. cit.*, p. 219.

The specimens of this species were collected along with those of the preceding species in the same mangrove-swamps. They are of all ages and some have hermit-crabs in the empty shells.

Genus *Septaria*, Fer.*Septaria tessellata* (Lam.).

1899. *Septaria tessellata* with vars. *clypeolum*, *compressa* and *lineata*, Dautzenberg, *op. cit.*, pp. 23-26, pl. i, figs. 14, 14a, 15, 16.

Many specimens of the *forma typica*, showing all grades of tessellated colouration and closely corresponding with Lamarck's original figures and also with those of Dautzenberg cited above, are represented from the streamlet along the road to Anak Laut, Sabang. Besides these specimens of the *forma typica*, shells of the three varieties *clypeolum* (Recluz), *compressa* (v. Martens) and *lineata* (Lam.), collected in the mangrove-swamps at Belawan (Deli) are also present in the Sumatran collection.

Family OSTREIDAE.

Genus *Ostrea* Linn.

Specimens of three species of this genus are represented in the collection from the regions of mangrove-swamps in Sumatra. One of these, which I consider to be identical with the widely distributed miocene and recent *Ostrea gryphoides* (Schlotheim), belongs to the subgenus *Ostrea*, s.s., and was probably brought into the estuarine region by the tides as there are remains of corals on the shells,¹ but it is likely that the species in Sumatra, like an allied form found living in the Chilka Lake,² is a true inhabitant of brackish waters. The other two species belong to the subgenus *Alectryonia*, and are true estuarine forms.

¹ Might it not be possible that the shells are subfossil, and at the present day are found in the mangrove-swamps in consequence of the retiring of the sea by land elevation, which is here very prominent. [den Doop].

² See Annandale and Kemp, *Mem. Ind. Mus.* V pp. 348, 349 (1916).

Ostrea gryphoides (Schlotheim).

1912. *Ostrea gryphoides*, Newton and Smith, *Rec. Geol. Surv. Ind.* XII, p. 7, pls. i-vi.

Newton and Smith have identified the recent species, which occurs very commonly from the Mekran Coast to the Malay Peninsula, with the miocene *O. gryphoides*; Annandale and Kemp (*loc. cit.*), on Mr. Vredenberg's authority, consider it doubtful whether the living form should not be known as *O. virginiana* rather than *O. gryphoides*. As the identity of the Indian and the American species has not yet been definitely established, I prefer to designate the Indian and Sumatran forms *O. gryphoides*. The differences in the shell of the American *O. virginiana* and the Indian species were fully noted by Newton and Smith, and are summarised in the paper by Annandale and Kemp.

The Sumatran shells are closely similar to the Indian forms from the Malay Peninsula and other localities in the Indian Museum collection. They resemble the photographs on pls. iv and v of Newton and Smith's paper. The specimens were collected by Mr. den Doop in the mangrove-swamp region at Belawan (Deli). The shells are not much worn, but are parasitised by some species of boring sponge of the genus *Cliona*. The external surface of the shell and the inner layer are whitish, the muscle scar is somewhat yellowish, while the ligament has a blackish colour.

Subgenus Alectryonia, Fischer Waldh.**Ostrea folium, Linn.**

1897. *Ostrea folium*, v. Martens, *op. cit.*, p. 222.

Typical specimens of this species are present from the mouth of the Soengei Batang Kwis (Serdang). The specimens were collected in the estuarine area and are stated to be subfossil in a sandy incision of an old *pematang*. This incision was made for a new drain-canal on the estate.

Ostrea cuculata, Born.

1897. *Ostrea cuculata*, v. Martens, *op. cit.*, p. 223.

1916. *Ostrea cuculata*, Annandale and Kemp. *Mem. Ind. Mus.* V, p. 349, pl. xiv, figs. 2.

This widely distributed species is represented by two partially bleached shells from the same locality as the preceding species. The specimens are rather broken and imperfect.

Family UNIONIDAE.

Many species of this family have been recorded from Sumatra by Bruno Strubbel, von Martens and others, but in the present collection this family is poorly represented.¹ In a recent paper I

¹ I think in the region where I collected this family is very poorly represented. Of this the freshwater Neritinas afford another instance. These are entirely

have dealt with one of the species and here only include a few notes on it. There are, however, in the collection a few specimens of a species of the genus *Contradens*, Haas, a short account of which is given below.

Genus *Monodontina*, Conrad.

Monodontina vondembuschiana var. *chaperi* (de Morgan).

1919. *Monodontina vondembuschiana* var. *chaperi*, Prashad, *Rec. Ind. Mus.* XVI, pp. 407, 408.

In my recent paper I unfortunately missed a reference to one of von Marten's papers¹ in which he had recorded a Sumatran form under the name *Pseudodon vondembuschianus*. Probably his specimens also belonged to the variety *chaperi*.

In the Sumatran collection the variety is represented by a large series of specimens from the Soengei Kalau (a streamlet near Bohorok), Soengei Deli at Medan and a few empty shells from Bohorok. Mr. den Doop informs me that the empty shells had been left there after the soft parts had been eaten.

Genus *Contradens*, Haas.

1913. *Contradens*, Haas, *Nachr. Deutsch. Malakozool. Ges.* XI.V p. 35.
1914. *Contradens*, Haas, *Mart. Chemn. Conch.-Cab. Unio*, p. 173.
1914. *Nodularia* (in part), Simpson, *Des. Cat. Naiades*, p. 108.

Haas proposed this genus on both shell-characters and soft-parts for the species included by Simpson² in his group of *Nodularia contradens*. Simpson in his later work, cited above, has not accepted Haas' new genus and continued his original scheme. I have had a chance of examining the shells of some of the species and the soft-parts of *C. dimotus* var. *lugens* recorded below, and think that the genus is well characterised and should be separated from *Nodularia* as accepted by Simpson.

Contradens dimotus var. *lugens* (Drouet and Chaper).

1892. *Unio lugens*, Drouet and Chaper, *Mem. Soc. Zool. France*, V, p. 147, pl. v, figs. 1-3.
1914. *Contradens dimotus lugens*, Haas, *op. cit.*, pp. 182, 183, pl. xix, fig. 7.
1914. *Nodularia lugens*, Simpson, *op. cit.*, p. 1012.

A large series of rather young shells from the Soengei Krah at Medan, and a young specimen from a fresh-water area near Medan, quite resemble Drouet and Chaper's description and figures and also Haas' figure of one of the co-types. The only differences are in the beaks being a little more high and having a

absent (even in the chalky mountains) from the northern part of the government "Oostkust van Sumatra" whereas they are abundantly represented in Sabang. [den Doop].

¹ *Nachr. Deutsch. Malakozool. Ges.* XXII, p. 13 (1900).

² *Proc. U. S. Nat. Mus.* XXII, p. 817.

distinct sculpture of rather thick wavy lines; they show distinct V-shaped curvatures in the upper regions of the umbones, and some of the lines extend on to the posterior wing as well. The posterior ridge is not single but distinctly double, and in some specimens another faint ridge is also indicated above these ridges. In outline, as stated above, the specimens quite resemble Drouet and Chaper's figures. The specimens are all quite fresh, and are of a brownish yellow colour with a few greenish stripes in the region of the posterior wing. The largest specimen does not exceed 40 mm. in length.

This form had hitherto been known from Borneo only but the *forma typica* and other nearly allied forms have been recorded from Sumatra.

The animal resembles that of the species *C. hageni* and *C. verbecki* described by Haas (*loc. cit.*, pp. 175, 199 and 200, text-figures 2, 3).

Family CYRENIDAE.

Genus *Cyrena* (Lam.) Gray.

Cyrena sumatrensis, Sowerby.

1897. *Cyrena sumatrensis*, v. Martens, *op. cit.*, p. 92.

One complete specimen and a few rather worn shells of this species were collected from the mangrove-swamps at Belawan (Deli). These specimens agree fairly well with the large series of this species in the Indian Museum collection.

Genus *Corbicula*, Meg.

In Mr. den Doop's Sumatran collection the genus is represented by dry shells of the four species dealt with below, and a few young shells which it is not possible to identify specifically. It may also be noted here that the shells of practically all the specimens are greatly eroded.

Corbicula moltkeana, Prime.

1897. *Corbicula moltkeana*, v. Martens, *op. cit.*, pp. 111, 112.

This species is represented by a few rather imperfect specimens from a streamlet at Timbang Langkat. The specimens closely agree with a specimen named by the late Prof. E. von Martens.

Corbicula trapezoidea, v. Martens.

1897. *Corbicula trapezoidea*, v. Martens, *op. cit.*, pp. 115, 116, pl. vii, figs. 14-19.

A single specimen from a streamlet at Timbang Langkat agrees in shape and hinge-teeth with one of v. Martens' co-types, but the ribs on the surface are more closely situated and not so prominent as in that specimen.

***Corbicula angulifera*, v. Martens.**

1897. *Corbicula angulifera*, v. Martens. *op. cit.*, p. 116, pl. vii. figs. 28-31.

A few specimens from fresh-water areas near Medan and Tandjong Djatti, from the Soengei Lapan (Langkat) and a young shell from a streamlet at Timbang Langkat agree closely in shape with one of von Martens' co-types, but the sculpture of all the shells, owing to erosion, is very indistinct, and it is, therefore, impossible to be quite certain about their identification.

***Corbicula pullata*, Phil.**

1897. *Corbicula pullata*, v. Martens, *op. cit.*, pp. 117, 118.

I assign a single specimen from a streamlet at Timbang Langkat to this species. This specimen agrees with the description of the species and also with Issel's description and figures of *C. dayakorum*,¹ which von Martens considers to be only a synonym of Philippi's species.

Genus *Sphaerium*, Scopoli.

So far as I can find no species of this genus of world-wide distribution has so far been recorded from Sumatra. This may be due to the various collectors having overlooked the rather minute shells. The only species known from the adjacent island is *P. borneense* (Sowerby), but the single shell in the Sumatran collection found in a tubeful of *Limnaea javanica* var. *subteres*, v. Martens, is quite different from it. As it does not correspond to any previously described form, I have described it here under the name *Sphaerium ceciliae* at the request of Mr den Doop.

***Sphaerium ceciliae*, Prashad (sp. nov.).**

(Plate xiv, fig. 17).

The shell is ovate, somewhat swollen, subequilateral, rather thick, with the anterior margin small and rounded; the posterior margin is a little longer than the anterior and is broadly rounded; the upper and lower margins are regularly curved, the upper curve being deeper than the lower. The umbones are prominent, swollen, recurved inwards and separated from one another in the middle line by a narrow chink. The epidermis is nearly smooth in the umbonal region but has closely situated faint concentric striae below on both the valves. The shell is of a pale horny colour in the umbonal region, but is much darker in the lower region and shows greenish stripes in some places; the inner surface of the valves is dusky bluish. The right valve has two lamellar laterals on each side, of these the upper is very feeble; there are

¹ *Ann. Mus. Civ. Stor. Nat. Genova*, VI, p. 410, pl. vii, figs. 25-27 (1874).

two cardinals, the anterior one being narrow, elongate, somewhat triangular, and the posterior thick and tooth-like. The left valve has a single lateral on each side; of the two cardinals of this valve the anterior is thick and blade-like, while the posterior is small and reduced to a knob.

The single type-shell measures 9.3 mm. in length by 7.4 mm in maximum breadth, and is 4 mm. thick. It was collected in the valley of the Lau Kling (stream near Brastagei in the Karo-Batak High Plain).

FAMILY SOLENIDAE.

Genus *Cultellus*, Schumacher.

1887. *Cultellus*, v. Martens, *op. cit.*, p. 263.

1820. *Cultellus*, Ghosh, *Rec. Ind. Mus.* XIX, pp. 61, 62.

Three subgenera *Cultellus* s.s., *Pharella* and *Enisculus* are known from the Dutch East Indies, while specimens of the first two have been recorded from Sumatra. In Mr. den Doop's collection only specimens of *C. (P.) javanicus*, a species previously recorded from Sumatra, are represented.

Subgenus *Pharella*, Gray.

1887. *Pharella*, v. Martens, *op. cit.*, p. 266.

1820. *Pharella*, Ghosh, *op. cit.*, p. 63.

Von Martens redescribes this subgenus in the paper cited above and Ghosh has given a fairly complete description of the gross anatomy based on Bloomer's work.¹ He considers it with Bloomer to be worthy of separate generic rank, but the small differences in the gills of *Pharella* and *Cultellus* s.s. are not, in my opinion, sufficient to separate the two into distinct genera. The shells of the two are closely similar and it appears best, therefore, to consider the two as subgenera rather than as distinct genera.

Cultellus javanicus (Lam).

1897. *Cultellus (Pharella) javanicus*, v. Martens, *op. cit.*, pp. 267-269.

Three specimens of this species collected in the mangrove-swamps at Belawan (Deli) agree closely with von Martens' description and with the large series of this species from Penang and other localities in the Malay Peninsula, preserved in the Indian Museum collection.

FAMILY PHOLADIDAE.

Genus *Teredo*, Linn.

Subgenus *Furcella*, Lam.

Teredo arenaria (Linn.).

1897. *Teredo (Furcella) arenaria*, v. Martens, *op. cit.*, pp. 284-286.

A rather small and somewhat broken specimen is assigned with some doubt, to this species. The shape and texture is quite

¹ *Journ. Malacol.* X pp. 114-121 (1903).

like the specimens in the Indian Museum collection, but the imperfect condition of the shell renders exact identification difficult.

The specimen was obtained by Mr. den Doop in the mangrove-swamps at Belawan (Deli).

EXPLANATION OF PLATE XIV.

Auricula limnaeiformis, Annandale.

FIG. 1.—Dorsal view of the type-shell.

,, 2.—Ventral view of the same.

Auricula percha, Annandale.

FIG. 3.—Dorsal view of the type-shell.

,, 4.—Ventral view of the same.

Physastra doopi, Prashad.

FIG. 5.—Dorsal view of the type-shell.

,, 6.—Ventral view of the same.

Vivipara hendrici, Prashad.

FIG. 7.—Dorsal view of the type-shell.

,, 8.—Ventral view of the same.

,, 9.—Outer view of the operculum.

,, 10.—Inner view of the same.

Melanoides sluiteri, Prashad.

FIG. 11.—Dorsal view of the type-shell.

,, 12.—Ventral view of the same.

Neritina simoni, Prashad.

FIG. 13.—Dorsal view of the type-shell.

,, 14.—Ventral view of the same.

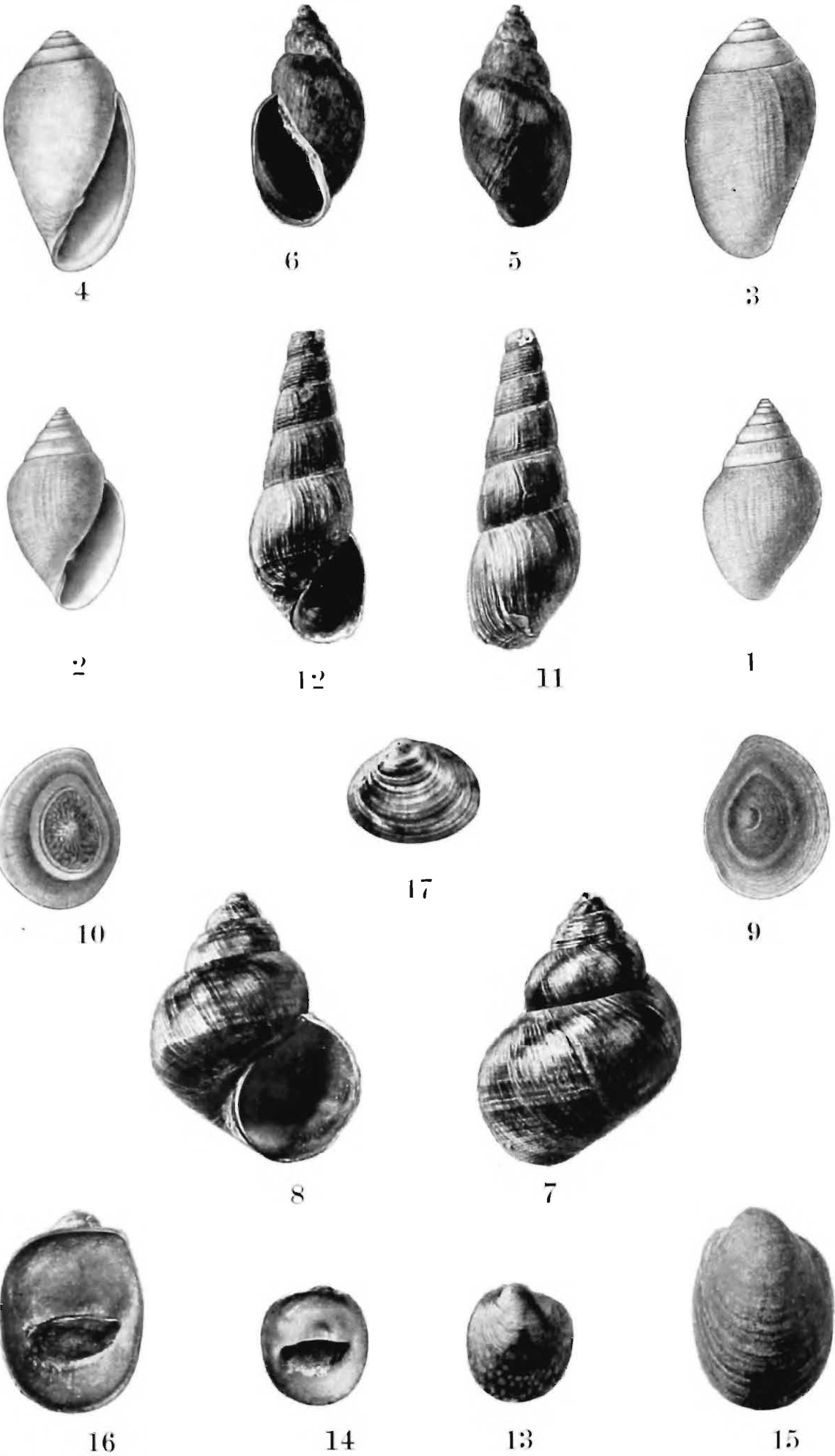
Neritina weberi, Prashad.

FIG. 15.—Dorsal view of the type-shell.

,, 16.—Ventral view of the same.

Sphaerium cecilae, Prashad.

FIG. 17.—Left valve of the type-specimen.



S. C. Mondul, photo.

NEW SUMATRAN MOLLUSCA.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921.

XXVI TWO NEW SPECIES OF RAGMUS¹ FROM SOUTH INDIA.

By E. BALIARD, B.A., F.E.S., Government Entomologist,
Madras.

(Plate XXVII).

In the course of investigation into the infection of young cotton bolls by bacteria the two species of *Ragmus* described below were discovered. They are common on both "country" and Cambodia cotton during most of the season (December to August), but become scarce about the end of June. Both species, besides being plant feeders, kill and feed on one another and on Thrips, Aphids and Mites. They are however primarily plant feeders.

Ragmus morosus, n. sp.

(Plate xxvii, figs. 1, 2).

This species is closely allied to *R. importunitas*, Dist. and *R. pellucidus*, Dist. General colour dorsally pale to dark ochraceous. Some specimens are virescent and the green colour of the abdominal segments shows through the hemelytra. This is much more noticeable in living than in dry specimens. There is some green colouration on the head and the anterior border of the pronotum. Ventrally virescent.

Antennae.—First joint, partially and entirely black; second joint black at the base, otherwise pale ochraceous; shorter and thicker than in *R. importunitas*, slightly thickened distally; third joint much longer than half the second joint; third and fourth joints, both pale ochraceous.

Head.—Between the eyes narrow and pilose. Eyes black, often reddish-brown in living specimens.

Pronotum.—Virescent anteriorly.

Legs.—Spotted with pitchy black. This is much more marked in the last pair. First pair almost entirely without spots. Tibiae spinulose but more longly spinulose on last pair.

Length.—1.75–2 mm.

Food plants.—Cotton (*Crotalaria juncea*), Cholan (*Andropogon sorghum*), Gingelly (*Sesamum indicum*).

Localities.—Coimbatore, Samalkota (Madras Presidency).

Type.—In the collection at Agricultural College, Coimbatore.

Ragmus morosus was first found sucking young cotton bolls, but it will attack and kill Thrips, Aphids and Mites. When con-

¹ Capsidae. Div. Camtotylaria.

fined in a tube with others of the same species it will kill them, especially if they are already injured. It feeds readily on boll-extract-agar medium. One specimen was seen sucking what appeared to be the remains of a small lepidopterous larva. It is suspected together with the other species of being instrumental in introducing pathogenic bacteria into young bolls and causing premature boll fall.

Ragmus flavomaculatus, n. sp.

(Plate xxvii, fig. 3).

Colour virescent, head pronotum scutellum and hemelytra with large yellow spots arranged as follows:—

Head.—Anteriorly a $\cap$ -shaped marking, on the vertex an irregular spot by each eye.

Pronotum.—Six spots. Two anteriorly, four along the posterior margin.

Scutellum.—Two spots. Some specimens show two spots on mesonotum.

Wings.—Hemelytra with ten conspicuous spots, seven on the corium, three on the clavus. Clavus, corium and cuneus obscurely spotted dark brown.

Antennae.—Black spot near distal end of first joint; base of second joint and base of third black. Second joint not so thick as in *R. morosus*. Third joint slightly longer than half the second joint. In some specimens the distal end of the fourth joint is fuscous.

Head.—Between the eyes narrow as in *R. morosus* and hairy; on the vertex two irregularly shaped yellow spots bordering the eyes.

Legs.—Last pair of legs have the femora conspicuously spotted with black as in *R. morosus* and other species of the genus, and in addition a rosette of five spots at distal end. First and middle pair obscurely spotted. Tarsi spinulose but more strongly so on last pair of legs.

Wings.—Hemelytra with ten conspicuous yellow spots as described above. Posterior margin of the cuneus spotted with black. A triangular black spot half way between cuneus and tip of membrane. Tip of membrane fuscous. Cells of membrane outlined fuscous.

Length.—2 mm.

Food plants.—Cotton bolls and leaves (*Andropogon sorghum*). Will attack and feed on Aphis and Thrips.

Locality.—Coimbatore (Madras Presidency).

Type.—In collection at Agricultural College, Coimbatore.

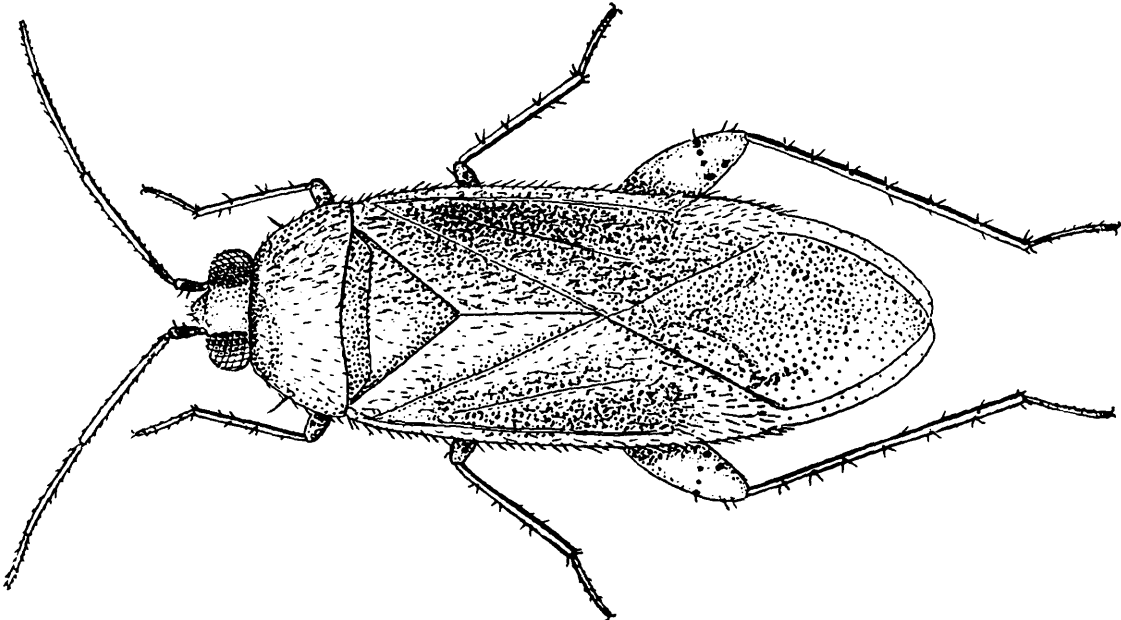
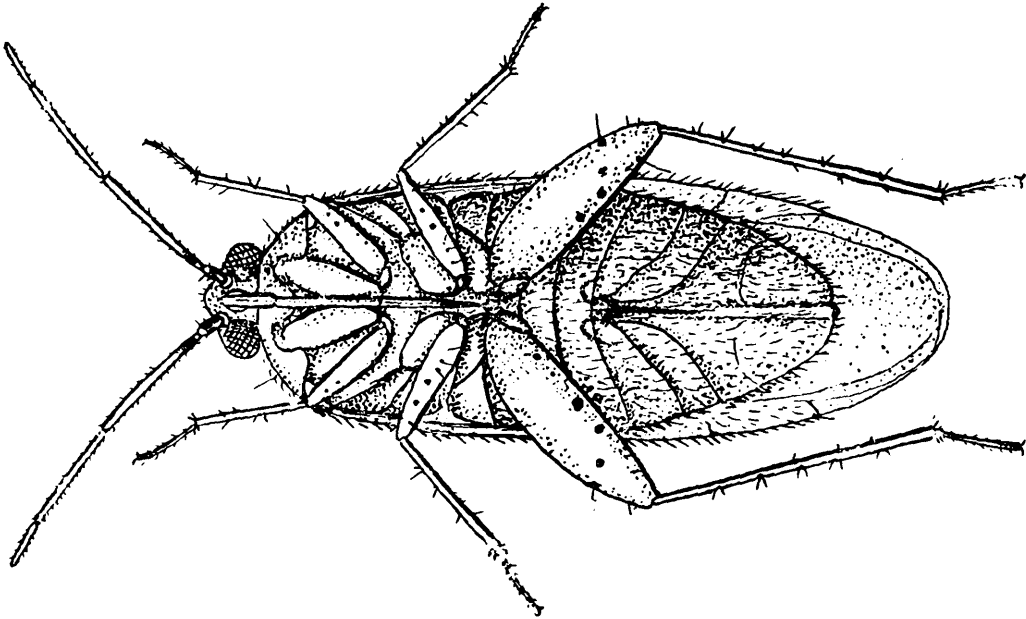
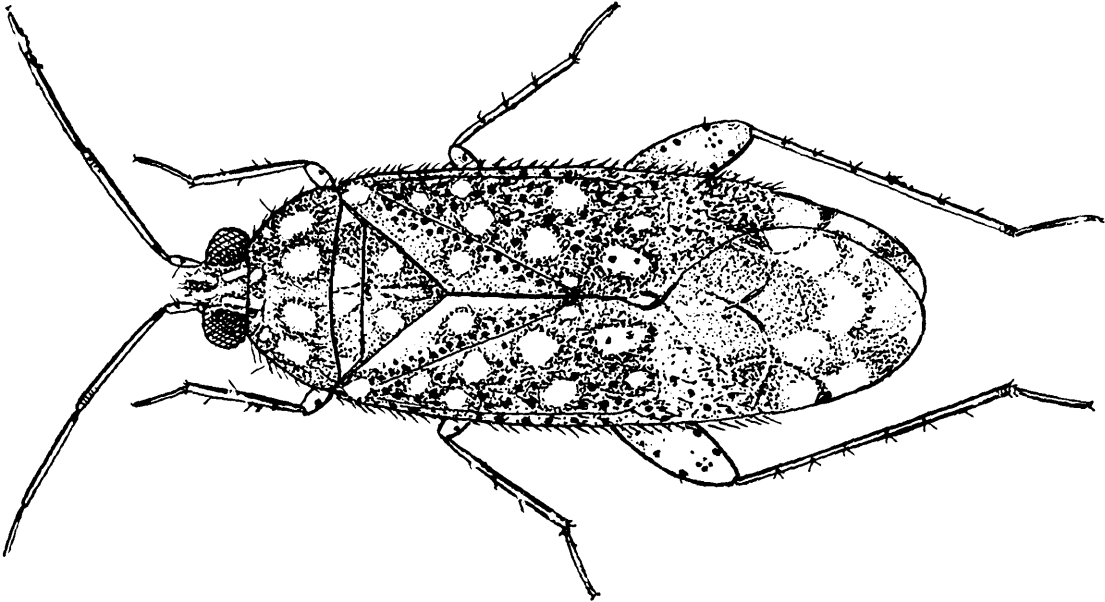
Found associated with *R. morosus* on cotton bolls. It was not found on gingelly. Persists throughout most of the cotton season but had practically disappeared by the end of June.

I wish to express my indebtedness to Dr. G. A. K. Marshall for comparing these two species with types of the other species of the genus at the British Museum and to Mr. B. P. Uvarov for drawing up a list of the chief differences found.

EXPLANATION OF PLATE XXVII.

FIGS. 1, 2.—*Ragmus morosus*, n. sp.

FIG. 3.—*Ragmus flavomaculatus*, n. sp.



2.
RAGMUS FROM S. INDIA.

XXVII ON SOME CAVERNICOLOUS DERMAPTERA AND ORTHOPTERA FROM ASSAM

By L. CHOPARD, D.Sc.

(Plates XXI—XXIII.)

In a previous paper (*Mem. As. Soc. Beng.* VI [1919], pp. 339–396) I described a *Diestrammena* from Cherrapunji which was the first cavernicolous Orthopteron collected in that region of India. Since then, Dr. N. Annandale has had the kindness to send me another collection of Orthoptera from caves in Assam, containing the following species:—

Forcipula trispinosa, Dohrn, Siju Cave.

Chelisoches morio, F, Siju Cave.

Spelaeoblatta (?) *caeca*, sp. nov., Rupmath Cave.

Rhaphidophora rufobrunnea, sp. nov., cave near Yawnghwe.

Diestrammena brevifrons, Chop., Rupmath Cave.

Diestrammena indica, sp. nov., cave near Yawnghwe.

Tachycines adelungi, sp. nov., Ngot bat Cave.

Arachnomimus sp., Siju Cave.

It may be seen from this short enumeration how little known this cavernicolous fauna is. The Blattid hereafter described is particularly of great interest, being completely blind and showing remarkable characters of adaptation to cavernicolous life.

DERMAPTERA.

The two species of Dermaptera here referred to, as well as the other few species of this group recorded from caves in various parts of the world, are common lucicolous species. They do not show any character of adaptation to cavernicolous life but seem nevertheless quite well accustomed to this special habitat. In fact both of them are represented by a certain number of individuals of both sexes and by immature stages which proves that they live completely and reproduce themselves inside the caves.

Fam. FORFICULIDAE.

Subfam. LABIDURINAE.

Gen. *Forcipula*, Bolivar.

Forcipula trispinosa, Dohrn.

Siju Cave, Garo Hills (R. Friel, Nov. 1917); 2 ♂, 4 ♀, 2 young individuals.

This species is found outside of caves in the north of India.

Subfam. *CHELISOCHINAE*.Gen. *Chelisoches*, Scudder.*Chelisoches morio*, F.

Siju Cave, Garo Hills (R. Friel, Nov. 1917); 4 ♂, 3 ♀, 4 young individuals.

This species is very common in India. I reported it previously from Batu and Jalor Caves (*loc. cit.*, p. 342).

ORTHOPTERA.

Fam. *BLATTIDAE*.Subfam. *BLATTINAE*.Gen. *Spelaeoblatta*, Bolivar.*Spelaeoblatta* (?) *caeca*, sp. nov.

(Pl. xxi, figs. 1 to 11; pl. xxii, figs. 12 to 14.)

Type.—One immature male from Rupmath Cave, north of Jaintiapur, Jaintia Hills, Sylhet District [alt. *ca.* 1000–1500 ft.], (R. Friel and W. Ballantine, iii-18).

Apterous, size medium; coloration rather bright yellow, becoming almost orange about the middle of the body, lighter, rather greyish and translucent on the sides. Legs and antennae concolourous. Body shining, glabrous; legs with scarce pubescence.

Head narrow; occiput convex, exposed, face straw-yellow, with scarce pubescence; forehead broad, little convex, united with the facial shield without limit; clypeus twice as long as broad, almost rectangular, labrum as long as broad, subacute at the apex. Eyes, ocellae and ocelliform spots absent. Antennae a little longer than the body, yellow, pubescent; 1st joint large and thick, almost glabrous; 2nd short, cylindrical; 3rd almost thrice as long as broad, smooth, almost glabrous; the following joints are very short, with scarce pubescence; little by little they become longer and about the middle of the antennae they are thrice as long as broad, with an abundant hairy clothing. Maxillary palpi rather short, the 1st and 2nd joints very short; 3rd longer, dilated at the apex; 4th equal to 3rd in length, more strongly dilated; 5th a little longer than the preceding joints, subtriangular. Labial palpi with 1st and 2nd joints short, subequal to length, 3rd almost equal to them united, rather slender, not dilated at the apex.

Pronotum a little broader than long, with anterior margin widely rounded, posterior one weakly convex, posterior angles almost right angles, a little rounded; disk of a dark yellow, with a very fine longitudinal median keel; surface little convex, smooth, glabrous; anterior margin a little thickened, a rather long bristle on each posterior angle. Meso- and metanotum rather short, their

posterior margin a little sinuated, the angles prominent, provided with a bristle. Inferior part of the thorax whitish with a short rufous pubescence.

Abdomen rather narrow, depressed, yellow above, whitish beneath, glabrous, with a bristle at the posterior angle of each tergite. First tergite very short, the following regular, their posterior margin straight, to the 6th; 7th, 8th and 9th very short. 10th forming a small triangular supraanal plate, with sinuated margins and rounded apex. Sternites with their posterior margin a little concave, the 9th forming a short (incompletely developed) subgenital plate with posterior margin convex; style very short, bearing a few bristles. Cerci rather long, slender, composed of 8 joints, the first 3 of which are broader than long, the 4th almost square, 5th and following ones longer and longer, 8th slender, almost cylindrical; pubescence rather scarce, composed of long bristles.

Legs of the same colour as the body, with a short and scarce pubescence. Front femora compressed, armed beneath, at the external margin with a single apical spine, the internal margin bearing, near the base, 4 rather strong spines, then a series of about 10 spinuliform hairs, 1 strong enough spine and the apical one rather long, above this is a long, curved spur, inserted almost in the middle of the apical margin. Tibiae almost as long as the femora, cylindrical, with scarce pubescence, armed with 5 apical spurs, 1 external inferior and 3 superior spines (2 int., 1 ext.). Tarsi rather long, the 1st joint longer than the three following united, these equaling together the 5th; pubescence scarce, almost spinuliform. No arolia between the claws. Intermediate femora compressed, armed with a long, curved, apical spine on the superior external margin; inferior internal margin bearing 4 small spines, external margin with 4 or 5 weak spines separated by spinuliform hairs, one of which is apical. Tibiae rather long and strong, armed with 5 apical spurs, 7 superior (2 int., 2 med., 3 sup.) and 4 inferior spines (3 ext., 1 int.). Tarsi rather short, the metatarsus equaling the other joints together. Posterior legs similar to the intermediate ones, femora armed with a long, superior, internal apical spine, their inferior margins bearing 4 to 5 weak, irregular spines and 1 apical, a little stronger one. Tibiae armed with 5 apical spurs, 12 superior (5 int., 3 med., 4 ext.) and 8 inferior spines (4 int., 4 ext.), the external longer than the internal ones. Tarsi similar to the intermediate ones.

Length of body 11.5 mm., length of pronot. 2.6 mm., width of pronot. 3.5 mm.; ant. fem. 1.9 mm.; ant. tib. 1.5 mm., interm. fem. 2.4 mm.; interm. tib. 2.3 mm.; post. fem. 3 mm.; post. tib. 3.5 mm.; post. tarsi 3.6 mm.; cerci 3 mm.

Although represented by a single immature specimen, this species is very distinct from all the known cavernicolous Blattids and I do not hesitate to describe it. A careful examination of the genitalia allows me to suppose that this insect had two moults to make before being adult, very likely the imaginal stage would

not be much larger (about 15 mm.) and, as it shows absolutely no trace of elytra or wings, it would be apterous. If correct, this feature would need the creation of a new genus, the female of *Spelaeoblatta gestroi*, Bol., showing rudimentary elytra, and considering that an apterous male could not enter the same genus as a female provided with elytra. Yet, the male of *S. gestroi* being unknown, it seems better to leave the present species in the same genus till more abundant material is obtained.

It would be of the greatest interest to search those remarkable species which are known both from a single *type-specimen* only.

As I stated before, *S. caeca* is one of the most interesting cavernicolous Orthoptera, as it shows remarkable adaptative characters consisting in the disappearance of the pigment, the unusual length of antennae, legs and cerci and the complete disappearance of the organs of sight. From that point of view, it is the most adapted cockroach known, as none of the species described till now show completely blind males.

Fam. PHASGONURIDAE.

Subfam. RHAPHIDOPHORINAE.

Gen. *Rhaphidophora*, Serville.

Rhaphidophora rufobrunnea, sp. nov.

(Pl. xxii, figs. 15 to 17.)

Type.—One immature male from a cave near Yawngnaw, foot of Elephant Hill, S. Shan States (F. H. Gravely, 6.iii.17).

Species of a probably medium size, with a very marked coloration, stout stature, almost without pubescence.

Head little narrower than the pronotum, occiput and forehead almost black, rostrum narrow, black, forming two sharp tubercles, separated by a very narrow furrow which does not extend to the base of the rostrum; two large whitish ocellar spots. Face yellow with two small brown spots beneath the eyes and two brown bands beneath the antennae which do not extend to the clypeus; anterior part of the face very broad, narrowing suddenly at the base of mandibles, clypeus about once and a half broader than high, much narrower downwards, presenting two impressions in its inferior part and two small brown spots in the superior part; labrum longer than wide, brown with a short basal keel.

Mouth parts short, brown; maxillary palpi long, yellow, the three last joints subequal in length (2.2—2.4—3.1 mm.), labial palpi rather long, the 3rd article equaling the other two together. Antennae rufous brown, almost glabrous at base, pubescent after, very close together at base; first joint big, yellowish, with a brown band along the internal border; second joint very short, yellow; third a little longer, brownish; fourth shorter than the third but longer than the following ones.

Pronotum rather narrow, with anterior and posterior margins little convex, lateral lobes moderately high, their inferior margin

regularly and slightly convex, thickened, anterior angle completely obliterated; colour dark rufous brown, marbled on the disk with large brown spots along the anterior and posterior borders. Mesonotum and metanotum coloured like the pronotum; posterior margin of mesonotum rather strongly, of metanotum feebly convex; lateral lobes moderately high, their inferior border thickened, sub-angulate before the middle.

Abdomen dark rufous, the tergites posteriorly lined with brown; 10th tergite presenting a median impression, bordered with two little diverging keels and two large lateral facets to which the supraanal valve is articulated; this is large, lengthened, sub-acute at the apex, with blackish margins, it is set very exactly on the inferior valves which are broad, triangular. Inferior face of abdomen yellowish; subgenital plate forming a little apical process, weakly bilobed, furrowed; styli rather short, cylindrical.

Cerci moderately long, rather thick at base, yellow, darkened near the apex.

Legs rather short, rufous yellow, the apex of femora and the base of front and intermediate tibiae strongly darkened. Front coxae exteriorly compressed and bearing a weak spine; femora a little compressed, armed with a rather long, movable internal spine and a very short external one, tibiae thick, hairy, armed with two subequal apical spurs and 3 inferior spines, 1 of which internal in the midst and 2 external, longer, inserted a little above the internal and between that one and the apex. Tarsi short with metatarsus very little dilated at the apex, a little shorter than the other articles together, carinate beneath in its distal half, the basal one bearing small spinules, 2nd and 3rd joints very short, carinate beneath, the carina, as well as that of the metatarsus, blackish. Intermediate legs similar to anterior ones; coxae enormous, femora armed with 2 long, subequal, apical spines; tibiae rather thick at base, armed with 4 apical spines, the 2 superior of which are shorter than the inferior ones; superior margins armed each with 2 spines, the internal a little above the external ones; inferior margins armed with 2 external and 1 internal spine, disposed as those of the anterior tibiae.

Posterior femora short and stout, rufous brown at base, blackish at apex, external face presenting oblique blackish bands; tibiae blackish except the apex which is rufous brown; their superior margins armed with about 20 spines (20 ext., 21 int.), rather strong and close, the apical one a little remote from the preceding; 6 apical spurs, the superior internal one equaling the metatarsus; tarsi short, the metatarsus equaling the other articles together, compressed, feebly dilated at the apex, its superior margin little convex, armed with a broad apical yellow tooth and 4 very little denticulations, inferior margin as that of the other metatarsi; 2nd and 3rd article extremely short, 4th rather long and slender.

Length of body 16 mm.; length of pronot. 5.5 mm.; width of pronot. 5 mm.; cerci 5 mm.; ant. fem. 6 mm.; ant. tib. 6 mm.;

interm. fem. 6 mm.; interm. tib. 6 mm., post. fem. 13 mm.; post. tib. 12.5 mm., post. tarsi 5 mm., post. metat. 2.5 mm.

This species is described after a single immature male, from what I know of these cavernicolous Orthoptera the mature specimens must present almost exactly the same characters and their size must be about 25 mm. It is closely allied to *R. mulmeinensis*, Chop., having like the latter species very short legs but the rostrum of the vertex is more acute and the coloration shows a very decided contrast between the rufous ground-colour and the blackish markings of the body and legs.

Gen. *Diestrammena*, Brunner.

Diestrammena, Brunner, 1888, *Verh. zool. bot. Ges. Wien*, XXXVIII p. 298.

Paradiestrammena, Chopard, 1919, *Mem. As. Soc. Beng.*, VI, p. 375.

When I described the genus *Paradiestrammena*, I explained that its creation seemed necessary to me on account of the specific identity of *Diestrammena marmorata*, Haan and *Tachycines asynamorus*, Adel. Since then, Dr. H. Karny had the opportunity of examining the types of Haan in the Leyden Museum and he wrote to me that *D. marmorata* was quite a different species of the *Tachycines* found in the hot-houses of Vienna and several other towns of Central Europe. A little later Pr. R. Ebner had the kindness to send me all the specimens of *Diestrammena* and *Tachycines* of the Brunner collection and I could ascertain that both species are very different from one another. *D. marmorata*, Haan, is a large species of the *longipes* group, known only from Haan's type and 6 specimens (4 of which are very young) in the Brunner collection.

The genotype of *Diestrammena*, Br., is therefore *D. marmorata*, Haan, and the description I gave for *Paradiestrammena* can be applied exactly to this genus.

The cavernicolous species of *Diestrammena* are much smaller than the typical species and form a pretty well-defined group. Several forms having been described and a few modifications made since I published a key for this genus (*Bull. Soc. ent. Fr.* [1916], pp. 154-159) I think it necessary to give a new synopsis of its known species.

Key to the species of *Diestrammena*, Br.

1. Anterior and intermediate tibiae armed with 2 apical inferior spurs without median spine between them ... 2.
- Anterior and intermediate tibiae armed with 3 and 4 apical spurs with a small median spine between the inferior spurs ... 3.
2. Small size (10 mm.), slender; anterior tibiae bearing 1 single spine beneath, intermediate tibiae without spine; posterior tibiae unarmed beneath; ♂ subgenital plate very large, widely rounded, epiphallus very small, conical; ♀ sub-

- genital plate triangular with convex borders, apex subacute, ovipositor rather long, acute at apex ... *D. minuta*, Chop.
- Medium size (18—20 mm.); posterior femora spined beneath; anterior tibiae with 3, intermediate ones with 2 inferior spines; legs, cerci and face whitish: subgenital plate of ♀ triangular, very narrow, subtruncate at apex ... *D. apicalis*, Br.
3. Posterior femora unarmed beneath; general colour rufous without brown markings on the disk of pronotum; size rather small (12—16 mm.) ... 4.
- Posterior femora armed beneath with small spines on one edge at least; body and legs very often marbled with fuscous; size medium or large (16—35 mm.) ... 6.
4. Frontal rostrum divided into two acute tubercles, very widely separated; epiphallus of ♂ cylindrical with its apex free, crescent shaped; subgenital plate of ♀ triangular, ovipositor short with superior valves weakly excavated near the apex ... *D. feai*, Chop.
- Frontal rostrum very short or truncated at apex; epiphallus of ♂ rather large, depressed, trapezoidal or Y-shaped; subgenital plate of ♀ rounded, ovipositor longer than the cerci with superior valves regularly incurved ... 5.
5. Frontal rostrum short, truncated and feebly divided at apex; intermediate tibiae unarmed beneath; large internal spur of posterior tibiae shorter than the metatarsus which is spined beneath on all its length; subgenital plate of ♂ truncated at apex, epiphallus trapezoidal with rounded angles; inferior valves of ovipositor armed with 12 teeth towards the apex ... *D. brevifrons*, Chop.
- Frontal rostrum very short, divided into two small triangular tubercles, almost crushed; intermediate tibiae armed beneath with 2 spines on each border; large internal spur of posterior tibiae equaling the metatarsus which is carinated and unarmed in its apical half; subgenital plate of ♂ rounded, epiphallus Y-shaped (pl. xxii, figs. 21 and 22); inferior valves of ovipositor armed with 6 large denticulations towards the apex... *D. vitalisi*, Chop.
6. Medium sized species (16—20 mm.); 7th tergite of males without process. General colour rufous with fuscous markings ... 7.
- Large sized species (25—35 mm.); 7th tergite of males usually with a long process extending to the apex of abdomen; tegument very thick, general colour brown or fuscous or rather bright, mixed with yellow and whitish¹ ... 9.
7. Posterior femora armed beneath with 7—8 small spines on the internal margin. Coloration yellowish rufous, marbled with fuscous markings;

¹ The *Diestrammena* of this group are large insects, none of which seem to inhabit caves exclusively. Accordingly their tegument is more resisting than that of the species of the preceding group. The long process of the 7th abdominal tergite of the males is very remarkable and I thought it characteristic of the group, yet it seems absent in several species, as Karny does not speak of it in a recent description (*D. ingens*, Karny, 1918,) and the male of *D. marmorata*, Haan, of the Brunner collection does not appear to possess such a process, but its posterior end being very much damaged does not permit of being quite certain.

subgenital plate of ♀ notched at apex (♂ unknown) ...

D. indica, sp. nov.

—Posterior femora armed beneath with 1—3 very small spines on the internal margin, subgenital plate of ♀ with 3 or 5 apical lobes ...

8.

8. Coloration rufous, rather uniform, thorax weakly shining, the tergites bordered with brown posteriorly, subgenital plate of ♀ with 5 apical lobes, cerci shorter than the ovipositor (♂ unknown) ...

D. annandalei, Kirby.

—Coloration less uniform; pronotum marked with two large, very neat, yellowish spots near the anterior border and presenting, as well as the mesonotum, a median brown band; thoracic and three first abdominal tergites very shining; subgenital plate of ♀ trilobed at apex, the median lobe more or less notched at apex; cerci as long as or longer than the ovipositor, epiphallus of ♂ rectangular with a subacute process ...

D. gravellyi, Chop.

9. Large internal spur of posterior tibiae shorter than the metatarsus ...

10.

—Large internal spur of posterior tibiae at least equal to the metatarsus ...

12.

10. Posterior femora armed beneath with 9—10 external and 16—17 internal spines; anterior tibiae with 2 spines on each inferior margin; coloration rather bright, mixed with small brown, light yellow and whitish spots; pubescence almost invisible; process—of 7th abdominal tergite of ♂ rounded at apex (♀ unknown) ...

D. longipes, Rehn

—Coloration dull chestnut brown; armature of the posterior femora weaker (unknown in *D. ingens*, Karny) ...

11.

11. Formosan species; subgenital plate of ♂ large, posteriorly submarginate (♀ unknown) ...

D. ingens, Karny.

—Tonkinese species; posterior femora armed beneath with 2—3 external, 9—11 internal spines; anterior tibiae with 2 external and 1 internal spine; subgenital plate of ♀ square (♂ unknown) ...

D. maculata, Chop.

12. Face wholly black; large internal spur of posterior tibiae longer than the metatarsus; posterior femora presenting a large fuscous, longitudinal band on their superior margin; subgenital plate of ♀ carinated, notched at apex (♂ unknown) ...

D. griffinii, Chop

—Face adorned with longitudinal, blackish bands; large internal spur of posterior tibiae equal to the metatarsus; subgenital plate of ♀ triangular ...

13.

13. Face adorned with 2 longitudinal bands; 7th tergite of ♂ without process, subgenital plate of ♀ acute at apex, ovipositor short (length of post. fem. 31 mm., of ovipositor 12 mm.) ...

D. marmorata, Haan.

—Face adorned with 4 longitudinal bands; 7th tergite of ♂ with a long process, slightly notched at apex; subgenital plate of ♀ rounded at apex, ovipositor longer (length of post. fem. 32 mm., of ovipositor 21 mm.) ...

D. palpata, Rehn.

Diestrammena brevifrons, Chopard.

Rupmath Cave, north of Jaintiapur, Jaintia Hills, Sylhet District [alt. ca. 1000–1500 feet], (R. Friel and W. Ballantine, iii:18);

1 adult ♀, 3 immature ♀ and 5 immature ♂ (stages A and B), 6 very young examples.

This species was previously recorded from Maosmai Cave, Cherrapunji (*cf.* Chopard, *Mem. As. Soc. Bengal* VI [1919], p. 381).

Diestrammena indica, sp. nov.

(Pl. xxii, figs. 18 to 20.)

Type.—One immature female from a dark cave near Yawng-hwe), foot of Elephant Hill, S. Shan States (F. H. Gravely, 6·iii·17).

Medium sized species (ca. 16–18 mm.); coloration very neat, golden, abundant hair-clothing.

Head with short occiput, spotted with brown behind the eyes; face yellowish with a scarce pubescence, a longitudinal fuscous band beneath each eye and two other irregular ones from the internal angle of the antennary socket to the external angle of the clypeus; this is almost three times as broad as high, weakly carinated in the middle in its inferior half; labrum small, rounded, yellow. Mouth parts lengthened, yellow, maxillary palpi very slightly darkened, with 2nd joint rather long, the following joints being respectively 3·5–3·8 and 6 mm. in length; labial palpi with 3rd joint a little longer than the two other ones. Frontal rostrum short, formed of two blackish tubercles, broad at base but rather acute, widely separated at apex; a big, round, whitish ocellar spot at their base on each side. Antennae long, rufous, 1st joint large, 2nd thick and short, 3rd very long, cylindrical, 4th almost half as long as 3rd, 5th scarcely longer than the following ones.

Pronotum strongly convex, anterior border almost straight, posterior border very convex, subangulate in the middle; lateral lobes high, their inferior margin forming a feebly marked angle. Coloration rufous yellow, marbled with fuscous markings, irregularly disposed along the anterior and posterior borders; these markings are neat, chiefly near the posterior angle of the lateral lobes. Mesonotum with posterior margin very convex, coloured as the pronotum, its lateral lobes high with inferior margin very strongly convex; metanotum similar to the mesonotum but with posterior margin almost straight and lateral lobes a little high. Meso- and metathoracic episterna spotted with fuscous, the inferior margin of the mesothoracic episterna a little dilated in an angular lamina.

Abdomen presenting the same system of coloration as the thorax, 3rd tergite showing a fuscous mark larger than on the other tergites; 10th tergite emarginate at apex, brown in the middle; superior anal valve lengthened with sides a little convex, apex acute. Inferior face yellowish; subgenital plate not completely developed but its outline truncated and notched in the middle at apex. Cerci rather long, yellow, with a wide ring and the apical fourth fuscous.

Anterior coxae spotted with brown with a rather weak spine; femora presenting 3 fuscous rings and bearing a long external

yellow spine and a very small internal one; tibiae yellow with 4 fuscous rings, armed with 2 rather long, subequal, inferior apical spurs between which is a small spine, and with a short external superior spur, besides their inferior borders bear 2 external spines and 1 internal inserted a little above the inferior external one. Tarsi: long metatarsus longer than the other articles, wholly spined beneath except at apex, 2nd and 3rd joints keeled and glabrous beneath. Intermediate legs similar to the anterior ones, apical spines of the femora long and movable, the external a little longer than the internal one; armature of the tibiae similar but with 2 small superior spurs.

Posterior femora adorned with a brown ring and a few brown spots, bearing 2 very small genicular and 7-8 very small spines on the internal inferior border; tibiae spotted with brown, armed on each superior margin with 25-30 spines, one of which is stronger than the others and the apical one somewhat distant from the preceding. Apical spurs very long, the superior internal a little shorter than the metatarsus; this one is spined beneath and armed with a small apical spine.

Length of body 13 mm., pronot. 5 mm.; width of pronot. 5 mm., ant. fem. 11 mm., ant. tib. 11.5 mm.; interm. fem. 9.5 mm.; interm. tib. 10 mm.; post. fem. 20.5 mm.; post. tib. 21 mm.; post. tarsi 8.5 mm., post. metat. 5 mm.; sup. int. spur 4 mm.; cerci 8.5 mm.; ovipos. 5.5 mm.

This species belongs to the group of the medium sized cavernicolous species of *Diestrammena* (*D. annandalei*, Kirby, *D. gravelyi*, Chop., etc.); it differs from them in the numerous small spines of the inferior internal margin of the posterior femora, besides the shape of the subgenital plate must be very different when the insect is adult.

Gen. *Tachycines*, Adelung.

Tachycines, Adelung, 1902, *Ann. Mus. zool. Ac. Petersbourg* VII, p. 56.
Diestrammena, Chopard, 1919, *Mem. As. Soc. Beng.* VI, p. 376.

This genus, established by Adelung for *T. asynamorus*, is quite well characterised by the disposition of the spines on the superior margins of the posterior femora. All the variations shown by the species of *Diestrammena* as to the form of the subgenital plate and anal valves, the presence of a process on the 7th tergite of the ♂, the number of spines on the posterior femora, etc. may be found in the species of the present genus. A key for the determination of these species has been published by me in *Bull. Soc. ent. Fr.* [1916], p. 158.

Tachycines adelungi, sp. nov.

(Pl. xxii, figs. 23 to 25; pl. xxiii, figs. 26 to 28.)

Type.—One male from Ngot bat Cave, Yawngnaw State, S. Shan States, ca. 4000 ft. (F. H. Gravely, 1913:17).

Co-types.—Three adult ♂, 1 immature ♀ and 3 young examples, same locality.

Size medium, coloration rather high, not shining; pubescence rufous, rather abundant.

Head rufous; occiput very short with a squamiform, brownish pubescence; frontal rostrum short, formed of two conical tubercles, very obtuse and smooth with a few hairs at apex, punctate at base, brown with a large ocellar spot; forehead very short and narrow, face uniformly yellowish, long; clypeus about twice as broad as high, presenting a slight transverse keel; labrum longer than broad. Maxillae with 2 apical and 1 anteapical teeth; palpi very slender, yellowish, each joint weakly darkened at base and apex; length of 3rd to 5th joints: 4-4.5-7 mm. Basilar almost square, mentum rather long, palpigere and lobes long; palpi with 3rd joint a little longer than the other two together. Antennae extremely approximated at base, rufous, internal face of the 1st joint almost touching each other.

Pronotum with anterior border weakly, posterior border rather strongly convex, lateral lobes high, their inferior margin weakly convex, subangulate in the middle, disk rufous, a little darkened in the middle, anterior and posterior margins narrowly and not neatly bordered with brown; a rather vague brown spot on each side of the median line, near the anterior margin and the posterior angle of the lateral lobes. Mesonotum with posterior margin rather strongly convex, lateral lobes with inferior margin straight, forming a rounded process backwards; colour as that of the pronotum with a large brownish spot in the middle, lateral lobes and 2 small spots near the posterior border brown. Metanotum like mesonotum with lateral lobes regularly rounded and posterior margin a little convex. Mesothoracic episternum with inferior border broadened, subangulate.

Abdomen rather bright rufous with posterior margin of each tergite slightly darkened; 10th tergite short, with posterior margin laterally keeled; supraanal valve triangular with convex sides, inferior anal valves triangular, acute at apex. Inferior face yellow, subgenital plate wide, convex at base, emarginate at apex.

Cerci long, very slender with extremely fine pubescence.

Genitalia composed of 4 membranous triangular valves and a flat, subrectangular epiphallus.

Legs long and slender; anterior and intermediate femora annulated with brown, tibiae brownish; anterior femora with a very short internal spine and a long external one, anterior tibiae armed with 4 apical spurs, the superior external one very small, and 1 short inferior spine between the spurs; inferior margins bearing 2 external and 1 internal spine; intermediate tibiae likewise armed but with only 1 external and 1 internal inferior spine, inserted at about the apical third; tarsi slender, the metatarsus equaling the other joints together. Posterior femora very slender, annulated near the apex and adorned, at their external face, with a few brown spots; inferior margin unarmed; 2 very small apical

spines; tibiae a little longer than the femora, armed with 65 to 75 very close spines forming very neat increasing series according to the formula below; superior internal spur equal to metatarsus, which is armed at apex with a very short spine, wholly keeled beneath.

Individual variations.—The armature of the posterior tibiae vary as follows (the series marked in thick cyphers is terminated by a spine stronger than the others).

- int. 3-4-6-7-4-5-6-3-4-**5**-8-4-4-2-1=66.
- ext. 1-3-3-4-2-3-7-4-4-6-5-**5**-7-3-3-4-1=65.
- int. 2-3-3-2-3-3-4-2-2-2-4-3-5-7-**3**-8-3-4-2-1-1=67.
- ext. 1-1-3-4-4-6-4-4-3-5-2-5-3-6-**8**-9-3-5-2-1=79.
- int. 1-1-2-2-4-3-3-7-3-4-6-4-**7**-6-2-3-2-1-1=62.
- ext. 2-2-3-3-3-4-5-3-3-4-7-**7**-8-3-4-1=62.
- int. 1-2-3-3-3-3-6-3-5-7-6-6-**7**-12-4-2-1=74.
- ext. 1-2-2-4-4-6-1-6-6-5-**8**-10-7-2-1-1=66.
- int. 1-3-4-3-6-5-5-6-4-5-**4**-7-3-3-4-1-1=65.
- ext. 1-2-1-3-3-4-3-3-5-4-5-5-4-**5**-6-3-8-1-1=67.
- int. 1-2-2-3-3-3-4-5-3-3-4-6-4-5-**3**-7-3-3-3-2-1=70.
- ext. 1-2-2-1-1-4-1-5-3-4-4-4-5-3-**4**-6-5-5-1-1=62.
- int. 2-2-1-2-6-4-2-6-3-6-4-**5**-4-5-4-1-3-1=61.
- ext. 1-1-2-1-1-3-4-5-7-5-5-4-4-**7**-6-2-4-3-1=66.
- int. 1-3-1-2-4-4-5-4-5-9-6-**7**-8-4-3-2=68.
- ext. 1-4-3-2-3-7-4-4-5-6-6-6-**5**-10-5-1-1=73.
- int. 1-1-2-3-1-6-9-5-4-5-3-6-**4**-7-3-4-3-1-1=69.
- ext. 2-3-4-1-7-5-2-5-7-4-5-5-**6**-6-4-4-3-1=75.
- int. 1-3-3-2-2-4-5-**7**-5-4-**6**-6-3-6-1-1=59.
- ext. 1-1-3-1-3-6-4-3-2-3-6-4-4-**6**-10-3-2-1=63.

Length of body 15 mm.; pronot. 5.8 mm., width of pronot. 5.2 mm.; cerci 10 mm.; ant. fem. 11 mm.; ant. tib. 12.5 mm.; interm. fem. 10 mm.; interm. tib. 11 mm.; post. fem. 22 mm.; post. tib. 23.5 mm.; post. tarsi 9.6 mm.; post. metat. 5 mm.; sup. int. spur 5 mm.

This species is certainly very closely allied to *T. (Gymnaeta) beresowskii*, Adel., from occidental China and it is most difficult to give a good character to separate these forms. The latter is described from a single, very probably immature female, and a knowledge of the subgenital plate of the ♀ and epiphallus of the ♂ will be necessary to identify these two species with certainty. Yet I do not think there is the least doubt as to the validity of both of them as species of this group, chiefly the cavernicolous ones, prove to have a very restricted geographical distribution.

Fam. GRYLLIDAE.

Subfam. PHALANGOPSINAE.

Gen. *Arachnomimus*, Sauss.*Arachnomimus* sp.

Siju Cave, Garo Hills (R. Friel, Nov. 1917); two very young examples, ♂ and ♀

These very young specimens may belong either to one of the known species or to a hitherto undescribed form; their characters which merely allow a recognition of the genus are as follows:—

Length of body ♂ 8 mm., ♀ 5 mm.; post. fem. ♂ 6.5 mm. ♀ 4.5 mm.; post. tib. ♂ 7.5 mm. ♀ 5 mm.

Yellowish brown, legs spotted with fuscous, chiefly the posterior femora; face yellow; maxillary palpi with 3rd joint longer than 4th and 5th longer than 3rd. Pronotum showing two large brown impressions on the disc, lateral lobes with inferior margin strongly ascending backward, meso- and metanotum almost uniform dark brown. Posterior femora with 3 small internal spines and 3 longer and 1 very short external the latter quite near the apex; external spurs short, intermediate and superior ones long, the latter shorter than the former; metatarsi very long.

APPENDIX.

Two species must be ascribed to the genus *Tachycines*, both of them known only from the types in the Indian Museum collections; one is new, the other having been very shortly described by me in *Bull. Soc. ent. Fr.* [1918], p. 245. Although this latter species is described from a specimen having lost its posterior limbs, it is so very close to the other that there is little doubt that they both belong to *Tachycines*, they form a special group in that genus characterized by rather stout shape and comparatively short legs. I give hereafter a full description of these two species.

Tachycines cryptopygius, Chopard.

(Pl. xxiii, figs. 29—33 & 34B.)

Diestrammena cryptopygia, Chopard, 1918, *Bull. Soc. ent. Fr.*, p. 245; 1920, *Recherches sur la conformation et le développement des derniers segments abdominaux chez les Orthoptères*, p. 144, fig. 187 et 188.

Diestrammena palpata (♂), Griffini, 1914, *Aiti Soc. it. Sc. nat.*, LIII, p. 30.

Nemotha, Cachar (Assam); 1 ♂

A rather large-sized, brown-coloured species, face with 4 longitudinal brown bands; anterior and intermediate femora darkened near the apex and in the middle; hair clothing little abundant.

Head with occiput short, showing 4 longitudinal, indistinct, lighter lines; vertex terminated in a rather narrow rostrum furrowed and divided at apex forming two rounded, smooth tubercles; face yellowish, presenting 4 longitudinal brown bands,

one beneath each eye, extending to the external angle of mandible, the other two going from internal border of antennal socket to inferior angle of clypeus. Eyes rather small, black, broad and rounded in their superior portion, narrower inferiorly; ocellar spots scarcely visible at base of rostrum. Antennae rufous, approximated at base, 1st joint big, swollen, yellowish beneath, darkened above, 2nd joint very short, cylindrical, 3rd long and slender, 4th about half as long as 3rd, 5th and following ones short, cylindrical; the 2 first joints bear a short, weak pubescence above only, the following to the 10th are almost glabrous; from that last one on, each article bears beneath a rather thick tuft of rufous hairs; the antennae are broken off at about the 30th article, but it is probable that this special pubescence continues a little farther into a general regular pubescence. Mouth parts rather long; maxillae with 1 anteapical tooth almost as long as the apical ones; palpi long and very slender, the 3rd to 5th joints being respectively 4.5-5.5 and 8 mm. in length, labial palpi with 1st joint short, dilated at apex, 2nd lengthened, somewhat curved, 3rd almost as long as both preceding ones together, a little swollen and rounded at apex.

Pronotum rather dark rufous, somewhat darkened anteriorly and in the middle; anterior border weakly convex, posterior one subangulate in the middle, concave laterally; lateral lobes high, their inferior margin forming a rounded angle a little before the middle, anterior angle completely obliterated, posterior one rounded. Mesonotum with posterior margin subangulate in the middle, strongly concave laterally, lateral lobes very high; their inferior margin convex. Metanotum a little shorter than the mesonotum, with posterior margin regularly convex, lateral lobes not so high, their inferior margin weakly convex.

Abdomen above rufous, each tergite being slightly darkened posteriorly, 7th tergite ending in a long, slightly curved process, the margins of which are almost parallel to the base, apex slightly emarginate; superior face of this process compressed with a rounded shelving ridge; 8th to 10th tergites very short, hidden under the process of the 7th, 10th truncate at apex with lateral right angles, feebly projecting, the 11th tergite is very small, triangular, actually crushed between the inferior anal valves, the strange aspect of which has been already pointed out by GRIFFINI (*l.c.*, p. 31). They are greatly developed, ending in a process rather longer than the body of the valve, somewhat curved, truncate at apex, pubescent beneath; external and superior faces of the valve very strongly rounded, swollen, inferior one flat. Subgenital plate large, swollen at base, regularly convex at apex.

Cerci rather short, dilated at base, with a short, fine pubescence and long, scarce bristles.

Genitalia presenting no sclerified epiphallus, the valves being divided into two groups, forming triangular lamellae.

Anterior and intermediate legs rather long, posterior ones failing, anterior femora armed with 2 apical spines, the internal

one being short as is usual in the genus; tibiae slender, somewhat compressed, armed with 4 apical spurs, the superior of which are very short, and 5 inferior spines of which 1 apical and 4 disposed in pairs a little beneath the middle and the apical third of the tibia; tarsi long, compressed, the metatarsus longer than the other articles together, the 3 first joints carinated beneath. Intermediate legs a little shorter than the anterior ones, presenting the same features and armature except the femora which bear two long apical spines.¹

Length of body 22 mm.; pronot. 7.5 mm.; width of pronot. 7.3 mm.; ant. fem. 17.5 mm.; ant. tib. 19 mm.; interm. fem. 15 mm., interm. tib. 16.5 mm.; process of 7th abd. terg. 4.5 mm.

This species shows very remarkable characters in the abdominal end and also in the antennae; it is to be noted that the special pubescence of these organs is certainly restricted to the male sex, thus showing a link to the much differentiated antennae of the *Pachyrrhama* Br.

Tachycines validus, sp. nov.

(Pl. xxiii, figs. 34A and 35 to 38.)

Type.—One female from Dawna Hills, Misty Hollow to Sukli, alt. 2100–2590 ft. (F. H. Gravely, 22–24-xi-11).

A species remarkable by its large size and chiefly by its stout form and relatively short and thick legs; colour rather irregularly and probably strongly marbled with brown (the type is much discoloured by a long stay in alcohol); face showing 6 longitudinal irregular bands; anterior and intermediate femora a little neatly annulated, darkened at apex, posterior femora almost unicolourous. Pubescence rufous, very caducous.

Head with occiput short, presenting a brown spot behind each eye. Frontal rostrum very narrow and lengthened, furrowed on its whole length but very feebly incised at apex, forming two acute tubercles. Face wide, yellowish, adorned with 6 longitudinal, irregular bands, joined to one another in their inferior part. Clypeus very broad, its inferior margin scarcely shorter than the superior one, adorned with two brown spots. Eyes small, much behind the base of antennae, ocellar spots very neat. Antennae about three times as long as the body, rufous; 1st joint large, cylindrical, 2nd very short, little swollen in the middle, 3rd almost twice as long as the 2nd, 4th a little longer than the following ones. Maxillary palpi long, testaceous, the 3rd and 4th joints not very slender, 5th almost twice as long as 4th (their length being respectively 3.1–3.7 and 7.5 mm.); labial palpi rather short, the 3rd joint a little shorter than the other 2 together.

¹ To tell the truth, the specimen described does not bear on the one intermediate femur remaining more than 1 internal, long, movable apical spine, the external one being very short; but it is evident that this is an anomaly caused by a mutilation before the last moult, this spine being thick and yellowish and not at all slender and brown as the immovable spines of the anterior femora.

Pronotum very strongly convex, its anterior border convex, the posterior one rather strongly convex in the middle, almost straight laterally, lateral lobes very high, their inferior margin rather regularly rounded, anterior and posterior angles obtuse, rounded. Coloration rufo-testaceous with interrupted brown spots, forming a narrow band along the anterior and posterior margins and a large median, irregular fascia. Meso- and meta-notum similar to pronotum, the former with posterior margin sub-angulate in the middle, very strongly concave laterally, lateral lobes rather high, with inferior border weakly convex, the latter with its posterior margin almost straight, lateral lobes widely rounded.

Abdomen rufous above with a few irregular brown spots along the median line and near the posterior margin of each tergite; these margins are regularly convex to the 5th, 6th somewhat angular in the middle, 7th weakly projecting above the 8th and 9th, which are very short; anal valves triangular, acute at apex, the superior one very small, and pressed between the inferior ones which are somewhat projecting at apex. Subgenital plate yellowish, large enough, flat, presenting 2 small basal lobes, narrowing towards the apex which is rounded, feebly incised in the middle.

Cerci rather short, thick at base, little curved, presenting a blackish ring near the middle and darkened at apex.

Ovipositor somewhat longer than half the body, rather slender, almost straight; inferior valves bearing a few broad denticulations near the apex, internal ones extending almost to the apex.

Legs relatively short and thick; anterior femora armed with 2 apical spines, the external of which is long and movable; tibiae slightly longer than the femora, rather slender, armed with 3 or 4 apical spurs (the superior ones very short, the internal sometimes failing), 4 inferior spines disposed in pairs at the basal and apical thirds and 1 small spine between the inferior spurs; tarsi rather long, compressed, the metatarsus a little longer than the other joints together, the 3 first joints wholly carinated beneath. Intermediate legs very similar to anterior ones, femora armed with 2 movable spines, tibiae bearing 4 apical spurs, 2 external, 1 internal and 1 apical inferior spine. Posterior femora thick at base, their filiform part much shorter than the swollen part, their internal inferior margin armed with 9-10 small brown spines in their proximal part, genicular lobes armed with a small spine. Tibiae scarcely longer than the femora, indistinctly annulated, armed with about 80 spines, disposed in increasing series as follows —

{ int. 2-4-4-4-5-4-5-5-5-4-5-5-5-6-7-6-4-2-1=83.
 { ext. 2-5-5-3-3-4-4-5-5-5-5-4-5-4-6-4-4-3-1=77.
 { int. 3-4-4-4-6-6-4-5-5-6-6-5-5-5-4-5-4-1-1=83.
 { ext. 1-3-5-4-4-3-4-5-5-5-5-5-3-5-4-6-4-4-3-1=79.

One of the spines on each margin (marked in thick cyphers) is stouter than the others, the apical one is rather strong and

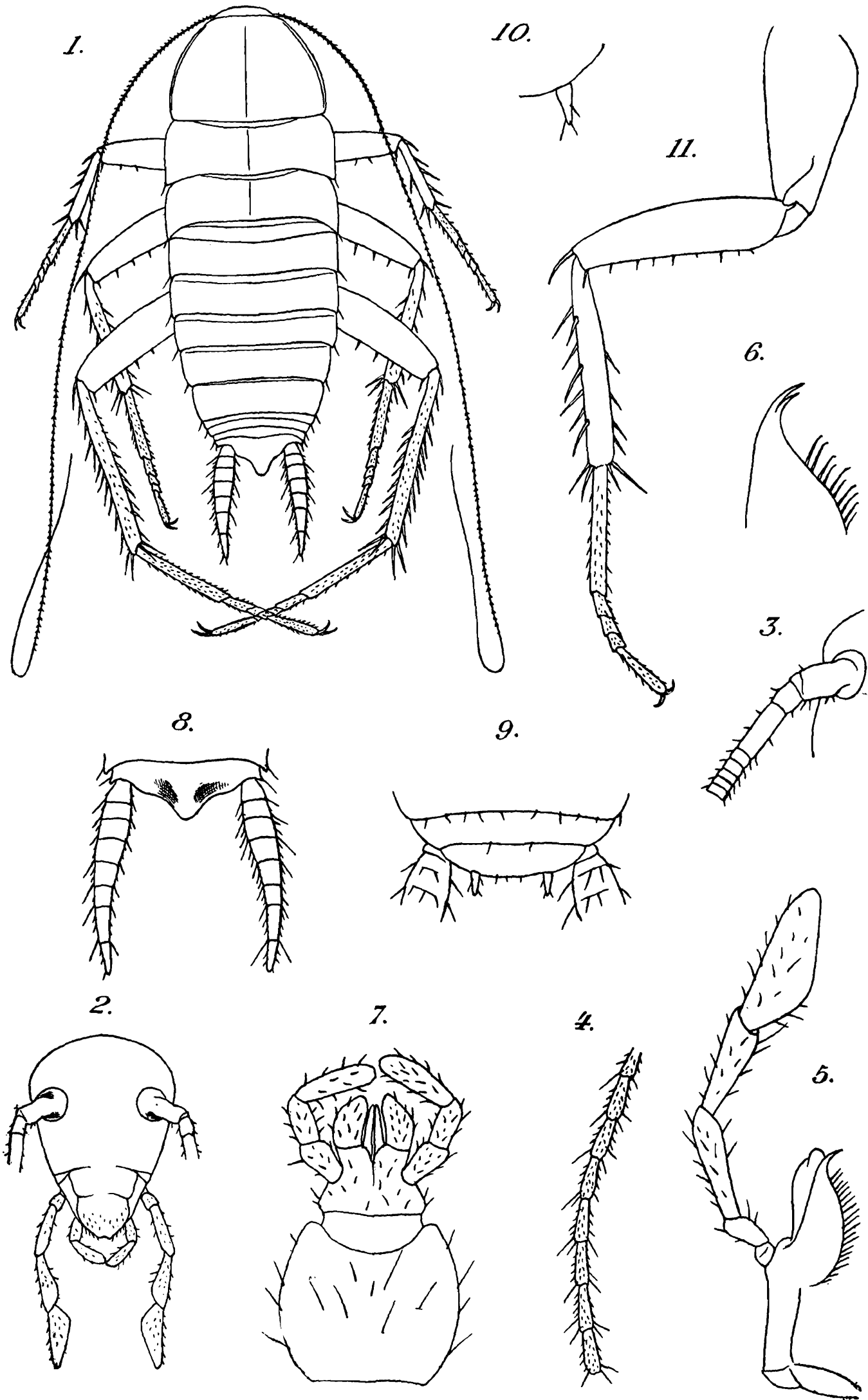
separated from the preceding by a small inermous space. Spurs long, hairy, the superior internal extending to the apex of metatarsus ; this is provided at apex with 3 small brown spines.

Length of body 27 mm. ; pronot. 8·5 mm. ; width of pronot. 8 mm. ; cerci 7 mm. ; ovipos. 15·5 mm. ; ant. fem. 14·5 mm. ; ant. tib. 15 mm. ; interm. fem. 13 mm. ; interm. tib. 13·5 mm. ; post. fem. 30·5 mm. ; post. tib. 31 mm. ; post. tarsus 11·5 mm. ; post. metat. 6·5 mm.

This species is very similar to the preceding one but it cannot be the female of that species as it differs from it in many characters, chiefly in the length of the maxillary palpi and the shape of the pronotum.

EXPLANATION OF PLATE XXI.

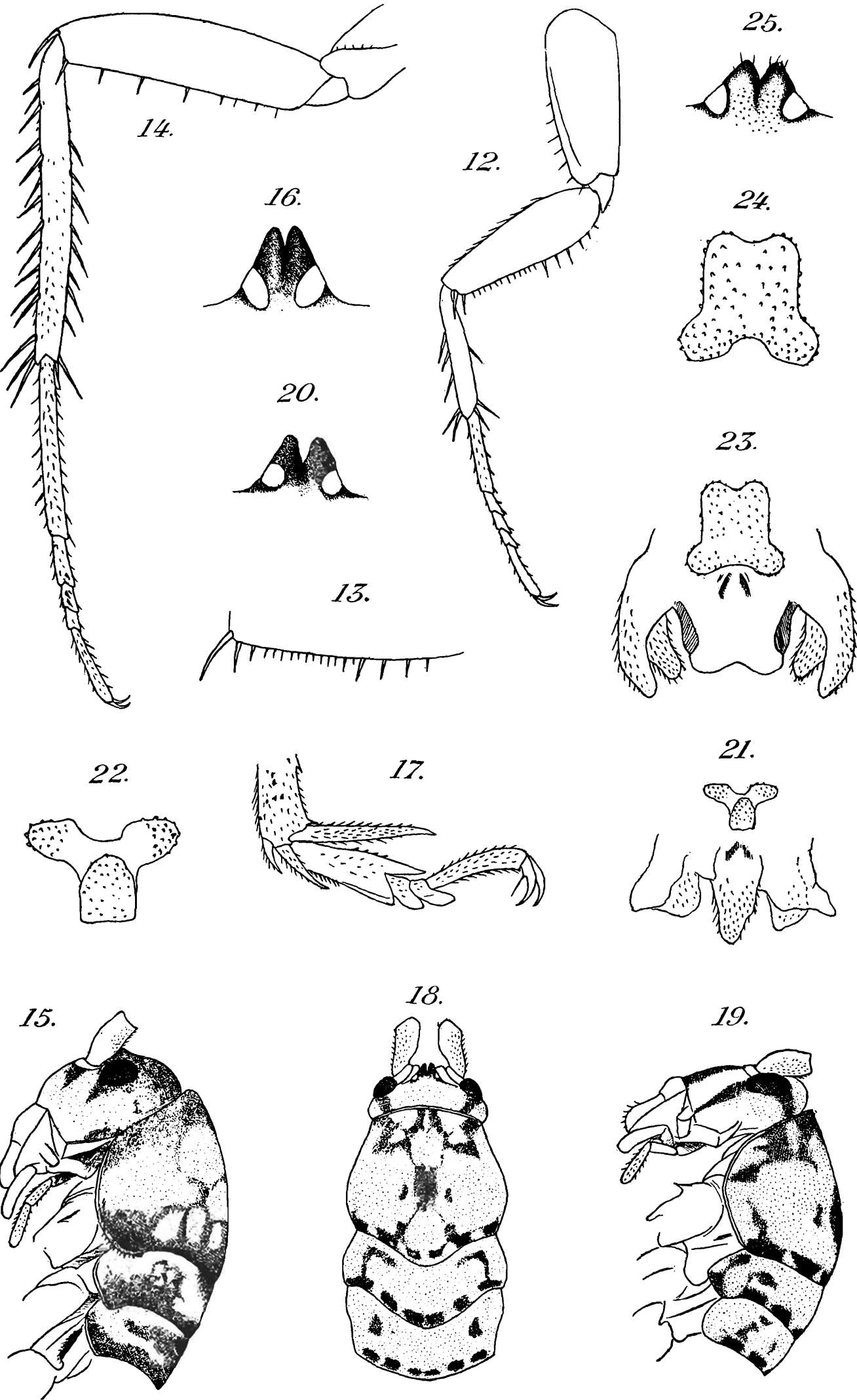
- FIG. 1.—*Spelaeoblatta* (?) *caeca*, sp. nov.—Male, type, dorsal view, $\times 6$.
- „ 2. *Id.* Face, front view, $\times 14$.
- „ 3. *Id.* Basal joints of right antenna, $\times 28$.
- „ 4. *Id.* Joints of the middle part of antenna, $\times 28$.
- „ 5. *Id.* Maxilla, $\times 28$.
- „ 6. *Id.* Apex of maxilla, $\times 56$.
- „ 7. *Id.* Labium, $\times 28$.
- „ 8. *Id.* Supra-anal plate and cerci, $\times 14$.
- „ 9. *Id.* Subgenital plate, $\times 19$.
- „ 10. *Id.* Styles, $\times 28$.
- „ 11. *Id.* Intermediate leg, $\times 17$.



CAVERNICOLOUS ORTHOPTERA.

EXPLANATION OF PLATE XXII.

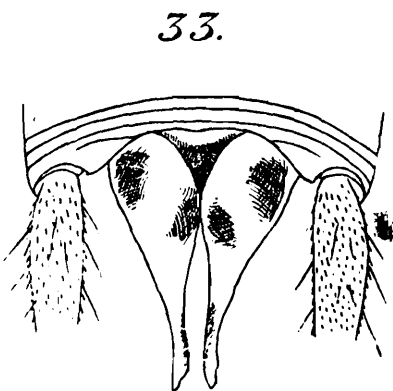
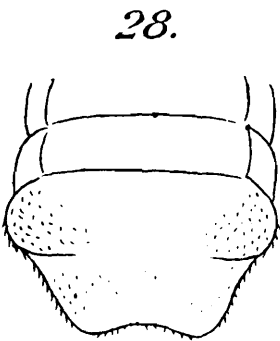
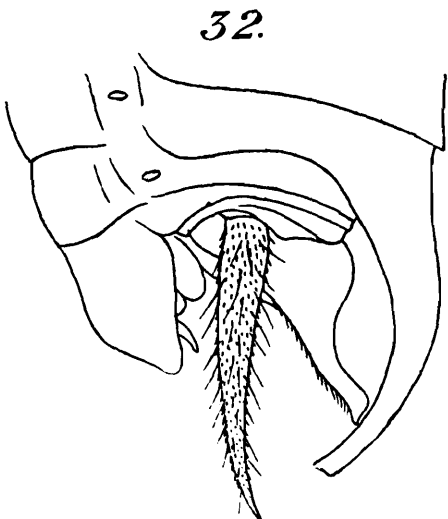
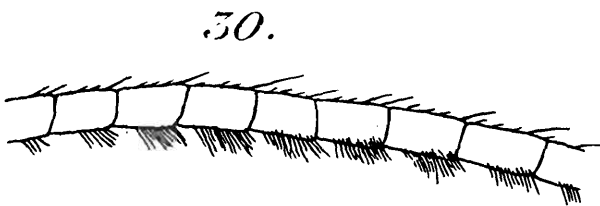
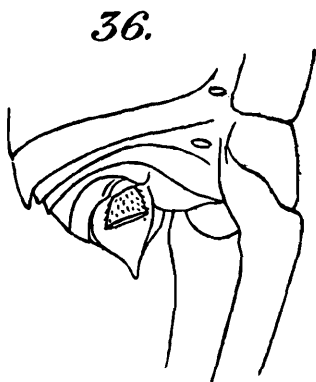
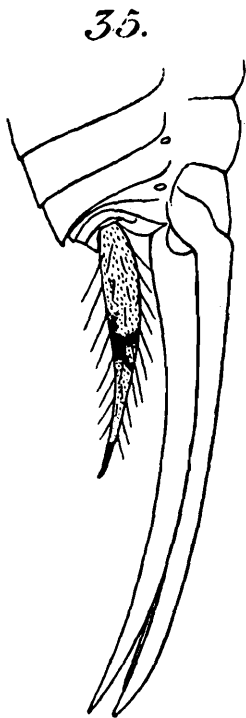
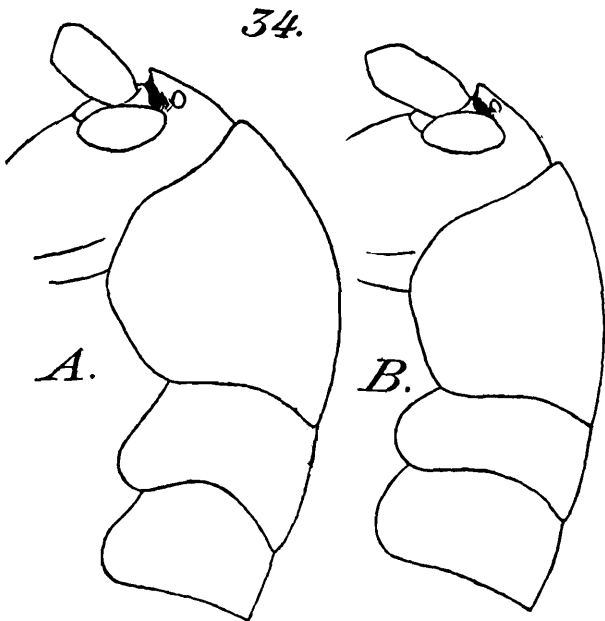
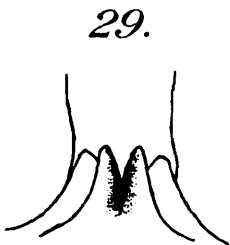
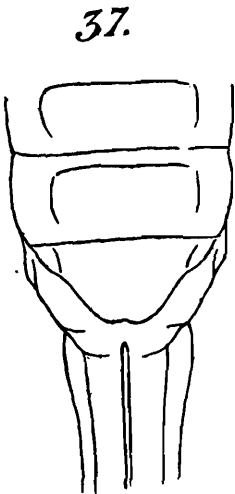
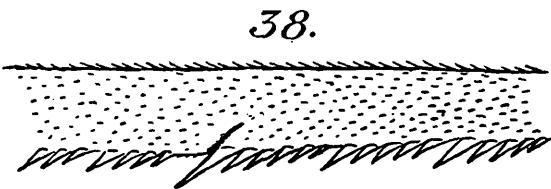
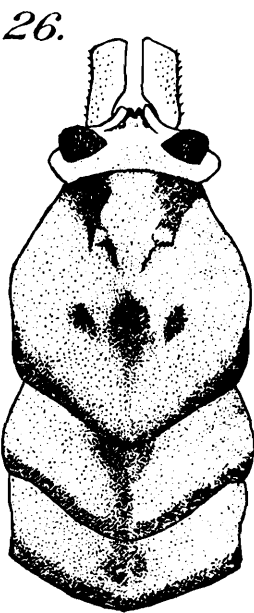
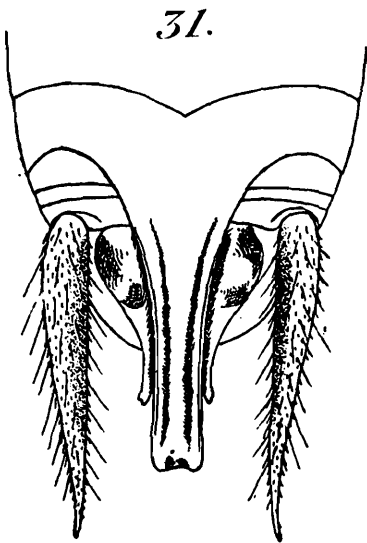
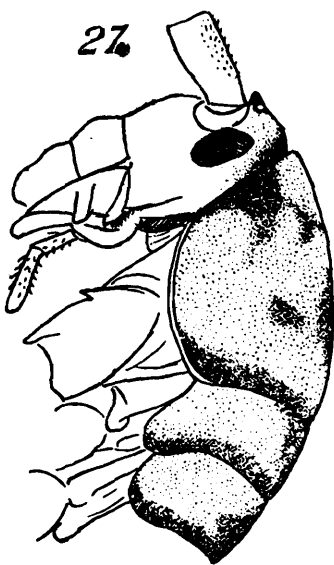
- FIG. 12. *Spelaeoblatta* (?) *caeca*, sp. nov.—Anterior leg, $\times 14$.
 „ 13. *Id.* Internal inferior margin of anterior femur,
 $\times 19$.
 „ 14. *Id.* Posterior leg, $\times 14$.
 „ 15. *Rhaphidophora rufobrunnea*, sp. nov.—Lateral view
 of head and thorax, $\times 6$.
 „ 16. *Id.* Frontal rostrum, dorsal view, $\times 14$.
 „ 17. *Id.* Posterior tarsus and spurs of tibia, internal
 view, $\times 7$.
 „ 18. *Diestrammena indica*, sp. nov.—Head and thorax,
 dorsal view, $\times 4.5$.
 „ 19. *Id.* Head and thorax, lateral view, $\times 4.5$.
 „ 20. *Id.* Frontal rostrum, dorsal view, $\times 14$.
 „ 21. *Diestrammena vitalisi*, Chop.—Genitalia, dorsal view,
 $\times 14$.
 „ 22. *Id.* Epiphallus isolated, $\times 28$.
 „ 23. *Tachycines adelungi*, sp. nov.—Genitalia, dorsal
 view, $\times 14$.
 „ 24. *Id.* Epiphallus isolated, $\times 28$.
 „ 25. *Id.* Frontal rostrum, dorsal view, $\times 14$.



CAVERNICOLOUS ORTHOPTERA.

EXPLANATION OF PLATE XXIII.

- FIG. 26. *Tachycines adelungi*, sp. nov.—Head and thorax, dorsal view, $\times 4.5$.
- „ 27. *Id.* Head and thorax, lateral view, $\times 4.5$.
- „ 28. *Id.* Subgenital plate of male, $\times 6$.
- „ 29. *Tachycines cryptopygius*, Chop.—Frontal rostrum, dorsal view, $\times 6$.
- „ 30. *Id.* A few joints of the antenna, from the 10th to the 17th, $\times 14$.
- „ 31. *Id.* Apex of abdomen of male, showing the process of the 7th tergite, $\times 6$.
- „ 32. *Id.* Apex of abdomen of male, lateral view, $\times 6$.
- „ 33. *Id.* Anal valves of male, dorsal view, $\times 6$.
- „ 34. Outlines of head and thorax, of : A. *Tachycines validus*, sp. nov., B. *Tachycines cryptopygius*, sp. nov., $\times 4$.
- „ 35. *Tachycines validus*, sp. nov.—Apex of abdomen and ovipositor of female, lateral view, $\times 3$.
- „ 36. *Id.* Same as the preceding with the cercus cut off to show the anal valves, $\times 4$.
- „ 37. *Id.* Subgenital plate of female, $\times 4$.
- „ 38. *Id.* Disposition of spines of posterior femur, $\times 6$.



XXVIII. THE AQUATIC AND AMPHIBIOUS MOLLUSCA OF MANIPUR.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director*, B. PRASHAD, *D.Sc., Assistant Superintendent*, and AMIN-UD-DIN, *M.Sc., Research Assistant, Zoological Survey of India*:

(Plates IV—VIII.)

PREFATORY NOTE.

The following paper is based on a visit to the Manipur Valley paid in February and March, 1920. The party consisted of myself, Mr. Sunder Lal Hora and Mr. Amin-ud-Din, Research Assistants, and Mr. R. Hodgart, Zoological Collector. I was able, however, to spend only a short time in the valley myself and was obliged, in order to save time, to travel there and back by motor, while the others made short marches and collected on the way. Mr. Sunder Lal Hora, moreover, remained in Manipur for three weeks longer than the others and visited every part of the valley. A large proportion of the collections is therefore due to his energy. He has himself published an account of the fish-fauna, in which he was particularly interested.

I have to thank His Highness the Maharajah of Manipur for inviting me to visit his State in the interests of science and for having a special camp put up for our use on Thanga I. in the Loktak Lake. I must also express my obligations to Mr. C. W. R. Cosgrave, I.C.S., at the time Political Agent, who gave us help in many ways. To Lieut.-Col. H. H. Godwin-Austen, F.R.S., I am indebted for much advice and assistance. The specimens collected by him in Manipur more than fifty years ago and now in the Indian Museum have proved very useful in the preparation of this paper

N. Annandale.

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INTRODUCTION.

By N. ANNANDALE.

Among the districts on the frontiers of Burma few have greater interest for the zoologist than Manipur, the position of which is thus defined by Mr. B. C. Allen in the official Gazetteer of the Naga Hills and Manipur (Calcutta: 1905).

"The Native State of Manipur is situated between $28^{\circ} 50'$ and $25^{\circ} 41'$ N. and $93^{\circ} 2'$ and $94^{\circ} 47'$ E. and covers an area of 87,456 square miles. On the north it is bounded by the British district of the Naga Hills, on the west by Cachar, on the south by the Lushai Hills and Burma, and on the east by Burma."

The greater part of the State is occupied by mountainous country, which, though of great zoological interest, is less important from the point of view of the study of the freshwater molluscs than the comparatively small valley that forms the richer and more civilized part. I propose, therefore, to say no more than a few words about the hill-streams and their fauna and to devote the greater part of this introduction to a succinct account of the valley.

Within the limits of the State of Manipur small hill-streams that belong to several different water-sheds occur, viz. (1) those that flow down into the valley; (2) those that flow northwards to join the Brahmaputra system; (3) those that flow eastwards to Burma and (4) those that flow westwards towards Sylhet. The fact that the hill-tracts of the state are much more extensive though less valuable than the valley renders the number and direction of their streams large and varied. Hill-streams, however, rarely have a rich molluscan fauna and the only ones in which my party was able to make collections were those that entered the valley and those that flowed northwards to the other side of the Naga Hills.

The streams closely resemble those of other hill-ranges in north-eastern India. They are as a rule little more than mountain torrents, though in some of the valleys among the hills they may assume for a time a placid and even course. Their beds are for the most part rocky or stony and there is little aquatic vegetation.

The fauna of such streams has a very similar facies all over south-eastern Asia from Nepal to HongKong and probably to Formosa and the Philippines. Its main characteristics are: (1) the production of special adhesive apparatus, more particularly in the Batrachian larvae, fish and insects, all of which provide numerous and highly interesting instances of convergence in this respect, and

Hill-streams of Manipur.

Fauna of Oriental Hill-streams.

(2) the scarcity of molluscan life, to which, however, there are exceptions at certain places. These features may be observed in the fauna of the hill-streams of Manipur as clearly as in that of the streams of Sikkim or southern China, but as the main character of the Mollusca is negative, the peculiarities can naturally be discussed more appropriately when dealing with the fish than when describing this group.

The Manipur valley is a flat swampy plain lying 2,600 feet above sea-level and 50 miles long by 25 miles broad. It is surrounded by mountains considerably higher than itself and is thus completely isolated from the rest of Assam, to which the Manipur State is attached politically. The river system has no connection with that of the Brahmaputra, but drains through a narrow pass into the Chindwin, the largest tributary of the Irrawadi.

The climate is comparatively temperate and equable. The highest and lowest shade temperatures recorded in Imphal, the capital, which is situated in the central part of the valley, are 92° and 30° Fahr. The rainfall is moderate as compared with that of some parts of Assam, but varies greatly from year to year. The average at Imphal is about 70 inches, but while in 1896-97 it was only 57 inches, in 1899-1900 it was over a hundred inches. The winter and early spring are usually dry, but in 1920 a considerable amount of rain fell at the beginning of March. About half the annual rainfall normally takes place between June and August inclusive. The prevailing winds are from the south and the west. In February and March a strong westerly breeze, apparently originating in the ranges of mountains that separate the Manipur from the Sylhet valley, almost invariably arises about 10 a.m. and blows until the evening, putting a stop to all fishery operations and transport by boat in the open part of the larger swamps, except at night and in the early morning and evening.

The greater part of the valley is cultivated and is very fertile, rice being the principal crop, while even the hill-slopes are also utilized in agriculture by the Naga tribes, who burn down the jungle in patches, which they use for one year only. On a few of the smaller hills that crop up like islands in the valley there is fairly high and dense jungle, but the vegetation even here is not so luxuriant as perhaps might be expected, the soil being extremely friable and apparently incapable of supporting large woods or a great profusion of creepers, bamboos being frequently the dominant form of plant-life.

The river-system of the valley is derived mainly from small streams that arise in the Naga Hills in the northern part of the State. These flow down in an almost straight course. A few small streams also come from the western slopes, but they are of no great importance. No water reaches the valley from Burma and none from the Sylhet or Brahmaputra Valley.

The whole of the basin is covered by a net-work of water

courses and swamps and after prolonged rain a great part of it is under water. Several different rivers have local names, but their course as indicated on the maps seems to be imperfectly understood. Indeed, no part of the State has been properly surveyed except the hills to the north and west. It will be sufficient for my purpose to say that these streams unite to form the Imphal River, which flows out through the hills at the south-east of the valley down into the Chindwin. They are all sluggish and turbid and even after uniting form, at any rate in the dry season, but a comparatively small stream.

Depressions of various sizes are found all over the valley. In the flood-season several of these might be legitimately called lakes, but in winter the majority are almost or quite dry and the only one of them to which this term can be applied is the Loktak Lake, which occupies a considerable but very variable area in the southern part of the valley.

Even the Loktak Lake is little more than a large, deep swamp. In places the water is as much as 10 feet deep, but even in such spots it is blocked up almost to the surface with submerged vegetation, while a very large part of its area is covered with floating islands formed of living and decayed plants. The bottom is composed of evil-smelling soft mud containing much rotten vegetable matter. In the dry weather the lake is normally about 8 miles long by 5 miles broad, but its extent probably varies greatly in different years.

Towards the eastern side of the Loktak a chain of small rocky islands, the chief of which is called Thanga, rise from the surface to a height of several hundred feet. In February, 1920 these islands were separated from a broad peaty area, occupying the eastern part of the valley, only by a stream of running water. At that season only a few small pools remained in the peaty area, but in the flood season it must be entirely submerged.

At no point has the lake definite shores, and even the rocky islands are surrounded in winter by flat mud-banks which slope down under the water very gradually. On the northern and western sides the floating islands become, as it were, gradually stranded and changed into grass-land.

Owing largely to the strong breezes which blow across the surface and disturb the water it is more or less turbid. At spots where the submerged vegetation is particularly dense it is, however, clearer than elsewhere.

I have to thank Sir H. H. Hayden, F.R.S., Director of the Geological Survey of India, for having samples of the water analyzed in the laboratory of his department. These analyses show that there is no great amount of dissolved mineral matter. They may be compared in detail with the analyses of the water of the Inlé Lake printed on pp. 2 and 4 of Vol. XIV of the *Records of the Indian Museum*. A general comparison is given later in this Introduction.

	Water from chan- nel s. of Thanga I., Manipur. Total amount received 554 c.c.; solid suspend- ed matter found therein .0148 gm.	Water from open part of Loktak Lake. Total amount received 1107 c.c.; solid suspended mat- ter found therein .0189 gm.	Water from stream flowing into Lok- tak Lake s. of Potsengbam, Manipur. Total amount received 1079 c.c.; solid suspended matter found therein .0134 gm.
Total Solids per litre	.0670	.1010—.1240	.1050—.1040
Organic matter ..	.0240	.0128—.0237	.0240—.0251
Sulphate (SO ₄) ..	.0079	.0063	.0041—.0057
Carbonate (CO ₃) ..	.0180	.0480—.0495	.0450—.0435
Chloride (Cb) ..	.0028	.0023—.0024	.0039—.0042
Silicia (SiO ₂) ..	.0027	.0020—.0062	.0030—.0035
Fe ₂ O ₃ .Al ₂ O ₃ ..	nil	.0075	nil
Calcium (Ca) ..	.0049	.0148	.0118
Magnesium (Mg) ..	.0053	.0068—.0134	.0110—.0105

As one of the chief objects of my visit to Manipur was to obtain material for a comparison between the fauna of the Loktak and that of the Inlé Lake, a short summary of the physical characters of these two bodies of water may be given.

Both are situated in isolated valleys at altitudes between 2,500 and 3,000 feet. Their river-systems are connected with adjacent watersheds, that of the Irrawadi in the one and that of the Salween in the other. The climate of the two valleys also is similar, and they are only some 340 miles apart as the crow flies. Even the appearance of the two lakes is not dissimilar, for both lie in open plains between ranges of rather bare mountains running almost due north and south, and both are remarkable for the floating islands which cover a considerable part of their surface. Both, moreover, are shallow, and neither has well-defined shores or a definite permanent area.

On detailed comparison, however, it becomes clear that, in this, as in so many instances the physical differences, though much less apparent, are actually of greater importance from a biological point of view than the physical resemblances. The structure of the two valleys and of the hills surrounding them, as we shall see when discussing the origin of the Loktak Lake, is very different, the most important feature characteristic of the Manipur valley being probably the absence of limestone, for as a result of this the composition of the water of the two lakes is quite unlike.

This chemical divergence occurs in every particular. The percentage of calcium and magnesium salts is very much smaller

in the Loktak Lake, in the more open parts of which calcium occurs only to the extent of 0.0148 per cent as compared with 0.022 per cent in the Inlé Lake, and magnesium to that of 0.0068 to 0.0134 as compared with 0.0279. On the other hand, the amount of organic matter in the much more congested Loktak Lake is considerably greater than it is in the clear water of the central region of the Inlé Lake, while the amount of carbonic acid is more than four times as great in the former as in the latter. The percentage of silica, further, is much greater in the Loktak Lake, and this is also so, as might be expected, with SO_4 . These differences are due doubtless, so far as most of the mineral salts are concerned, mainly to the composition of the surrounding rocks and of those amongst which the water-supply of the lakes flows before entering them. The larger amount of organic matter, of carbonic acid, of SO_4 and possibly of silica may be accounted for, on the other hand, partly by differences in the vegetation, but these again are correlated with the chemical composition of their environment.

It is impossible to consider the origin of the Loktak Lake without considering also that of the Manipur valley

Origin of the Loktak Lake. in its present condition. Two different views have been held on this point, one, that the whole valley is a comparatively recent lake-bed and that the Loktak once filled it and has shrunk to its present size, perhaps even in historical times; the other, that the valley is of comparatively ancient date and has been filled in gradually to its present level by debris brought down from the hills by the tributaries of the Imphal River. As I have already said, the valley has never been properly surveyed. From a geological point of view its structure is practically unknown, but the rocks of the surrounding hills appear to resemble closely those of the Naga Hills to the north. I have to thank Dr. E. H. Pascoe of the Geological Survey of India for the following note on rock-specimens from islands in the Loktak Lake.

“The rocks consist for the greater part of hard shale but two of the specimens are of siliceous sandstone. They belong in all probability to the Disang series, about the age of which we know nothing definite beyond the fact that it is pre-Tertiary. The Disang series is essentially argillaceous and the rocks thereof would produce somewhat muddy water but not so muddy as softer argillaceous deposits.

“As to any organic connection of Lake Loktak with Assam, there is not sufficient evidence to go upon. An idea which I believe is a very old one and mentioned by La Touche makes the present Chindwin-Irrawadi the former continuation of the Tsang-po or Tibetan-Brahmaputra, the upper waters of this large river being afterwards captured by the Assam-Brahmaputra. Whether Lake Loktak was connected with the Chindwin at the time it was a continuation of the Tsang-po I cannot say, nor do I know whether this would help you in any way.”

The most important facts about the specimens from my point of view are that they certainly represent rocks common all round the valley, and that those which represent the rocks most abundant in the neighbourhood are extremely friable and readily crumble to form a fine soil precisely like that in which the cultivated parts of the Manipur valley are deeply buried. Soil of this kind extends on the north and west sides of the lake well down to high water-level and it is only on the east, and probably also on the south side, that large deposits of peat are being formed. The peat in these deposits is less coherent than, and not quite so black as that found round the Inlé Lake. There is no sign whatsoever of raised beaches at any point.

This last fact induced Col. Godwin-Austen, who was the first man with any knowledge of geology to visit Manipur, to doubt whether the lake had ever extended much beyond its present high-water limits. The peaty deposits on its eastern shores are very like those found in other parts of the valley and known to represent swamps that were recently larger than they are now, but even if the whole of these swamps were completely submerged the greater part of the valley would still be above water.

All of these facts seem to me to support Col. Godwin-Austen's views, to which Mr. R. D. Oldham gave his adherence. The Manipur valley, moreover, although at first sight it closely resembles a lake-bed, with its dead level only broken by small island-like hills rising abruptly from the plain; nevertheless, on closer examination seems to differ in little but its greater extent from other swampy valleys in the Naga and Khasi hills which have certainly never been lakes but have been filled in to an almost equal level by the silt brought down in streams that now meander through them with sluggish waters in which flow has been diminished by a gradual filling in of their old beds and consequent diminution in fall.

No factor is more important in influencing the fauna of any body of water than its vegetation, and it seems to be a general rule, at any rate in warm countries, that over-abundant submerged plant-life, especially if it includes a luxuriant growth of small sessile algae, is inimical to many forms of animal life, partly doubtless on account of actual toxins produced by the vital activities of certain species and partly on account of the poisonous nature of the rotting material at the bottom. The latter feature, however, is of a very complex character, evidently depending at least in part on the activities of microscopic organisms. But these again are dependant largely on the physical and chemical characters of the water. As we shall see later, the fauna of the Loktak Lake, and especially the invertebrate fauna, is a rather poor one. I associate this fact with the extreme luxuriance of the vegetation.

As has already been stated, this luxuriance of the vegetation, both submerged and floating, gives the lake the character of a large swamp. The submerged weeds are of various kinds, but

perhaps the most abundant of all is the Water-chestnut (*Trapa bispinosa*)¹, which has leaves floating on the surface as well as a profuse growth under water. The floating leaves dot the whole surface of the more open parts of the swamp, growing up through dense thickets of *Potamogeton* and *Hydrilla*. The leaves and stems of these completely submerged plants are as a rule densely covered with small algae, and it is quite exceptional to find beds of any kind of water-weed that have a clean appearance.

In the channels among the floating islands surface-plants such as *Pistia*, *Azolla* and *Lemna* are often fairly abundant, but not sufficiently so to play a great part in the formation of the islands.

These islands are not so coherent and do not support so varied and luxuriant a flora as do those of the Inlé Lake. The chief agent in their formation is a comparatively small grass which sends out long trailers on the surface of the water. A *Caladium*, several species of *Polygonum* and a fern are common upon them, but the bulk of the vegetation consists of grasses and sedges.

The islands are not used for horticulture or stock-keeping as are those on the Inlé Lake, but occasionally small fishing-huts are built on the firmer islands, and pieces are frequently cut off from them and towed away to be utilized in forming fishing-enclosures.

A whole volume of these *Records* was devoted to the fauna of the Inlé Lake and the help of a number of specialists was invoked in its preparation. It is unnecessary to deal with the fauna of the Loktak Lake in the same detail, because it is a much less isolated association and does not consist for the most part of highly specialized species of animals. It will, therefore, be sufficient to have the molluscs and the fish completely worked out and to mention here a few salient representatives of other groups. The molluscs will be described in full in the succeeding paper, and has already Mr. Sunder Lal Hora dealt in detail with the fish. Here I shall merely refer to these groups as constituting the most important elements in the fauna and give a few facts of a general kind about them.

Conditions in the Loktak Lake are favourable to the growth and reproduction of Protozoa and many water-plants were observed that bore a profuse growth of Vorticellids. Small masses of sponge were found in considerable abundance on the weeds of the open parts of the lake. On examination they proved to belong to but one species, *Spongilla carteri*, the commonest and most generally distributed of the Indian Spongillidae. They differed, however, from the typical form of the species in the small size and irregular shape of individual sponges. No Hydrozoa were observed and the only polyzoon collected was immature—evidently a species of

¹ This plant is utilized as a vegetable in large quantities by the people of Manipur, who unlike most Indian races, employ the leaves as well as the roots as an article of food.

Pectinatella and probably *P. burmanica*, but still in a stage in which the individual colonies had not become embedded in a common jelly. There were no statoblasts in these colonies. Small Oligochaete worms were abundant among the weeds and a larger form with gills on the sides of its posterior region was obtained from mud at the bottom. Leeches of various species were collected, but only one, a *Glossosiphonia* parasitic on *Vivipara oxytropis*, was at all common.

The Crustacea were less well represented than might perhaps have been expected. Small Ostracods were abundant at certain spots among the weeds, but few other Entomostraca were observed. The Decapoda were singularly scarce, the only species collected being a small *Palaemon*. Crabs were apparently absent, and so also were Atyidae, which might have been expected to abound among the weeds. Aquatic insects were also rather scarce, the commonest being dragonfly larvae of the families Agrionidae and Libellulidae. In the smaller channels among the floating islands large numbers of mosquito larvae (both Culicinae and Anophelinae) were often seen, and larvae of *Chaoborus* were dredged from the bottom of the lake. Several large species of Dytiscidae were fairly common, but water-beetles generally were scarce. Although the molluscs were rich in number of individuals, the number of species that occurred actually in the lake was small. Several typically non-lacustrine forms, notably *Limnaea acuminata* and *Indoplanorbis exustus*, were found all over the lake and the only Gastropods that could be regarded as really characteristic were two exceptionally large species of Viviparidae (*Vivipara oxytropis* and *Lecythoconcha lecythis*), both of which are also paludine. Dead shells of *Lamellidens corrianus* were picked up at the northern end of the lake, but Unionidae were evidently very scarce. A species of *Sphaerium* (*S. indicum*) was, however, fairly common among the weeds. All heavy-shelled forms were naturally absent.

Fish were very abundant, but unlike those of the Inlé Lake, they were not highly specialized. Few very small species were seen, but the great majority do not grow more than 5 or 6 inches long. Except eels, indeed, few fish in this lake attain the length of one foot. Cat-fish (Siluridae, *sensu lato*) are particularly well represented in our collection. A large proportion of the species of this and other families are provided with highly developed tactile organs, and the enlarged eyes so characteristic of the Inlé fish-fauna are not found among them. The general facies of the specimens is that of swamp-fish, and genera peculiar to swamps and similar bodies of water are present.

Frogs and toads are not abundant, at any rate in March and April, but *Rana limnocharis* and *Bufo melanostictus*, two of the most abundant Indian species, were observed on the shores of the lake and the tadpoles of the toad were found in a small pool of water on one of the islands. We saw no kind of water-tortoise and the local fishermen assured us that they were not acquainted with any.

It is not in my power to give an account of the water-birds of the Loktak Lake, on and around which both swimming and wading birds are extraordinarily abundant. On this subject Hume's paper in *Stray Feathers*, Vol. XI, should be consulted. I have not seen any other place in India where such enormous swarms of ducks and geese could be observed on the water as was the case in February on this lake, and wading birds were almost as abundant in the surrounding swamps. Some of the latter, notably the smaller Herons, the Open-bill (*Anastomus oscitans*) and the Glossy Ibis (*Plagadis falcinellus*), were proved by examination of their stomach-contents to be feeding mainly on aquatic molluscs, and even the ducks and geese must destroy enormous quantities of molluscan spawn and young with the weeds on which they depend mainly for their food-supply.

Otters are said to be abundant, but no specimens were obtained.

The fauna of the Loktak Lake must, therefore, be regarded as paludine rather than lacustrine. It is comparable to that of the marginal zone of the Inlé Lake rather than to that of the central region. Even from the former, however, it differs notably. The great abundance of different species of small bottom-haunting fish, the greater poverty of the arthropod fauna and the absence of several molluscan genera (*Pachylabra*,¹ all the Hydrobiidae, *Segmentina*, etc.) usually found in such situations are noteworthy features, and may be correlated directly with the superabundance of vegetation and indirectly with the composition of the water and therefore, still more indirectly, with the geological formation of the surrounding country and the meteorology of the valley. The absence of extreme specialization in the aquatic fauna may be put down partly to the same causes and partly to the absence of complete geographical isolation, while the curious fact, amply illustrated in the following paper, that, though the Imphal River belongs to the Irrawadi system and is cut off by high ranges of mountains from those of Assam, nevertheless the aquatic molluscs are essentially Assamese and include very few Burmese species—this fact would at any rate suggest that comprehensive physiographical changes have taken place in the Manipur valley and the surrounding hills at a date geologically not remote.

THE PROSOBRANCHIA.

By N. ANNANDALE.

This order is represented in the aquatic and amphibious fauna of Manipur by eleven species, belonging to the families Hydrobiidae, Viviparidae, Melaniidae and Ampullariidae. With one exception, that of the Viviparid genus *Lecythoconcha*, the genera are those usually found in the tropical districts of India, and this section of

¹ The place of this genus is taken to a large extent by gigantic Viviparidae.

the fauna may be regarded on the whole as normal in composition. Moreover, with the exception of the Viviparidae, the species are but little modified. The majority of them are, indeed, of wide or fairly wide geographical distribution, and, considering the isolation of the valley, perhaps less remarkable than might be expected.

The Viviparidae, however, are not only to a large extent endemic in the valley, to which two of the four species are apparently confined, but also peculiar in anatomical structure as well as in shell-sculpture. Two of the four are ornamented with smooth spiral ridges on the shell, while I have been obliged to institute for a third a new genus, founded mainly on the structure of the operculum and mantle. This species (*Lecythoconcha lecythis*) is, however, by no means endemic in Manipur, having a wide range in south-eastern Asia and belonging to a group essentially Chinese in distribution.

Family HYDROBIIDAE.

Three species of this family have been found in Manipur, all in the valley. Two belong to a genus recently described as new under the name *Digoniostoma*, but widely distributed in India proper and Assam; while the third represents the subgenus *Alocinma*, recently set up as a subgenus of *Amnicola* by Dr. Baini Prashad and myself with a Persian species as type. This genus has a wide range, which extends at any rate from Mesopotamia to Upper Burma.

The three genera *Bithynia*, Leach, *Digoniostoma*, Annandale, and *Hydrobioides*, Nevill, and the subgenus *Alocinma*, Annandale and Prashad, are so closely allied and so liable to be confused that it will be well to give a key to them here. The anatomy of all is very similar and they are distinguished mainly by the structure of the aperture of the shell and of the operculum.

- A. Peristome continuous; outer lip neither thickened nor attenuate; umbilicus closed or rimate, without an oblique channel running forward on the lower surface of the shell; *operculum with a distinct but paucispiral figure situated near the middle of the lower part and visible on both surfaces* ... *Alocinma*.
- B. Operculum concentric, with no spiral figure on the lower part or visible on both surfaces.
 - i. A well-defined oblique channel running forwards from the umbilicus on the lower surface of the shell.
 - a. Outer lip thin, not produced or angulate at its inner extremity ... *Bithynia*.
 - b. Outer lip slightly thickened, produced and angulate or subangulate at its inner extremity ... *Digoniostoma*.
 - ii. No well-defined channel running forwards from the umbilicus. Outer lip distinctly thickened, but not produced at its inner extremity; a supplementary varix often present outside the thickened lip. *Hydrobioides*.

Genus *Amnicola*, Gould and Haldeman.Subgenus *Alocinma*, Annandale and Prashad

1919. *Alocinma*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23.
 1920. *Alocinma*, Annandale, *ibid.*, XIX, pp. 43, 44.

I still think it more convenient to regard *Alocinma* as generically identical with *Amnicola*, for the soft parts and radula are closely similar and the operculum intermediate between that of *Amnicola* (s.s.) and that of *Pseudamnicola*.

Amnicola (Alocinma) orcula (Frauenfeld).

1876. *Bithynia orcula*, Hanley and Theobald, *Conch. Ind.* pl. xxxviii, figs. 8, 9.
 1885. *Bithynia orcula*, Nevill, *Hand List Moll. Ind. Mus.* II, p. 36.
 1919. *Amnicola (Alocinma) orcula*, Annandale and Prashad, *op. cit.*, p. 24.

Frauenfeld was the first to describe this species, though he gave it Benson's name. It is one of the commonest molluscs of the Indo-Gangetic plain and is replaced in Peninsular India by *A. stenothyroides* (Dohrn), which is hardly more than a local race. Manipur is apparently the limit of the range of the species in a south-easterly direction. It has not been found in Burma. The radula, operculum and male organ closely resemble those of *A. sistanica*. The last, however, varies in the proportions of its different parts, as it does also in other members of the family, in accordance with its condition when the animal is killed.

Nevill has named several "varieties" and "subvarieties". Of these the only one that concerns us here is his "var. *producta* (? dist. sp.)". It has a much narrower and more elongate shell than the *forma typica*, with which it often occurs, but in my opinion is no more than an aberration.

A. orcula is abundant in ponds and swamps in the Manipur valley. In the day-time it is to be found both on mud at the bottom and among water-plants, but in the evening rises to the surface and crawls, shell downwards, on the surface-film. The form *producta* is not uncommon with the *forma typica* in Manipur.

Genus *Digoniostoma*, Annandale.

1920. *Digoniostoma*, Annandale, *Ind. Journ. Med. Research*, VIII, p. 104.

The chief characteristics of this genus have already been mentioned in the key on a preceding page. I did not separate it from *Bithynia*, Leach, in my recent paper on the Indian species confused under the name of that genus, though I was aware of certain peculiarities in the shell, but I have to thank Mr. A. S. Kennard for drawing my attention to certain of the differences. These lie in the structure of the peristome. The lip is not so distinctly thickened as in *Hydrobioides* and a supplementary varix is never present. The columellar callus is thick, broad and prominent and always has a laminated appearance. At the point at which it

meets the lip a distinct projection is formed. This feature is distinct in *D. cerameopoma* (Benson), which I propose as the type-species of my new genus, in *D. lutea* (Gray), *D. pulchellum* (Benson) and the new species here called *D. textum*.

***Digoniostoma pulchellum* (Benson).**

1836. *Paludina pulchella*, Benson, *Journ. As. Soc. Bengal* V, p. 746.
1876. *Bithynia pulchella*, Hanley and Theobald, *Conch. Ind.* pl. xxxviii, figs. 5, 6.
1885. *Bithynia pulchella*, Nevill, *Hand List Moll. Ind. Mus.* II, p. 35.

This species is common in all parts of the plains of Assam but has not been found in Burma.

The aperture of the shell and the surrounding parts are not quite so characteristic of the genus as in some species, for the columella projects less and the umbilicus being practically closed, the channel running forward from it is not so deep or well-defined. The angle at the inner extremity of the lip is also blunted or rounded off. The operculum is distinctly concentric and its external surface is divided into several distinct areas by prominent concentric ridges.

Our specimens from Manipur are smaller than those from northern Assam. Several of them are in an interesting stage, having evidently been killed at a period of active growth. In these shells the lip is still thin as in *Bithynia* and the operculum, which in the fully formed shell cannot be retracted, is drawn in as far as the beginning of the new addition to the shell. I have observed a similar stage in shells of *Hydrobioides*.

The soft parts and radula are very like those of the new species (*D. textum*) now to be described (fig. 1).

D. pulchellum is much scarcer in the Manipur valley than either *A. orcula* or *D. textum*. We took it only in ponds at Imphal. In habits it resembles these two species.

***Digoniostoma textum*, sp. nov.**

The shell is not more than 8 mm. high and 5 mm. in maximum diameter. It is broadly and irregularly ovate in outline with the apex minutely and obliquely flattened, the whorls moderately convex and not at all angulate externally and the inner anterior extremity pointed and produced obliquely. There are $4\frac{1}{2}$ whorls, of which the first whorl and a half are minute and inconspicuous. The others increase evenly but rapidly in size. They are slightly flattened above and more distinct in the inner than in the outer outline. The suture is oblique, linear, and, except at the apex, impressed. The spire is shorter than the body-whorl in dorsal view. Its whorls are oblique and transverse, more than twice as broad as deep. The body-whorl in dorsal view is obliquely trumpet-shaped, expanding greatly towards the outer margin. The aperture is relatively long, rather narrowly oval, slightly oblique, less than $\frac{2}{3}$

as long as the body-whorl. The outer lip turns inwards above and meets the inner callus at an angle slightly greater than a right angle. The columellar border is arched, prominent and thick, with its lamellar structure well developed. The umbilicus is almost closed but the channel running forward from it well defined. The inner lower angle of the lip is strongly developed.

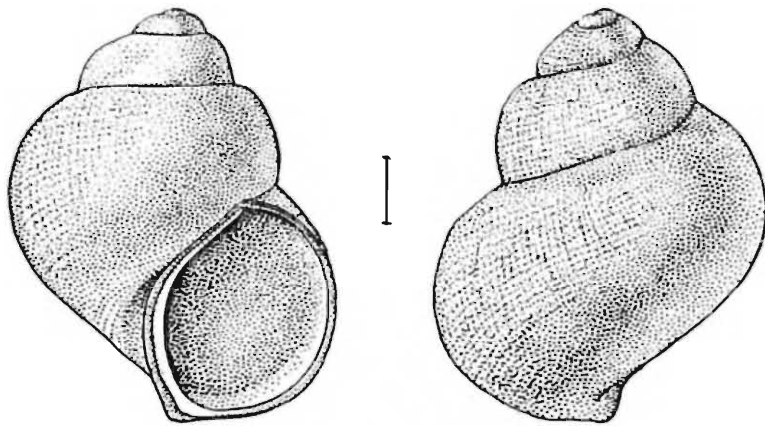


FIG. 1.—Type-shell of *Digoniostoma textum*.

The operculum is large, subrhomboidal, moderately thick, testaceous-translucent when fresh but soon becoming white and dull. There is a very delicate brownish periostracum on the external surface, which is rather deeply concave in the central region. The nucleus is subcentral, but situated slightly in front of the middle point. The sculpture is poorly developed but several faint concentric ridges can be detected round the periphery, while the nucleus retains traces of a spiral origin. The internal surface is convex and faintly granular, with a rather broad flattened border on the outer margin.

The radula is like that of a typical *Bithynia*. The specific characters of the teeth are well shown in fig. 2.

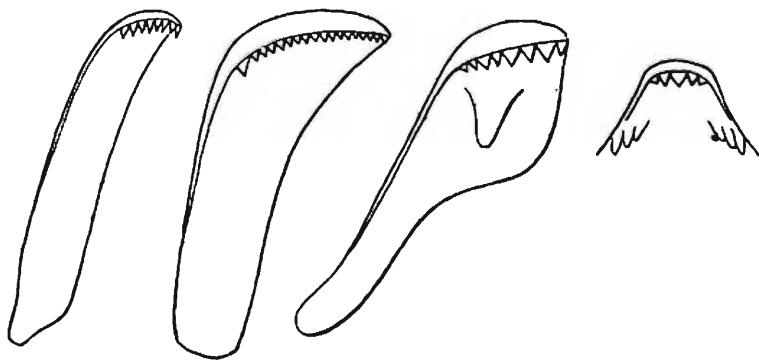


FIG. 2.—Radular teeth of *Digoniostoma textum*.

The external soft parts are dull greenish speckled with yellow. The feet, snout and tentacles are normal, the foot is rather shorter and the operculiferous lobe larger than some species. The male organ is densely pigmented, long, coiled, tapering and produced to a very fine point. Its subsidiary appendage is colourless, long and slender, cylindrical and with a simple cup-shaped depression at the

tip. It projects outwards towards the left at a right angle and originates near the base of the inner side of the penis.

Type-series.—No. 11860/2 Zool. Surv. Ind. (*Ind. Mus.*).

Habitat.—The species is abundant and generally distributed in the Manipur valley, outside which it has not been found. It lives in small sluggish streams, pools and swamps in the plains but was not found in the Loktak Lake. It crawls slowly on the lower surface of floating grass-stems and water-weeds and can float shell downwards on the lower side of the surface film. It is resistant to drought, and individuals brought dry to Calcutta revived on being placed in water after over a fortnight's desiccation. The shell is usually covered with mud.

Affinities, etc.—As in most Indian species of the genus the shell is somewhat variable in shape and the spire is more produced in some individuals than in others. In the majority, however, it is relatively short and has a rather close resemblance in general outlines to some species of *Alocinma*. In sculpture it closely resembles *A. travancorica* (Benson). The structure of the aperture and the adjacent parts is, however, eminently characteristic of *Digonios-toma* and the operculum, though like that of *Hydrobioides nassa* it shows traces externally of a spiral origin in the nuclear region, is much less spiral than in *Alocinma*. I am not acquainted with any species to which *D. textum* is closely related.

Family VIVIPARIDAE.

This family may almost be called the dominant one among the Gastropods of the Manipur valley, for not only are individuals extremely abundant, but the two commonest species attain a size quite exceptional. Four species are represented in our collection, of which two are rare, while two occur in all suitable bodies of water in very large numbers.

Vivipara, Montfort.

1920. *Vivipara*, Annandale, *Rec. Ind. Mus.* XIX, p. 112.

In the paper cited I have separated the Indian species of this genus into four groups, the *Viviparae bengalenses*, the *Viviparae oxytropides*, the *Viviparae dissimiles*, and the *Viviparae sindicae*. With the exception of the last, each of these groups is represented in the Manipur fauna by one species and all but one (*V. oxytropis*) of these species are apparently endemic.

VIVIPARAE BENGALENSES.

This group has as its Manipur representative a hitherto undescribed species quite distinct from both *V. bengalensis* (Lamarck), the races and phases of which are scattered over most parts of the Indian Empire, and *V. nagaensis*, Preston, which is known only from the Naga Hills. For this new species I propose the name:—

***Vivipara crassispiralis*, sp. nov.**

(Plate IV, fig. 1.)

The shell is ovate-conical, rather bluntly acuminate, from $1\frac{1}{4}$ to $1\frac{3}{8}$ times as high as broad, thin, of an almost uniform bright olive-green but with faintly darkened spiral bands, with the whorls tumid and obliquely, rather broadly flattened outside the

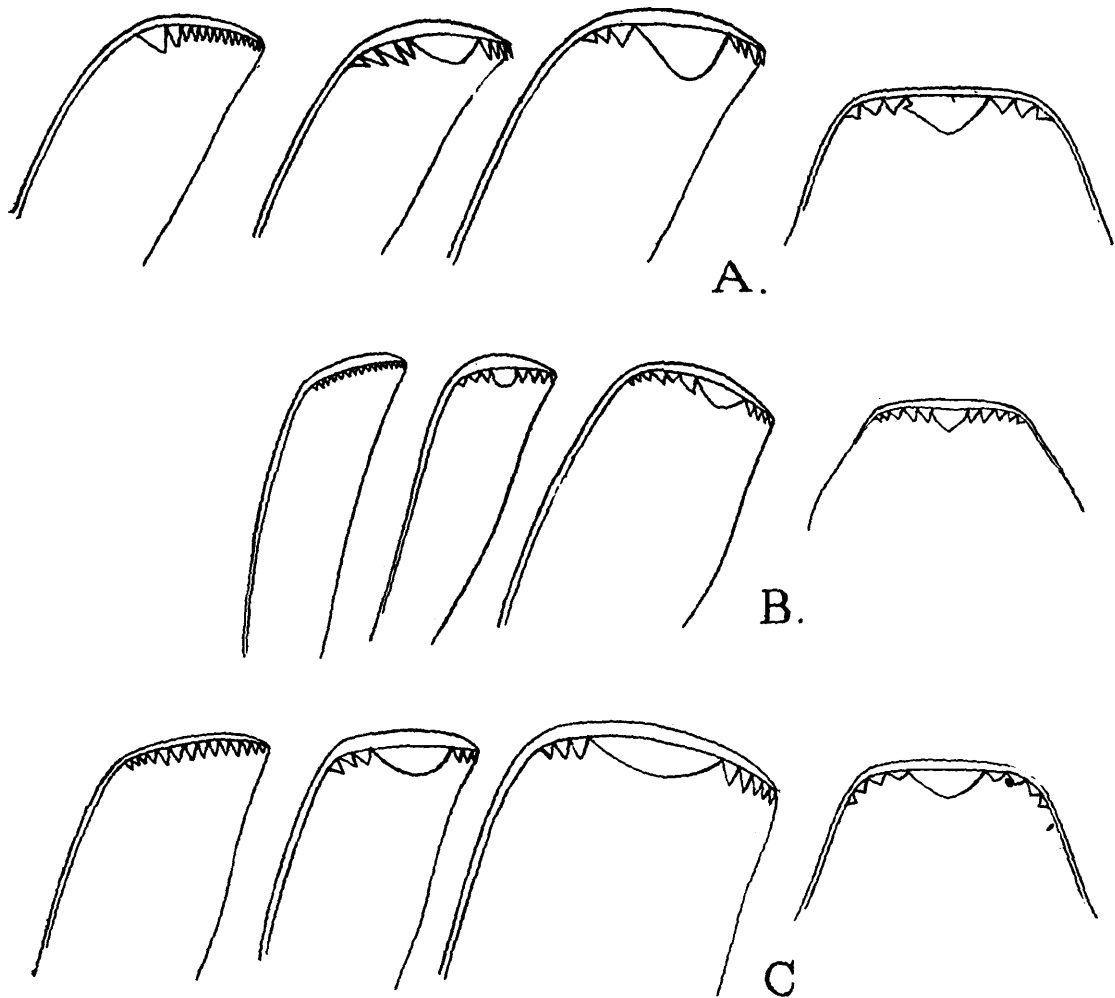


FIG. 3.—Radular teeth of Viviparidae.

A.—*Vivipara crassispiralis*.B.—*V. oxytropis*.C.—*Lecythoconcha lecythis*.

suture, which is linearly impressed. The sculpture consists of prominent spiral ridges, of which two are visible on the penultimate and antepenultimate whorls and three on the upper part of the body-whorl, and of numerous fine spiral lines crossed at fairly regular intervals by rather coarser oblique vertical lines. The ridges are nearly solid. There are $4\frac{1}{2}$ whorls in all when the shell is complete. The first whorl and a half are smooth except for the fine lines. All increase in size gradually and evenly. The body-whorl is transverse and oblique, with its anterior margin strongly sinuate. It shows no tendency to be biangulate and the peripheral ridge is hardly stronger than the others above it; below it there

are about six rather more delicate spiral ridges. The mouth is rather small, suboval, oblique, and from $1\frac{1}{4}$ to $1\frac{3}{4}$ times as high as broad. It is evenly rounded below and obliquely, bluntly pointed above. The peristome is not continuous. The outer lip is thin, evenly and broadly arched. Its outline is rendered irregular by the ends of the spiral ridges. The columella is arched, slightly laminated and retroverted, of a bluish white colour. The umbilicus is rimately perforate. The interior of the shell is faintly tinged with bluish white.

The following are the measurements in millimetres of the five shells in the type-series:—

Height	26	26	23	21	20
Max. diam.	20.5	19	17	17	16
Height of aperture (oblique)	14	12.5	12	12	12
Max. diam. of aperture	11	9.5	8.5	9	7.5

The operculum is very thin, of broadly ovate outline, broadly and rather deeply concave on the external surface. The scar, which is situated much nearer the inner than the outer margin, is not greatly thickened but much deeper in colour than the rest of the structure and surrounded by an opaque whitish ring. The external sculpture consists of fine concentric striae, the margin is very thin and slightly recurved.

The edge of the mantle is thin, with a fairly well-developed superior sphincter muscle. Minute papillae are present on the margin, corresponding in position to the coarse spiral ridges of the shell, but they are rather hard to detect in preserved material.

The radula is like that of *V. bengalensis*, but the lobular central process of the central and marginals is triangular and the lateral denticulations of the same teeth fewer and shorter.

Type-series.—No. M 11738/2 Zool. Surv. Ind. (*Ind. Mus.*).

Locality.—The five shells which form the type-series were purchased in the bazaar at Imphal in a living state by Mr. Sundar Lal Hora with living specimens of *Paludomus pustulosa*, sp. nov. They were said to have been brought from the Chakpi stream in the south of the Manipur valley near the Burmese frontier. I have not seen living specimens.

Affinities.—The species is allied to *V. bengalensis doliaris* from Burma but the spiral ridges are much more strongly developed and less darkened, the body-whorl is not at all biangulate and the colour is brighter and deeper. Unfortunately we know nothing of its habits with certainty but its occurrence with a *Paludomus* of the *conica* group would suggest that it is possibly fluviatile rather than paludine. It has no real relation to *V. oxytropis* in spite of its superficial resemblance on account of the thickened spiral ridges; for the base of the shell is not at all flattened but distinctly tumid, while the apical portion is conoidal rather than conical, and the peripheral ridge is no more prominent than the others. The resemblance to certain Chinese and Philippine shells is probably quite superficial.

VIVIPARAE OXYTROPIDES.

Vivipara microchaetophora, sp. nov.

1877. *Paludina bengalensis* var. *cingulata* (in part), Nevill, *Cat. Moll. Ind. Mus. E.*, p. 29.
1885. *Paludina bengalensis* subsp. *cingulata*, subvar. Nevill *Hand List Moll. Ind. II*, p. 22.

Although this species was not found in Manipur it may be conveniently described here as it has a distinct bearing on the origin of *V oxytropis*, one of the most characteristic of the Manipur molluscs.

The *shell* is small, thin, sharply acuminate, somewhat elongate and imperforate. It is divided into two regions by a blunt peripheral ridge on the body-whorl, above which it is narrowly conical, while below it is broad and rounded. There are $5\frac{1}{2}$ whorls. Those of the spire are very slightly convex but obliquely and not very broadly flattened above. The suture between them is not strongly impressed except sometimes in old shells above the body-whorl, and they increase in size gradually and evenly. The body-whorl is more swollen but transverse and less than twice as deep on the outer as on the inner margin. The aperture is of moderate size, subrhomboidal, rather narrow, higher than broad, pointed above and often subangulate below, slightly oblique. The peristome is complete, the outer lip sharp, the columella strongly arched, with its fold narrow and by no means prominent. The region to the left of the mouth in the natural position of the shell slopes upwards somewhat abruptly and is very slightly convex. In young adult shells the colour is a translucent olivaceous yellow, as a rule tinged with green on the body-whorl. The apical whorl and a half are dull purple and the others are marked with numerous fine spiral bands of the same colour. The suture is also deeply tinged with purple. The inside of the shell is white and the peristome is linearly edged with black. In old shells the distinctive colouration is apt to be obscured by a general blackening of the surface and this sometimes occurs in quite small specimens. On the body-whorl there is not as a rule any very definite trace of thickened spiral ridges, except for the peripheral keel, but sometimes the dark bands are a little thickened. On the whorls of the spire, however, at least two fine spiral ridges can as a rule be detected with the aid of a hand lens, while in the embryo there are several and even in the adult more than two can be discovered under a high power of the microscope. All these ridges are punctate and when the shell is fresh bear rows of minute chaetae-like processes of the periostracum. The processes are, however, so delicate that they usually disappear as the shell dries.

The embryonic shell differs from that of any form of *V bengalensis* in its broader, more conical form, in the produced character of the apical whorl and a half and in the very strong peripheral keel of the body-whorl.

The operculum is very thin and of a pale golden brown colour.

The outline is ovate and the external surface broadly concave with the concentric ridges poorly developed. The internal surface

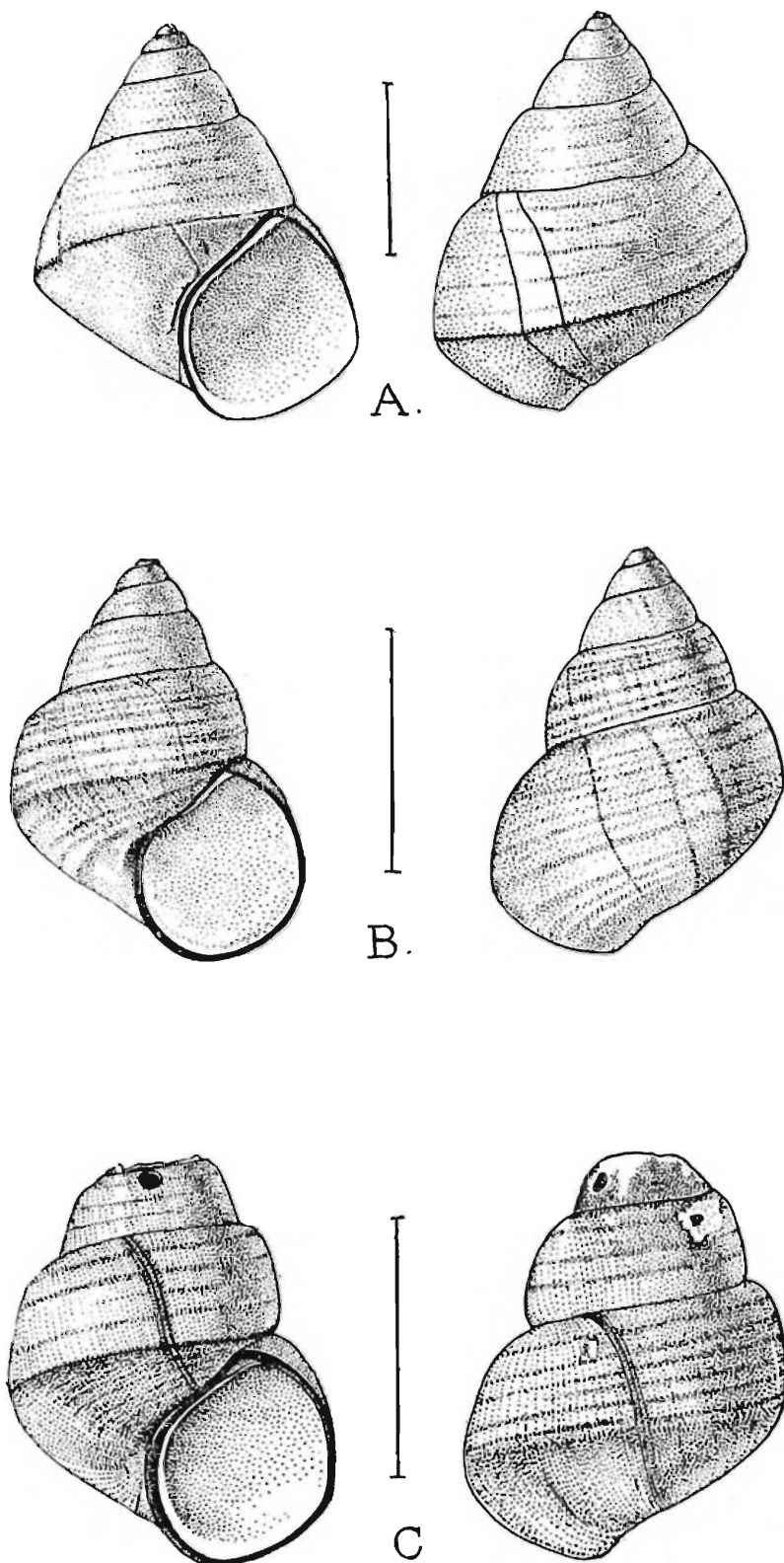


FIG. 4.—Shells of *Vivipara microchaetophora*.
A.—Young shell. B.—Shell of young adult.
C.—Old shell.

is convex as a whole. The muscular scar is poorly developed and only a little darker than the rest of the operculum. It covers a considerable area as a minutely granular thickening.

The radula has the denticulations of the teeth rather numerous and coarse but otherwise offers no particular feature of interest.

The animal offers no noteworthy particular except that it is rather pale in colour. The edge of the mantle is thin and almost smooth in the adult, at any rate in preserved specimens.

Type-series.—No. M 11856/2 Zool. Surv. Ind. (*Ind. Mus.*).

Distribution.—This species is only known from Dimapur, which lies in the plains of Assam immediately north of the Naga Hills and about 100 miles north of the Manipur valley. Nevill examined specimens from Assam but of unknown provenance.

Affinities.—I do not think that this species has any close relationship to the thick-shelled Indo-chinese forms with which Nevill associated it under the name *Paludina bengalensis* var. (or subsp.) *cingulata*. The shells he examined were old and in them the very characteristic sculpture and colouration was obscured. The embryonic shell is so unlike that of *V bengalensis* and so like that of *V oxytropis* that I believe *V microchaetophora* to be related rather to the latter species.

Habits.—The species was found in artificial ponds, particularly on floating grass-stems and the lower parts of plants that trail on the surface of water. In a rather deep clean pond, with a bottom of stiff yellowish clay and a rather profuse growth of *Hydrilla*, reserved for the water-supply of the Manipur Road railway station and the surrounding houses, large numbers died at the beginning of March, 1920, and by their decay gave the water a horrible ammoniacal smell. In a shallow, swampy pond a few hundred yards away many individuals were observed alive and active.

***Vivipara oxytropis* (Benson).**

(Plate IV, figs. 2-5.)

- 1836. *Paludina oxytropis*, Benson, *Journ. As. Soc. Bengal* V, p. 745.
- 1852. *Paludina pyramidata*, Küster, Martini and Chemnitz's *Conch. Cab.*, pp. 27, 28, pl. vi, figs. 1, 2.
- 1864. *Paludina oxytropis*, Reeve, *Conch. Icon.*, pl. ii, fig. 9.
- 1909. *Vivipara oxytropis*, Kobelt, Martini and Chemnitz's *Conch. Cab.*, p. 132, pl. xxiv, figs. 9, 10.
- 1915. *Vivipara oxytropis*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 84.

The shell is large or very large but thin and delicate, rather broadly conical, acuminate, narrowly perforate, ornamented with prominent spiral ridges, highly polished and of a bright translucent olive-green when clean and fresh. The base is flattened and recedes abruptly below the peripheral ridge of the body-whorl, especially on the ventral surface. There are $5\frac{1}{2}$ whorls, but the terminal half whorl is minute. The other whorls of the spire increase in size gradually. The suture is very little impressed and all the whorls are broadly but a little obliquely flattened outside it. The body-whorl as seen in dorsal view is transverse, but widens abruptly towards the aperture. It is broadly but obliquely flattened above and not at all tumid. The aperture is subcircular or

broadly oval, slightly narrowed at both extremities. The columellar margin is sharp and narrowly prominent. The umbilicus, though narrow, is circular and is approached from below by a deep and clear-cut channel. The aperture extends for some distance below the apparent base of the shell. The peristome is continuous. The outer lip is thin but not sharp, broadly and regularly arched, with a distinct prominence at the termination of the peripheral ridge. There are two smooth prominent spiral ridges on the three last whorls of the spire, three including the peripheral ridge or keel on the upper part of the body-whorl, and three rather less prominent ridges below the peripheral keel. All these ridges are darkened. Between each pair finer spiral ridges can be detected with a low power lens, crossed at regular intervals by straight, oblique striae, which do not interrupt the stronger ridges. The apex of the spire is darkened and the second complete whorl tinged with chestnut. The interior of the shell is washed with bluish white and the periphery of the aperture narrowly blackened and highly polished.

The female shell is distinctly broader than the male. The embryonic shell is extremely like that of *V. microchaetophora* but considerably larger.

The operculum is thin, relatively large and broadly ovate, bluntly pointed above, of a pale translucent brown colour, almost flat externally, with the concentric ridges feeble, the margin almost membranous and the scar small, poorly developed and only slightly darkened. On the peripheral region of the ventral surface radiating striae are well developed.

The radula is distinguished from that of *Vivipara bengalensis* by the much smaller denticulations of the teeth and narrower marginals (fig. 3B).

The animal is like that of *Vivipara bengalensis* (fig. 7B), except for the strong development on the free edge of the mantle in the adult of a number of finger-shaped processes three of which are larger and one much larger than the rest. Each process corresponds to a ridge on the shell and its size is proportionate to the development of the ridge. These processes are concealed in life when the animal is expanded. Their function, as hypertrophied structures, is probably that of accessory breathing organs and may be correlated with the fact that the branchial chamber is often almost completely filled with parasitic leeches (*vide postea*). There is no material difference in the gross internal anatomy of *V. bengalensis* and *V. oxytropis*.

The latter species has frequently been recorded in error from Bengal. The Manipur valley is apparently the only district in which it is common, but I collected some young shells apparently identical in a swampy lake near Kawkareik in the interior of the Amherst district of Tenasserim in 1908.

Two phases can be distinguished in the Manipur valley:—
(a) the typical phase from the Loktak Lake (pl. IV, figs. 2, 3), in which the shell is normally large and well developed, thin, trans-

lucent and conical, and (b) a pond phase (pl. IV, figs. 4, 5), in which it is usually smaller, thicker, less translucent and less regular in form, and has the mouth narrower and more pointed above. In the latter phase large individuals occur, but they are never of regular trochiform outline and the flattening of the whorls outside the outline is much less oblique. The surface in specimens from ponds is always more or less eroded. The sexual differences in the shell are less marked than in the lake phase.

Measurements of Shells (in millimetres).

	Lake Phase.						Pond Phase.					
	♀	♀	♀	♂	♂	♂						
Height	37	40	35.5	41.5	37	39.5	40	31.5	31	34.5	29	30
Max. diam.	31.5	35	31.5	32.5	28.5	33.5	33.5	23	26.5	24.5	22.5	21
Height of spire	17	20	16	21.5	17	17.5	15	14	13.5	16.5	15.5	14
Height of mouth	20.5	22	21	22.5	18	21	22.5	16.5	17	17.5	15	14.5
Max. diam. of mouth.	17	19	16	17.5	15	17	17	12.5	14	12.5	11.5	12

Thus in the lake phase the shell is about $1\frac{1}{8}$ times as high as broad in females and $1\frac{1}{5}$ times in males, whereas in the pond phase, in which sexual differences are concealed by individual variability, the height is from $1\frac{1}{8}$ to $1\frac{2}{5}$ times the breadth.

The pond phase comes nearer *V. microchaetophora* than does the lake phase and has in all respects a less peculiar shell, nearer that of the *Viviparae bengalenses*, from which the *Viviparae oxytropides* are perhaps derived. The Japanese form that has been assigned by some authors to the Manipur species has, as Pilsbry has pointed out, no relation to it.

V. oxytropis attains its maximum development and most characteristic form in the more open parts of the Loktak Lake, in which it is abundant with *Lecythoconcha lecythis*. In ponds it is much scarcer and it is apparently absent from the smaller swamps of the Manipur valley.

In the lake it is almost invariably infested by a leech of the genus *Glossosiphonia*, which often exists in the branchial cavity in such numbers as to occupy practically the whole lumen. Major Sewell, moreover, found Trematodes of the genus *Leucochloridium* encysted in the mantle of specimens brought living to Calcutta for examination.

Males in this mollusc seem to be considerably less abundant than females, at any rate in the Loktak Lake. The young are more numerous and smaller than those of *L. lecythis* living in the same conditions.

VIVIPARAE DISSIMILES.

Vivipara micron, sp. nov.

The shell is of very small size, moderately thick, acuminate, narrowly rimate, with the spire and the upper part of the body-whorl somewhat elongate but the basal part very short and convexly flattened from below upwards. There are probably $4\frac{1}{2}$ whorls in the complete shell, but in the only specimen I have

examined the apex is eroded. The whorls of the spire are convex and transverse, narrowly and somewhat obliquely flattened above, and increase in size evenly but rapidly. The suture is deeply but narrowly impressed. The body-whorl is almost trumpet-shaped as seen from the dorsal surface but with the mouth deeply depressed. Its periphery is subangulate and the area beneath the imperfectly developed keel is very broadly triangular with the apex of the triangle on the inner margin. The upper part of the body-whorl is tumid, but below the peripheral angle, which is better developed than on the closed surface, the base recedes abruptly and is only slightly convex. The aperture is rather small, but relatively broad, oblique in both planes, subrhomboidal and distinctly angulate on the inner margin, bluntly pointed above and narrowly rounded below. The outer lip is thin, broadly and a little irregularly arched. The columella is nearly straight. Its fold is fairly prominent and slightly reflexed over the narrow

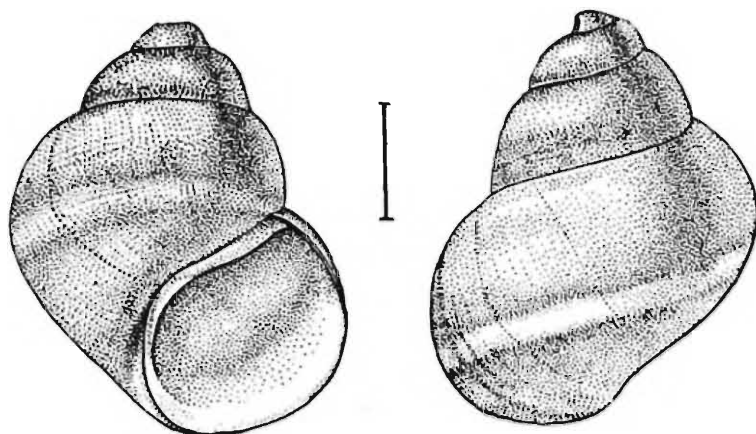


FIG. 5.—Type-specimen of *Vivipara micron*.

umbilicus. The peristome is complete. The colour is a rather pale olive-green, tinged with chestnut on the upper part of all the whorls and more deeply so over the whole apex. There is a broad pale band running round the periphery of the body-whorl. The margin of the mouth is very narrowly blackened and the interior of the shell is tinged with white. The sculpture consists of rather coarse longitudinal curved striae crossed by much finer punctate or sinuate spiral striae. The latter are more conspicuous on the spire than on the body-whorl.

Measurements (in millimetres) of Type-shell.

Height	12
Max. diam.	9
Height of spire (dorsal)	4.5
Height of mouth	6.7
Max. diam. of mouth	5.25

Type-specimen.—No. M 11855/2 Zool. Surv. Ind. (*Ind. Mus.*).

Locality.—A single empty but fresh shell was collected by Mr. Sundar Lal Hora in Manipur.

Affinities.—In spite of its small size this shell does not look like a young specimen of the genus, for the shape is too elongate, the peripheral keel too poorly developed and the aperture too complete. There can be little doubt that it belongs to the group to which I have assigned it, but it is unlike any of the Indian or Burmese forms with which I have been able to compare it by means of either specimens or figures. On the whole it seems to be nearer *V. ceylonica* (Dohrn) than any other, but the shape is much less conical and the base more flattened than in any form of that species.

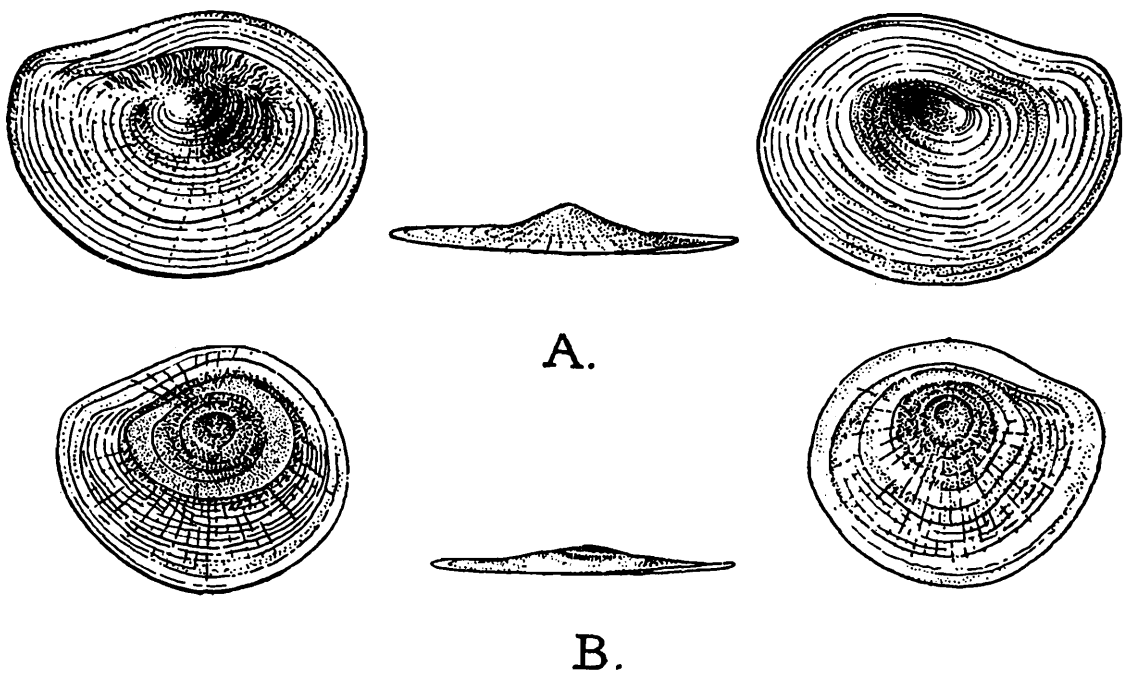


FIG. 6.—Opercula of *Lecythoconcha* and *Vivipara*. A.—*L. lecythis* (nat. size). B.—*V. oxytropis* (nat. size).

Lecythoconcha, Annandale.

1920. *Lecythoconcha*, Annandale, *Rec. Ind. Mus.* XIX, p. 114.

The shell is of large, sometimes of relatively gigantic size, but thin, smooth or more or less translucent. It is globose in form, with broad swollen whorls, and often bears a striking superficial resemblance to that of *Pachylabra* (Ampullariidae). The colour is uniform or very nearly so and dark spiral bands are never present. The aperture is large and patent, subcircular or broadly suboval. The columellar fold is not strongly developed, the umbilicus is narrowly perforate and the outer lip is thin.

The operculum is large, thin but stiff and rather brittle. Externally it is marked with strong but sharp concentric ridges and bears in its central region a deep funnel-shaped pit. There is no muscular scar on the internal surface but the pit is represented by a prominent rounded boss, round which there may be a ring-shaped area on which the surface is slightly roughened.

The animal differs from that of *Vivipara* in the greatly thickened and highly muscular free edge of the mantle, the sphincter muscle running along which is very strong and conspicuous. The radula is identical with that of *Vivipara*.

Type-species.—*Paludina lecythis*, Benson.

Geographical Range.—The range of the genus probably extends from the Manipur Valley through Upper Burma and possibly Tenasserim to Yunnan and Cochin China and thence across China to the Philippines, Celebes, Formosa and Japan. But I am not quite sure as to the generic identity of some of the Far Eastern species. In all those from China and Japan I have examined (except specimens of the type-species from Yunnan) the operculum differs in having the ring-shaped area round the central boss on the internal surface much more strongly roughened and scar-like than in *L. lecythis*.

Anatomically the new genus closely resembles *Vivipara*, as, indeed, do all the Asiatic genera of the family, but the structure of the mantle-edge and its sphincter is characteristic.¹

The strong mantle-sphincter has probably a definite function to perform, viz. that of protecting the branchial chamber from the entry of parasites.² As my assistant Mr. Amin-ud-Din pointed out to me at the Loktak Lake, almost every specimen of *Vivipara oxytropis* we examined there was infested by a leech of the genus *Glossosiphonia*, over 30 individuals of which were sometimes found in the branchial chamber of a single specimen, while the branchial chamber of *Lecythoconcha* from precisely the same habitat was invariably empty. The contraction of the powerful muscle must close this chamber much more effectively than that of the comparatively feeble muscle in *V. oxytropis*.

Lecythoconcha lecythis (Benson).

(Plate V and plate VI, figs. 1, 2.)

- 1856. *Paludina lecythis*, Benson, *Journ. As. Soc. Bengal* V, p. 745.
- 1852. *Paludina ampulliformis*, Eydoux and Souleyet, *Voy. 'Bonite'*, *Zool.*, p. 549, pl. xxxi, figs. 25-27.
- 1876. *Paludina lecythis* and var. *ampulliformis*, Hanley and Theobald, *Conch. Ind.*, pl. lxxvi, figs. 6, 7.
- 1877. *Paludina chinensis* varr. *ampulliformis* and *lecythis*, *P. siamensis* (in part), Nevill, *Cat. Moll. Ind. Mus. E.*, pp. 25, 36.
- 1885. *Paludina chinensis* varr. *ampulliformis* and *lecythis*, *P. siamensis* var. *burmanica*, id., *Hand List Moll. Ind. Mus.* II, pp. 20, 26.

The shell is of large or very large size, thin, of a uniform olive-green when fresh but often fading to brown, globose, narrowly perforate. There are $4\frac{1}{2}$ or 5 whorls. The apex is acuminate

¹ Annandale, *Rec. Ind. Mus.* XIX, p. 114, fig. 3 (1920).

² Major R. B. S. Sewell found the mantle of both *L. lecythis* and *V. oxytropis* from the Loktak Lake and ponds at Imphal infested with an encysted Trematode (*Leucochloridium*), but the orifice of the cyst was always on the external surface of the mollusc. I have found a minute parasitic mite among the gill-filaments of *L. lecythis*.

and the spire as a whole conical, but with the whorls tumid and flattened above and the suture deeply impressed. The spire, measured on the dorsal surface, is about as high as the central part of the body-whorl on the same surface. In this view the body-whorl is oblique and spiral and is considerably more than twice as deep at its outer as at its inner margin. The whorl is somewhat compressed from above downwards but strongly convex. In ventral view the spire is somewhat shorter than in dorsal view and the body-whorl, without the mouth, forms almost an equilateral triangle the apex of which is directed downwards. The upper part of the whorl is greatly swollen but it recedes inwards towards the umbilicus somewhat abruptly. The aperture is large and patent, more or less oblique and broadly oval. The outer lip is sharp and more or less narrowly tinged with black. The columella is arched and

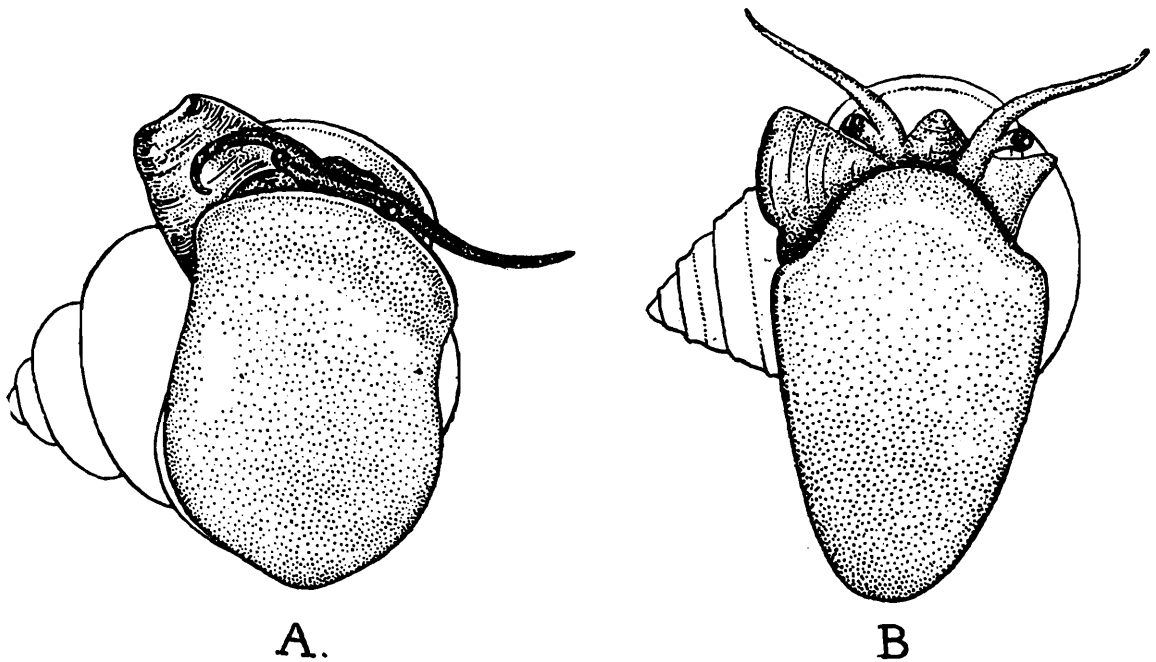


FIG. 7.—Living animals of *Lecythoconcha lecythis* ♂ (A) and *Vivipara oxytropis* ♀ (B). Nat. size.

its folds form a prominent ridge which is very little reflected over the umbilicus. This ridge is highly polished and of a bluish white colour, with which the whole interior of the shell is more or less deeply tinged. The sculpture consists of numerous fine, almost straight longitudinal ridges and frequently of close-set irregular indentations which give the whole shell a malleated appearance. These are more commonly present on the penultimate than on the body-whorl. In immature specimens a blunt ridge runs round the periphery of the latter whorl and even in large shells this is sometimes represented by a fine line, which may bear very fine cilia-like processes of the periostracum.

The female shell is a little more globose than the male and has the outline of the spire less broken (*cf.* figs. 1, 2, pl. V).

The operculum is thin and transparent, but hard and rather brittle, of a deep uniform golden brown colour and distinctly

pyriform. The central boss on the internal surface is situated nearer the inner than the outer margin. It is highly polished but its base is marked with fine radiating, iridescent ridges. The area surrounding it is smooth, but fine radiating lines proceed down on it from the boss.

The radular teeth are figured in fig. 3, on p. 544. They exhibit no essential difference from those of *Vivipara*.

The animal has the generic characters. It is rather less brightly coloured than most species of Viviparidae, the body being sooty black and the minute spots with which it is covered being dull yellow and very small. The tentacles are very long and thin and the foot is remarkably stout. Fig. 7 shows the outstanding differences between the living animal and that of *V. oxytropis*, which in most respects is a typical *Vivipara* so far as the soft parts are concerned.

Type-specimens.—No. 2300 Zool. Surv. Ind. (*Ind. Mus.*).

Geographical Range.—The type-specimens from the Asiatic Society's collection are labelled as being from Sylhet, but they agree so closely with shells from the more open part of the Loktak Lake¹ that I think this locality is probably incorrect. The species is not represented, so far as I am aware, in any recent collection from Sylhet and it must be remembered that at the time when Benson's collection was made Sylhet was on the way to Manipur. The true range probably extends from the Manipur Valley through Upper Burma to the Southern Shan States, Yunnan and Cochin China. Nevill records young specimens from the Philippines, but in view of their immaturity the record is open to doubt.

In Manipur no less than four phases can be distinguished, one of which, at one end of the series, is the *forma typica*, while another, at the other end has received the varietal name *ampulliformis*. I shall describe the phases under English names.

THE OPEN-WATER PHASE (= *forma typica*): plate V, figs. 1, 2. The shell is very large, globose, thin and translucent and is of a bright olive-green colour externally and only slightly washed with bluish white internally. The aperture is subcircular, the outer lip strongly arched and very thin. The sculpture is very fine and delicate and if varices occur on the body-whorl, as is often the case, they are poorly developed and as a rule not blackened. This phase is found in the more open parts of the Loktak Lake.

THE MARGINAL PHASE: plate V, fig. 3. The shell is thicker, heavier, more opaque and coarser than in the last phase and, though individuals grow at least as large, is usually smaller. The spire is relatively longer and not quite so broad at the base, the whorls are not quite so convex and the aperture rather

¹ Specimens of this phase are not difficult to obtain as they are brought up in hundreds by the fishermen in their nets. I have to thank Mr. C. Forster Cooper, Superintendent of the Cambridge University Museum, for examining the specimens in the Benson collection. He informs me that they also are labelled "Sylhet."

smaller. The lip is not so thin and has a deeper black border. The sculpture is much coarser and blackish varices can usually be detected on the body-whorl. This phase is abundant in the swamp at the north end of the Loktak Lake.

THE POND PHASE: plate VI, figs. 1, 2. The shell is smaller than in either of the last two phases but more variable both in size and shape. It is decidedly narrower than either and has the spire relatively longer, the whorls less tumid and less broadly flattened above. The mouth is variable in outline but as a rule is distinctly emarginate above the umbilicus. The sculpture is coarse and irregular and the shell more liable to erosion on the surface. This phase is found in ponds and in the smaller swamps of the Manipur Valley. Many of the specimens collected by the late Dr. John Anderson in Upper Burma and Yunnan also belong to it.

THE RICE-FIELD PHASE. (=var. *ampulliformis*, Eydoux and Souleyet): plate V, fig. 4. This is a small phase in which the upper part of the whorls of the shell is much less distinctly flattened, the spire is relatively long and the whole shell comparatively narrow. Some specimens of the pond phase approached it very closely. It is common in small pools in the rice-fields of the Manipur Valley and preponderates among the specimens collected by the late Dr. John Anderson in Upper Burma and Yunnan. It has also been recorded from Cochin China and appears to be, as might be expected, the most widely distributed phase of the species.

Habitat and Habits.—The concluding sentences of the preceding paragraphs indicate in a general way the habitats of the different phases, which are also indicated in the names given to them. There is one further point of interest to be noted, namely that the rice-field phase is peculiarly resistant to desiccation. A specimen was found in dry mud in February and brought to Calcutta dry. In cleaning the shell more than a month later the operculum was removed and the animal found to be in a perfectly fresh condition though quite immobile and apparently insensible.¹ It was accidentally left for the night in a dish of water and gave birth to a number of living young. It survived itself for several days, in spite of the removal of its operculum, but, probably on account of its injuries, did not regain sensibility.

No other noteworthy difference was observed between the habits of this species and those of *Vivipara bengalensis* and its allies.

The shells from Upper Burma and Tenasserim called *Paludina siamensis* var. *burmanica* by Nevill are merely young specimens of this species, as is evident from a direct comparison and from an

¹ The condition of this mollusc was apparently the same as that of a specimen of *Pseudovivipara hypocrites* examined after being dry two years and after a journey from China to Calcutta and from Calcutta to England and back. See *Mem. As. Soc. Bengal* VI, p. 312.

examination of their opercula. Probably the true *Paludina siamensis* of Frauenfeld is also the young of some allied species.

Family AMPULLARIIDAE.

Genus *Pachylabra*, Swainson.

The use of the name *Pachylabra* for the Oriental and African species of Ampullariidae has been discussed by Kobelt in the current edition of Martini and Chemnitz's *Conch. Cab.*, pp. 44-46 (1911). The genus is distinguished from the American *Ampullaria* by the structure of the operculum and the inhalent siphon. The former in *Pachylabra* is massive and calcareous with a coarse external horny covering. The siphon when contracted is a prominent fold forming an incomplete tube not very much longer than its transverse diameter. When expanded it is a funnel-shaped structure, considerably broader than long.

This genus is represented in the Manipur Valley by a single species (*P. maura*, Reeve), which is common throughout the plains of Assam. In the Manipur Valley, however, it was found only in a few ponds in the immediate vicinity of the capital. The question naturally arises, may it not have originally been introduced by man, either as food or accidentally? The Manipuris even now eat some kinds of molluscs and the Naga tribes of the surrounding hills are fond of all the larger freshwater species. *P. maura*, however, is well within the geographical limits of its range in Manipur, for it is found in the valley of the Brahmaputra on the one hand and on the Shan Plateau on the other.

Pachylabra maura (Reeve).

- 1856. *Ampullaria maura*, Reeve, *Conch. Icon.*, pl. xiii, fig. 57.
- 1887. *Ampullaria maura*, Nevill, *Cat. Moll. Ind. Mus. E.*, p. 5.
- 1885. *Ampullaria maura*, id., *Hand List Moll. Ind. Mus. II*, p. 4.
- 1918. *Ampullaria winkleyi*, Annandale (*nec* Pilsbry), *Rec. Ind. Mus.* XIV, p. 138, pl. xii, fig. 10.

My identification of specimens from the North Shan States as *A. winkleyi* was certainly incorrect and I can find no constant difference between them and shells from Assam except that they are paler and brighter in colour. Of the true *A. winkleyi* I have recently examined a shell from Patalung in Peninsular Siam.¹ Its minute spiral sculpture is much better developed and its shape different.

All the specimens examined from Manipur are small and have the shell very dark. They agree, however, precisely with some individuals from Dimapur and from Gauhati on the Brahmaputra.

The species is probably no more than an eastern race of *P. globosa* (Swainson), the common Ganges species. Nevill, however (*op. cit.*, 1887, p. 5), keeps it distinct on account of its "wider umbilicus, more contracted aperture with dark-coloured margins, more produced spire and thinner shell." I doubt whether these differences will be found to be constant, but until the Indian species

¹ Annandale, *Journ. Nat. Hist. Soc. Siam* IV p. 45 (1920).

of the genus have been revised, it seems best to regard it provisionally as a species. I figure the radular teeth.

In Manipur *P. maura* was found (in February and March) buried in the mud at the edge of certain ponds in or near Imphal, the capital. Dead shells were also found round these ponds, but not elsewhere in the valley. In the garden of the Residency the species was fairly abundant in one of two ponds, but not in the other. Both were shallow and had a dense submerged vegetation

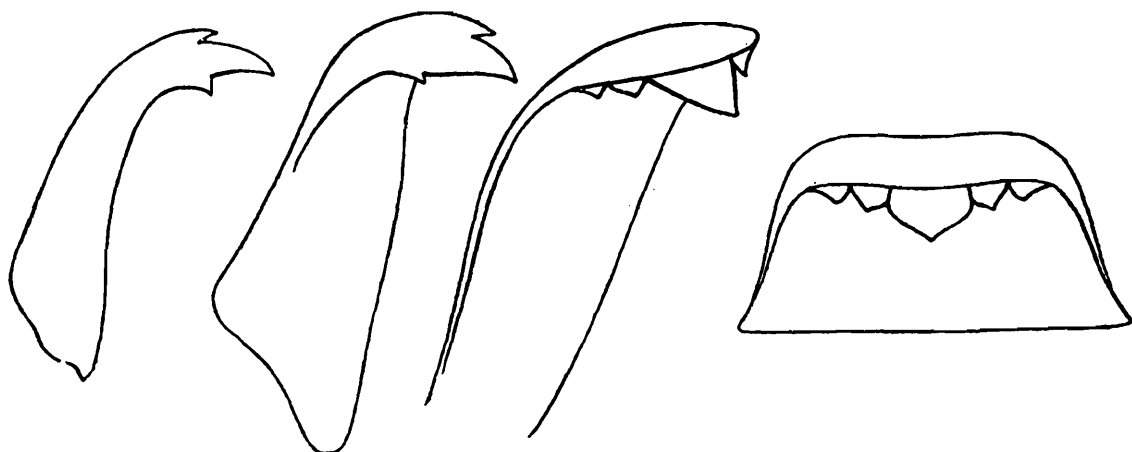


FIG. 8.—Radular teeth of *Pachylabra maura*.

of *Potamogeton* and *Hydrilla*, with a not very dense floating vegetation of *Azolla*, etc. The only difference seemed to be that in the pond in which *Pachylabra* occurred lotuses had been planted, and that there were none of these plants in the other. The other ponds in which the mollusc was found had a still richer submerged and floating vegetation with a profuse growth of plants that sent out long runners on the top of the water. Most species of the genus are dependent for their food on succulent leaves and stems and prefer such vegetation to the ordinary submerged water-weeds.

Family MELANIIDAE.

Subfamily MELANINAE.

Genus *Melanoides*, Olivier (*nec* H. and A. Adams).

- 1807. *Melanoides*, Olivier, *Voyage l'Emp. Ottoman* II, p. 40.
- 1854. *Plotia*, *Tarebia*, H. and A. Adams, *Gen. Recent Moll.*, pp. 295, 304.
- 1874. *Plotia*, *Tarebia*, *Striatella*, Brot, *Conch. Cab.*, p. 7.
- 1897. *Stenomelania*, *Tarebia*, *Melanoides*, *Plotia*, von Martens, in Weber's *Zool. Ergebn. Niederl. Ost. Ind.* IV pp. 40, 50, 62, 69.
- 1898. *Neomelanien* (in part), P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.
- 1915. *Radina*, *Striatella*, *Melanella* (in part), *Tarebia*, *Plotia*, Preston, *Faun. Brit. Ind., Freshw.-Moll*, pp. 10, 15, 32, 33, 35.
- 1919. *Melanoides*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 28.
- 1920. *Melanoides*, Annandale, *ibid.*, XIX, p. 108.

In the paper by Dr. Baini Prashad and myself cited immediately above we have given reasons for uniting *Melanoides*, s.s. and *Plotia*. Our views on this point are further strengthened by an examination of a large collection from various parts of the Madras

Presidency. In it I find all intermediate stages between the typical *M. scabra* (Müller) and *M. acanthica* (Lea) in the one direction and between *M. scabra* and the form we called *M. pyramis* var. *puteicola* on the other. The only constant difference that can now be claimed between *M. scabra* and *M. pyramis* as species is that in the former the lip of the shell is always strongly sinuate, its upper extremity as seen in ventral view being situated at a somewhat lower level than that of the columellar margin, though the central part of its margin lies level. This, as is shown in our original figures of the var. *puteicola*, is a marked feature of that form. The variety must, therefore, be retransferred to *M. pyramis*, with which Nevill originally associated it, and known as *M. scabra* var. *puteicola*. I can find no justification for separating *Tarebia* generically from forms like the typical *M. scabra*.

Melanoides tuberculatus (Müller).

1919. *Melanoides tuberculatus*, Annandale and Prashad, *op. cit.*, pp. 29, 31, fig. 3A, pl. iv, fig. 1.

Specimens from Manipur have no striking peculiarities. The species is common in ponds in the valley but was not found in the Loktak Lake.

The processes on the edge of the mantle arise on the ventral surface a short distance behind the actual margin. The largest is situated on the left side and they grow smaller as the series proceeds towards the right.

Genus *Acrostoma*, Brot.

1854. *Melanoides*, H. and A. Adams (*nec* Olivier),
1874. *Melanoides*, *Acrostoma*, Brot. *Conch. Cab.*, p. 7.
1897. *Brotia*, von Martens, in Weber's *Zool. Ergebn. Niederl. Ost. Ind.* IV, p. 33.
1915. *Melanoides*, *Acrostoma*, Preston, *Faun. Brit. Ind., Freshw.-Moll.* pp. 21, 30.
1920. *Acrostoma*, Annandale, *Rec. Ind. Mus.* XIX, p. 109.

I cannot find any constant difference between the shells, opercula, soft parts or radulae of *Brotia*, von Martens (= *Melanoides*, auct.) and *Acrostoma*, Brot. Indeed such forms as the one described here as *Acrostoma variabilis* var. *laevis*, though clearly falling within the limits of *Brotia*, are very closely related to *A. hugeli*, the type-species of *Acrostoma*.

In this genus some of the heaviest shells among the freshwater Gastropods occur.

The edge of the mantle of *A. variabilis*, in living individuals as in preserved specimens, is quite smooth. It is marked out, however, on the inner surface into well-defined areas by vertical lines of bright yellow pigment on a dark background. In preserved specimens of *A. hugeli*, the type-species of the genus, a similar condition is found. There is no difference in this respect between individuals of *A. variabilis* with smooth and those with highly sculptured shells.

Acrostoma variabilis (Benson).

(Plate VI, figs. 3—6.)

1836. *Melania variabilis*, Benson, *Journ As. Soc. Bengal* V p. 746.
 1872. *Melanoides spinata*, Godwin-Austen, *Proc. Zool. Soc. London*,
 p. 514, pl. xxx, figs. 1, 1a.
 1876. *Melania variabilis, episcopalis, spinata*, Hanley and Theobald,
Conch. Ind., pl. lxxii, fig. 7, pl. lxxv, figs. 5-7, pl. cix, figs. 1, 3,
 6.
 1885. *Melania variabilis, spinata*, Nevill, *Hand List Moll. Ind. Mus.*
 pp. 251-261.

This justly named species is represented in the Manipur Valley by three varieties which link together several forms that have sometimes been regarded as distinct species. The varieties, however, are by no means constant, though even quite young shells can usually be distinguished for many intermediate individuals occur. The three Manipuri forms may be called *laevis*, var. nov.,

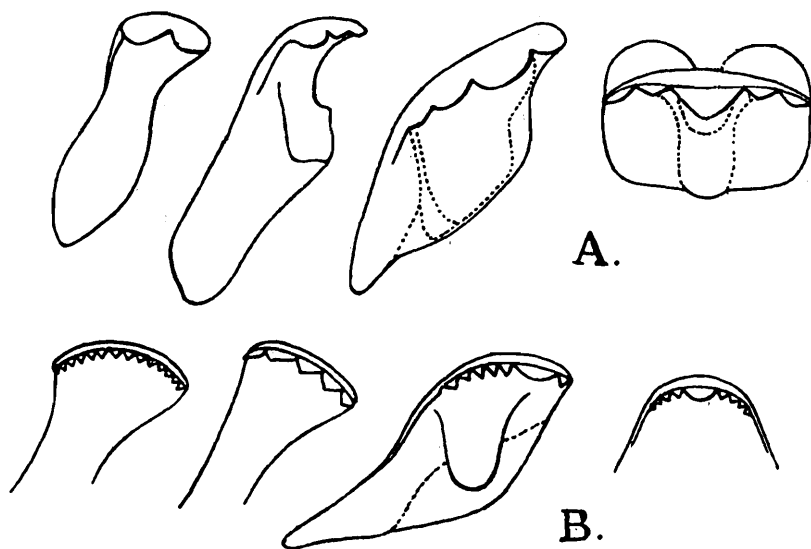


FIG. 9.—Radular teeth of Melaniidae.

A. *Acrostoma variabile*. B. *Paludomus pustulosa*.

semilaevigata, Nevill and *subspinata*, var. nov. I will describe each separately. Here I figure a living specimen of the var. *subspinata*, nov. from Dimapur, to show the form of the animal.

Var. *laevis*, nov. : pl. vi, figs. 3, 4. Under the name *semilaevigata* Nevill included two forms which seem to me to be distinct varieties. In one of them, for which I propose the name *laevis*, the shell is often almost as smooth as that of *Acrostoma hugeli*, the longitudinal ribs being completely obsolete, while in other shells I assign to the same variety they are only obsolescent and may even be produced into a small tubercle at the upper extremity. This may occur either on both the two last whorls or on the penultimate whorl only. The longitudinal sculpture in the smoothest shells consists merely of coarse striae, while the spiral sculpture is represented by ill-defined smooth ridges. The most highly sculptured shells of this variety approach the var. *pseudospinosa*, Nevill.

Var. *semilaevigata*, Nevill: pl. vi, fig. 5. In Nevill's type-

series of this variety I find shells of the form here called *laevis* mixed with others to which the definition he adopted from Berison applies more exactly, the essential difference being that in the obsolescent ribs of *semilaevigata* both extremities are produced into tubercles. Highly sculptured shells of this variety often approach Nevill's var. *binodulifera*.

Var. *subspinata*, nov.: pl. vi, fig. 6. This form is interesting as being precisely intermediate between the var. *binodulifera*, which occurs in abundance in the river at Dimapur just north of the Naga Hills, and Godwin-Austen's *Melanoides spinata* from northern Assam. The two rows of spines are nearer together than in *binodulifera* and the spines are more produced, but they are not foliaceous as in *spinata*.

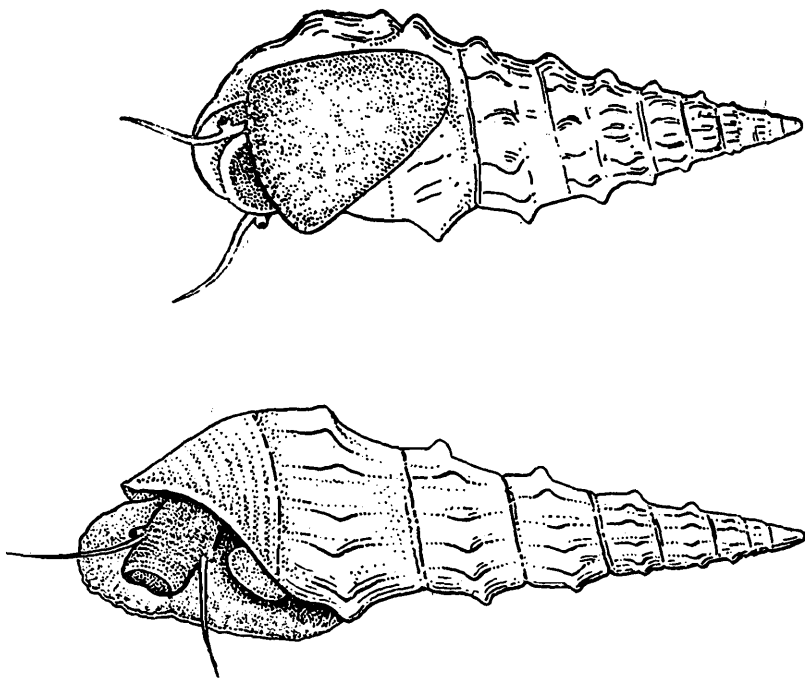


FIG. 10.—Living animal of *Acrostoma variabilis* var. *subspinata*, nov., from Dimapur, Assam.

These three varieties are, as I have said, by no means constant. The two last occur together and in most individuals can be readily distinguished even before the shell has attained a third of its full dimensions, the longitudinal ribs being well developed in this stage as strong keels on all but the first four or five whorls in *subspinata*, while the whole shell is smooth in *laevis*. Intermediate individuals occur, however, not uncommonly. They are much commoner among adult than among young shells. The vars. *laevis* and *semilaevigata* also occur together, but I have not found both *semilaevigata* and *subspinata* in any series examined. This would suggest that the smooth type of shell has been derived independently along two lines, by the suppression of the lower part of the ribs in one line and by that of the middle region in another.

The young shell removed from the oviduct at full time is identical in all the Manipuri varieties. It consists of $4\frac{1}{2}$ whorls and is conical in outline with the base produced towards the outer margin and pointed. The apex is minutely blunted and retracted, the apical half-whorl lying in a deeply canaliculate suture. Round the other whorls the suture is not impressed. The aperture is regularly rhomboidal, narrow, oblique and somewhat elongate. The colour is pale olivaceous green becoming darker and browner towards the apex, which is infuscated. A dark brown spiral band embraces both sides of the suture and is continued round the periphery of the body-whorl, on which a second band of the same colour appears towards the base.

The sculpture consists of microscopic spiral and longitudinal striae. The latter are strongly curved. There is an obscure, flattened spiral ridge running just below the suture and round the periphery of the body-whorl.

The Manipuri varieties have much thicker and heavier and, generally speaking, larger shells than the *forma typica*, which is common in ponds in the Gangetic delta. This seems to be so in all fluviatile phases of the species. In Manipur the varieties occur in the beds of the Imphal River and its tributaries, in muddy water and on a muddy bottom. Apparently they are not found in the swifter, clearer hill-streams.

The range of *A. variabilis* as a species extends eastwards from the Gangetic Delta, through Assam and Burma and it is represented in the Malay Peninsula, Sumatra and Java by very closely allied forms. Its "varieties" may be mere phases the peculiarities of which are due to some peculiarity (or rather combination of peculiarities) in the environment, but on this subject little is yet known. The animal is usually if not always found on a muddy bottom and obtains its food by scraping the surface with its radula.

Subfamily *PALUDOMINAE*.

Genus *Paludomus*, Swainson.

The number of the species and subspecies of this genus found in Burma and Assam is probably considerable, and some species from these countries, notably *P. conica* (Gray), are particularly liable to form local races. Indeed, specimens of *P. conica* seem to differ slightly in every stream in which they occur. The whole genus stands, however, in need of revision as far at any rate as the Indian forms are concerned, and it is important that young as well as adult shells should be examined, for in maturity the spire is often so distorted by erosion that the true form of the shell completely disappears. I have been unable to match a *Paludomus* fairly common in the southern part of the Manipur Valley with any previously described and am therefore obliged to call it new. Fortunately shells in all stages of development are available.

Paludomus pustulosa, sp. nov.

The shell when fully adult is thick and porcellaneous and of a uniform blackish colour externally. Only the body-whorl and part of the penultimate whorl usually remain. The former is tumid, very oblique and more than twice as deep at its inner than at its outer margin as seen from the dorsal surface. The inner margin is very broadly rounded. On the ventral surface the whorl has an elongate, irregularly oval outline. On the outer side it is highly convex above but recedes rather abruptly to-

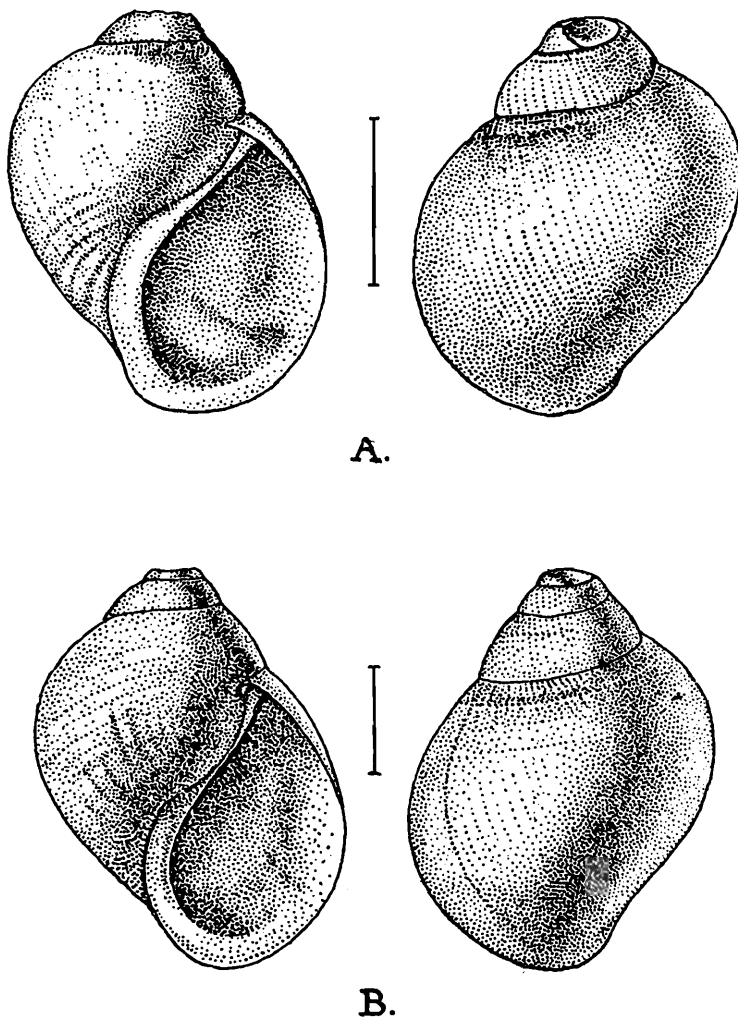


FIG. 11.—Shells of *Paludomus pustulosa*.

A. Adult shell.

B. Half-grown shell.

wards the lower margin. On the inner side the region above the aperture is short and convex. The ventral surface is swollen above, somewhat flattened below. The mouth projects obliquely at its upper end. It is slightly pyriform, rather narrow and oblique. The upper extremity is sharply pointed, the lower evenly and not very broadly rounded. The lip is thin, slightly everted and obscurely pleated internally. It forms a well-defined margin to the aperture and is highly polished and of a bluish white colour with a narrow black border. The columellar margin is similar in appearance and forms a continuous ridge with the

lip. This ridge is, however, broadly excavated above the columella. There is hardly any trace of the umbilicus. The sculpture consists of fine and regular longitudinal striae with coarser longitudinal lines set at irregular intervals and of minute, almost microscopic pustule-like granules scattered irregularly and sometimes confined to the ventral surface. Round the upper part of the whorl, and sometimes also at its base, there are traces of several obsolescent transverse grooves. The interior of the shell is olivaceous, sometimes with traces of two or three broad chestnut bands.

Half-grown shells are very different in appearance. They have at least $3\frac{1}{2}$ whorls and sometimes traces of a fourth. The outline is rather narrowly ovate with the spire tapering and rather narrow but blunt at the tip. The colour is dark olivaceous green or brown with the internal bands more distinct and the shell is much thinner. The whorls of the spire increase evenly but rapidly in size and are flattened above, with two or more rather deep grooves running round the upper surface. Without intermediate individuals I would hardly have thought these two types of shell specifically identical, but the series collected by Mr. Sunder Lal Hora leaves no doubt on the point.

In very young shells, not more than 5 mm. long, there are 5 whorls and the apex is acuminate.

The operculum is of the type normal in *Paludomus*, s.s., being of ovate form with a small spiral figure situated in the anterior inner region.

The radula does not differ materially from that of *Melanoides*, except that the outer lateral and the marginal are more spatulate (fig. 9B).

Type-series.—No. M 11855/2 Zool. Surv. Ind. (*Ind. Mus.*).

Localities, etc.—Specimens were obtained by Mr. Sunder Lal Hora from one stream in the south part of the Manipur Valley. Specimens were also purchased, with those of *Vivipara crassispinalis* in the Imphal bazaar, but were said to have come from the same district. Mr. Hora obtained his specimens on a pebbly bottom in clear, rapid-running water.

Affinities.—The species is closely allied to *P. conica* (Gray) and especially to the race *kopiliensis*, Nevill, from northern Assam. The sculpture is, however, more delicate and the body-whorl as seen in ventral view considerably more elongate. Of the shells figured in the *Conchologia Indica* the nearest is *paludinoides*, Reeve (pl. cxxiii, fig. 9), but the aperture in my new species is more oblique, longer and narrower, the inner outline more irregular and the colour much duller and darker. The young shell is not unlike the figure of *clavata* (fig. 4) from Ceylon on the same plate, but its aperture is much larger and more patent.

AQUATIC PULMONATA.

By N. ANNANDALE and B. PRASHAD.

The three families and most of the genera of this order that occur in the Oriental Region are well represented in the collection, namely the Limnaeidae, the Planorbidae and the Ancyliidae, the first by four species of *Limnaea*; the second by the unique species of *Indoplanorbis* and by species of *Gyraulus*, *Segmentina*, *Hippentis* (?) and the highly peculiar genus *Camptoceras*; the third by three species of the subgenus *Ferrissia* of *Ancylus*.

This collection has enabled us to discuss plasticity and variability in the Limnaeidae, to give particulars about the anatomy of the different genera of Planorbidae and to revise the Indian species of Ancyliidae. Perhaps the most interesting points that have become manifest in our investigation are (1) the differences in environmental plasticity and individual variability shown by different species of *Limnaea*; (2) the homogeneity of the anatomy of the Indian species of the genus, contrasting with (3) the great diversity of structure in the soft parts of the Planorbidae; (4) the generic status of the common Indian "*Planorbis*" *exustus* and of the scarce *Camptoceras lineatum*; and (5) the precise systematic position of the Indian Ancyliidae.

Family LIMNAEIDAE.

Genus *Limnaea*, Lamarck.

Of the four species of the genus found in Manipur two are widely distributed in India (*L. acuminata* and *L. ovalis*), the range of one (*L. andersoniana*) extends from south-western China to Kashgar and Nepal, while the third, here described as new under the name *L. ovalior*, has been found outside the Manipur Valley only at Dimapur in the plains of Assam on the north side of the Naga Hills.

Small as is the number of species, they include so large a proportion of the true Indian *Limnaeae* that it will be worth while to discuss here as briefly as possible the species that occur in India proper, Assam and Burma, omitting those found only in the Himalayas or in the districts west of the Indus. A key to the species to be considered will form a suitable basis for discussion.

*Key to the species of Limnaea found in the Indo-Gangetic Plain,
Peninsular India, Assam and Burma.*

- I. Spire of shell narrow and tightly coiled, with the suture very oblique and the upper extremity of the body-whorl not or hardly broader than the penultimate whorl.
 - A. Apex sharply pointed; shell usually large or of moderate size, with at least 5 whorls; columellar fold coarse and strongly twisted ... *L. acuminata*.
 - B. Apex minutely rounded; shell small or minute; columellar fold much less strongly developed.
 - i. Shell less than 8 mm. high, very fragile, with only two whorls in the spire, which is very short; columellar fold narrow and not at all twisted... *L. mimetica*.

- ii. Shell as a rule more than 8 mm. high, not so fragile with the spire normal and consisting of at least three whorls; columellar fold twisted ... *L. shanensis*.
- II. Whorls of spire transverse and increasing rapidly in size; suture not markedly oblique; at least four whorls in spire; columellar callus very coarse and broad; columellar fold coarse.
 - A. Apical whorls of spire much narrower than others, forming a distinct apical process; penultimate whorl of shell much narrower than upper part of body-whorl, broader than height of spire ... *L. ovalis*.
 - B. Whorls of spire increasing in size evenly; penultimate whorl at least nearly as broad as upper extremity of body-whorl.
 - i. Shell almost symmetrical bilaterally and its outline forming a remarkably even broad ovate figure, with the base of the spire more than twice as broad as its height; umbilicus imperforate ... *L. ovalior*.
 - ii. Shell of elongate ovate form, with the spire relatively long and narrow and the body-whorl sub-cylindrical; umbilicus imperforate ... *L. luteola*.
 - iii. Shell varying greatly in outline but always opaque, with the suture much more impressed and more oblique than in the last two species; the umbilicus, though always completely occluded by the columellar callus, usually forming a narrow aperture visible on the dorsal surface ... *L. andersoniana*.

There is no genus amongst the Indian molluscs more liable both to individual variability and to plasticity in response to environment than *Limnaea*. The two phenomena are not always correlated in the same species and both differ greatly in degree in different species. Probably neither is ever completely suppressed. These facts make it difficult to assign specific limits to the numerous forms, and at the same time render it probable that the number of true species is small.

Various attempts have been made to solve the taxonomic difficulties involved in the study of the Indian Limnaeidae. The most successful in practice was that of the late Mr. G. Nevill,¹ but unfortunately he gave no arguments for adopting the course he followed. Von Martens² has discussed certain species in detail and has given admirable figures, but he had not seen by any means all the Indian forms. We have now been able to study *Limnaea* in relation to its environment in many parts of Peninsular India and the Indo-Gangetic Plain, on the North West Frontiers and at several places in Assam and Burma, and we believe that we have seen specimens of almost all the Indian forms to which specific names have been given and, with the exception of the Eurasian species of the Western Himalayas, have examined the natural surroundings of the great majority. This has given us confidence to discuss the species on broad lines, both from a geographical and a purely taxonomic point of view.

¹ *Hand List Moll. Ind. Mus.* I, pp. 232-234 (1878).

² *Conch. Mitth.* I, pp. 75-80, pls. xiv, xv (1881).

From a geographical point of view the Indian species fall naturally into four groups, which may be defined as follows:—

1. THE EURASIAN GROUP.—A small group of species found in the higher valleys of the Indus system in the Western Himalayas and consisting of species identical or almost identical with those of Europe.

2. THE AFGHAN GROUP.—Another small group, consisting of species that bear considerable resemblance to the *L. lagotis* and *L. peregra* groups of the Palaearctic Region. The range of this group extends from Afghanistan through the mountains west of the Indus in Indian territory and thence across the Perso-Afghan desert to Eastern Persia.

3. THE INDIAN PENINSULAR GROUP.—A group of three species with numerous phases, varieties and mutations. It occupies the whole of Peninsular India and the Indo-Gangetic Plain, and ranges eastwards to Burma and northwards into the Lower Himalayas east of the Indus.

4. THE BURMESE GROUP.—We know comparatively little about this group, which is probably of Chinese origin in the main. Its range probably extends from Upper Burma into Eastern Assam, but it occupies much territory in common with the Indian Peninsular group.

We are at present concerned with species in groups 3 and 4. The Afghan forms have recently been discussed by us in another volume¹ of the *Records* and the Eurasian forms have still to be compared in detail with their European representatives. Neither of these groups is found in any part of Assam.

We have stated our opinion that the Indian group consists of only three species, thus agreeing with Nevill (*loc. cit.*), but a large number of races, phases, varieties and aberrations have received specific names. The three species are *L. acuminata*, Lamarck, *L. ovalis*, Gray and *L. luteola*, Lamarck. The last has been called *L. succinea*, Deshayes, by some authors. We have to discuss here only *L. acuminata* and *L. ovalis*.

The Burmese group also comprises, so far as we are aware, only three species, viz. *L. andersoniana*, Nevill, *L. shanensis*, Annandale and *L. mimetica*, Annandale. The last is probably derived from the Indian *L. acuminata*, but the other two are probably of Chinese origin. We have here to discuss *L. andersoniana* and describe a highly peculiar new species from Assam, probably related to *L. ovalis*. The name we propose for it is *L. ovalior*.

Before discussing individual species in detail it will be as well to say something of the principles on which we have based their classification. We had hoped to find some diagnostic features in their anatomy and have examined the radulae and other internal organs of most of the Indian forms with this object in view; but we have been disappointed and are forced to the conclusion that shell-characters, provided that a sufficiently large number of indi-

¹ *Rec. Ind. Mus.* XVIII, pp. 39–52, pls. v–vii (1919).

viduals be examined, and due attention paid to the protoconch, form the most satisfactory basis for specific identification among the Indian species, among which conspicuous anatomical differences such as Baker¹ discovered in the North American Limnaeidae do not exist. Anatomical differences of course there are, but they are so minute, so difficult to find and above all so inconstant that they are of little use in taxonomy.

The radular teeth in all the Indian, Persian and Mesopotamian species we have examined conform to a type somewhat different from that described for any European species, differing in detail in the different forms, but vary greatly not only in accord with race and locality but also with individual idiosyncrasy, while small specific differences in the genitalia are liable to be obscured by the state of sexual activity, especially by protandry.

In the anatomy of the radula and genitalia the Indian Limnaeidae (omitting the Palaearctic Himalayan species) differ little from those referred by Baker to the Holarctic genus or subgenus *Galba*, Schrank, but the shell does not quite conform to this type. It is, indeed, of more than one type and *Limnaea acuminata* stands out very distinct in shell-characters from its congeners, and is more like *Galba* than the other species in our fauna.

Limnaea acuminata, Lamarck.

(Plate VII, figs. 1—3.)

- 1878. *Limnaeus acuminatus*, Nevill, *Hand List Moll. Ind. Mus.*, p. 233.
- 1881. *Limnaea acuminata*, von Martens, *Conch. Mitth.* I, p. 75, pl. xiv.
- 1915. *Limnaea acuminata* (in part), Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 106.
- 1919. *Limnaea acuminata* (with var. *nana*), *L. amygdalum* and (?) *L. chlamys*, Annandale and Prashad, *Rec. Ind. Mus.* XVI, pp. 140—142, figs. 3, 4, pl. iv, fig. 1, pl. v, figs. 1—3.

Preston, in the *Fauna of British India* has distributed the forms of *Limnaea* indiscriminately into subgenera and species and several of those he attributes to *L. acuminata* have, as von Martens had shown previously, no resemblance to it. We include in it here all the forms comprised in the species by Nevill and by von Martens, with the possible exception of *L. chlamys*, Benson. Of all the Indian freshwater Gastropods *L. acuminata* is the most liable to individual variability and it also exhibits considerable plasticity in response to environment. It is not surprising, therefore, that numerous names have been given to different "forms." Several of these (*patula*, Troschel, *rufescens*, Gray, *strigata*, Hanley and Theobald, *gracilior*, v. Martens) refer merely to shapes of shell that may be assumed almost anywhere in the normal environment of the species, i.e. in a pool of perennial water provided with abundant aquatic vegetation of a succulent nature

¹ *Spec. Pub. Chicago. Acad. Sci.* III (1911).

and situated in a tropical climate. In many spots, however, one or other of these forms may predominate and in some one or other may be absent. For example the form *gracilior* is far the commonest, though by no means the only one in the pond in the

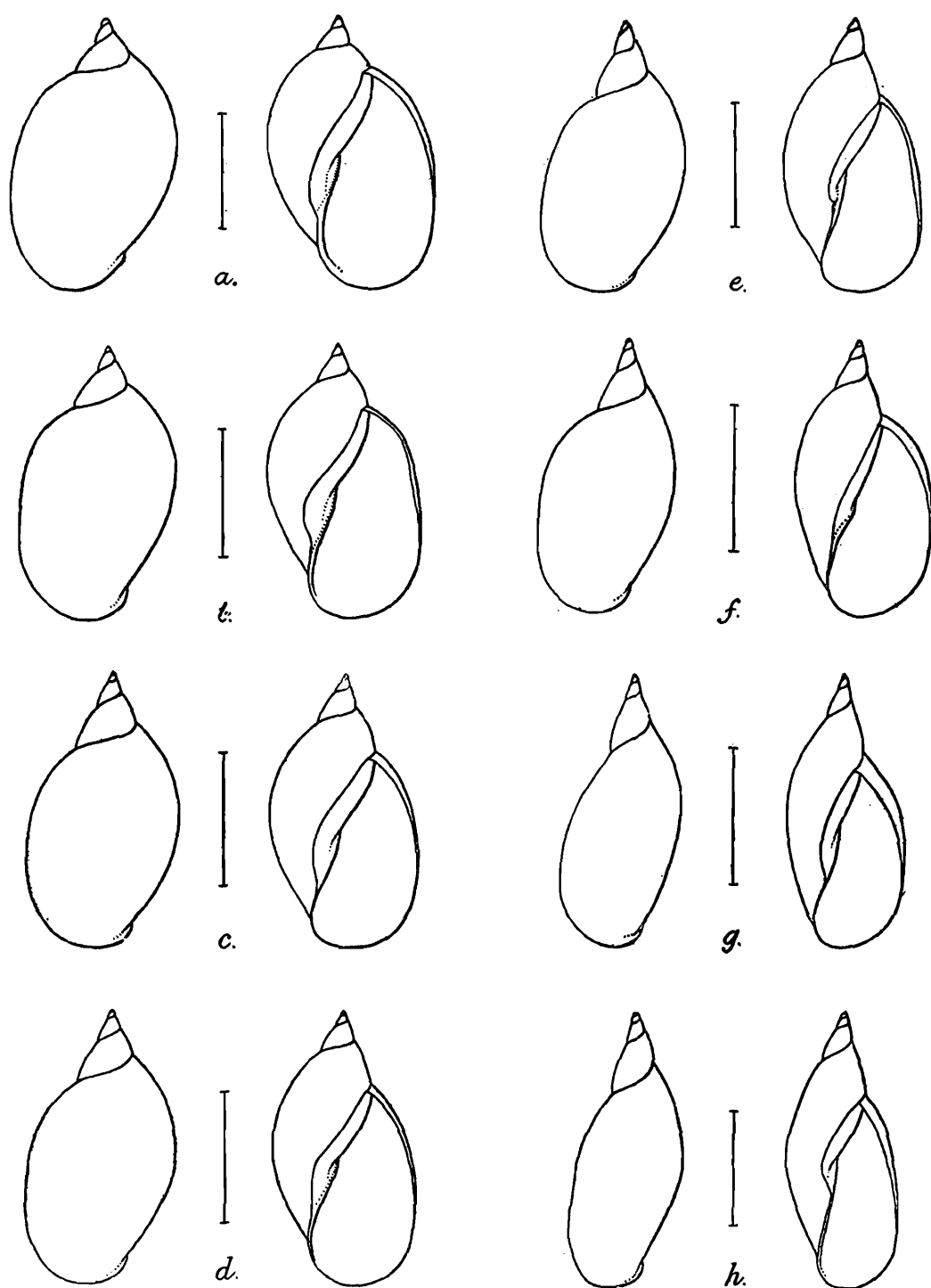


FIG. 12.—Series of shells of *Limnaea acuminata* from Manbhum, Bengal.

FIG. *a* may be taken to represent var. *patula*, Troschel and figs. *g* and *h* the var. *gracilior*, von Martens.

Museum compound, Calcutta, while no shell narrower than that of the form *rufescens* was found at any place in Manipur.

Other names again belong to phases associated with abnormal types of environment. The phase *nana*, Annandale and

Prashad, for instance, was described from a small ditch, liable to desiccation, in the Western Ghats and has since been found in a shallow pond at Rangoon. The phase *hians*, Sowerby, originally described from "Malabar," occurs, without much individual variation, in a swampy artificial lake situated at an altitude of 7,000 ft. in the Nilgiri Hills. A somewhat similar but more delicate phase, *ventricularis*, Küster, has been found in the Lake Nainital (altitude 6,400 ft.) in the Western Himalayas, and these two forms may probably be regarded as dwarfed mountain phases.

Differences in shell colour are probably correlated in most cases with differences in the water in which the specimens are found.

We are in some doubt about Benson's *L. chlamys*, which differs from all other forms of *L. acuminata* with which we are acquainted in the brilliant golden colour of its shell, the relative width of the body-whorl and its strong spiral sculpture. On the only occasion on which either of us has found *L. chlamys* it was discovered living in abundance on rocks covered with algae in an artificial reservoir in the hill-fort of Satara—a type of environment very unusual for *L. acuminata*. The specimens were small and rather narrow but exhibited the diagnostic characters clearly.

L. acuminata is common in the Manipur Valley, in which, however, we obtained no specimens of the extreme narrow type (*gracilior*, von Martens). Indeed the shells obtained showed less individual variability than in many districts and were for the most part of a type approaching the mean in shell form, neither very narrow nor particularly broad. No very large specimens were seen, and none that could be called dwarfed. The average size of shells was, however, distinctly smaller than usual. One or two points of interest may be further noted in detail as regards plasticity and aberration.

Our collection is from different parts of the Loktak Lake, from ponds, swamps and small bathing-pools and from a stream. The specimens from the Loktak Lake provide evidence of distinct but not extreme plasticity. If shells from clean beds of *Potamogeton* in the lake (pl. VII, fig. 2) be compared with those from its rather foul and swampy margin (pl. VII, fig. 1), the following differences are apparent:—(1) the shells from the open lake are in most instances distinctly smaller and have a shorter spire (see table of measurements) than those from the margin. In both series the colour is a deep chestnut brown, but those from the margin are coated externally with a black deposit. The shell in the latter is also a little thicker and the sculpture coarser and more regular.

The most characteristic series in our collection, however, consists of specimens from running water. These were found on floating grass-stems and among green filamentous algae in the small stream that runs past Potsengbam into the north end of the Loktak Lake. They occurred only at places at which the water was clean and deep and flowed fairly rapidly. The shells in this series are almost colourless and so thin and brittle that we found it difficult to secure perfect specimens. Their surface is deeply

but irregularly sculptured and may be described as coarsely malleated. The shells are narrow, with long spires but not of extreme type in shell-form. They are rather small. The animals in these shells were very pale in colour.

Two abnormal specimens may now be described. They were found together in a bed of *Potamogeton* at the point at which the main outflow leaves the Loktak Lake. One only differed externally from the majority found with it in its larger size. It is numbered A (1) in the table of measurements. We may note that its size was large only in comparison to other individuals found with it, for much larger individuals are common at some places. On dissection it was found that the body-cavity of this individual was occupied by a contorted mass of elongate filiform Trematode sporocysts, which completely surrounded the upper part of the genital system. All the genital glands were crowded together in a degenerate mass, while the female ducts could not be traced. The lower part of the vas deferens and muscular penis-sac with its retractor muscles were, however, intact.

The other abnormal specimen (pl VII, fig. 3) was peculiar in shell-form. It was remarkable for the very small size of its spire and the relatively great length of the aperture of the shell. The interesting feature of this abnormality (or ? mutation) is that the peculiarities in shell-form are among those commonly found in lacustrine species and phases of the genus. The shell, however, had not all the characteristics of such forms as it was no paler, thinner or smaller than those taken with it.

Measurements of Shells (in millimetres).

	A		B		C		D		E		F	
	1	2	1	2	1	2	1	2	1	2	1	2
Length ...	34.2	16.4	22	18.9	27.2	24.4	25.9	22.1	21	21.5	12.4	13.1
Breadth ...	19.3	9.7	13.9	11.4	16.3	14.5	15.7	12.6	11.9	13.3	6.9	7.8
Length of aperture ...	27.8	15	18.4	15.3	21.2	19.6	20.6	17.1	16.3	17.2	9.6	10.9
Breadth of aperture ...	15.1	8.2	11.5	9.4	12.8	12.1	14.2	9.8	1.4	10.3	5.8	6.5
Length of spire (dorsal view).	5.3	1.4	3.4	3.1	5.4	3.7	4.6	5	3.9	3.6	2.5	2.2
Breadth of spire (dorsal view).	8	2.7	4.3	4.2	6.5	5.6	6.1	5.4	4.7	4.5	3.1	2.8

- A. A small channel south of Thanga Island with bed of clean *Potamogeton* abnormal specimens; (1) is the large specimen and (2) the short-spined form.
 B. Same locality (normal individual).
 C. Swamp at Thanga Island in the Loktak Lake.
 D. Small muddy bathing pools Thanga Island.
 E. Potsengbam, northern end of the lake.
 F. Amingaon, near Gauhati, Assam.

Limnaea ovalis, Gray.1878. *Limnaeus ovalis*, Nevill, *op. cit.*, p. 233.1881. *Limnaea ovalis*, von Martens, *op. cit.*, p. 81, pl. xv, figs. 1-4, 8, 9.

This species is much less variable but more sporadic in occurrence than *L. acuminata*. One adult and two young specimens were found at Chigi Turel on the Chugnu Road in Manipur by Mr. Sunder Lal Hora in a small shallow channel of water. The adult specimen is not quite typical but may be described as intermediate between those figured as var. *prunum* and var. *nucleus* by von Martens in the paper cited. It is, however, smaller than either, its height being 19.5 mm. and its maximum diameter 12.1 mm. It is of a dull opaque purplish brown colour and rather thick.

L. ovalis has been found at various localities in the Ganges Valley and also at Golconda in Hyderabad (*Annandale* and *Kemp*). It is often abundant where it occurs. It has been recorded, doubtfully, from Assam and with less doubt from the lake country of Kumaon in the Western Himalayas, but not from Burma.

Limnaea ovalior, sp. nov.

(Pl. VII, figs. 4-6.)

The shell is of moderate size and thickness, of a very regular and symmetrical oval shape, of a bright chestnut brown colour and unusually opaque when quite fresh and clean. It is about $1\frac{1}{2}$ times as high as broad. The spire is short and blunt, consisting of $3\frac{1}{2}$ or 4 whorls and never occupying more than about $\frac{1}{4}$ of its total height. The spiral of the first $2\frac{1}{3}$ or 3 whorls is transverse, but above the basal whorl of the spire it becomes oblique and above the body-whorl still more so. The suture is impressed round the terminal whorls of the spire, but much less so above the two last whorls of the shell and the upper part of the whorls is not at all shouldered or angulate. The whorls increase in breadth rapidly and the basal whorl of the spire is nearly as broad as the upper part of the body-whorl. The latter is very regular in outline and dorsally is about $1\frac{1}{3}$ times as long as broad, its anterior extremity is evenly rounded and very little expanded. The aperture is long and rather narrow, extending for about $\frac{7}{10}$ the height of the shell; it has an auriculate outline, is sharply pointed above and very little oblique. The outer lip is sharp and evenly arched. The umbilicus is completely occluded by the columellar callus, which is broad, coarse and high, extending to the outer lip above and at its outer extremity covered over by it. The columella is short and twisted and nearly straight as a whole. The sculpture consists of fairly regular fine, slightly curved longitudinal ridges, some of which, probably representing the growth-periods, are coarser than others. They are barely visible to the naked eye. The profile of the external surface is moderate.

Shells from Dimapur, Assam, are a little smaller, narrower and less symmetrical than those from Manipur.

Measurements of Shells (in millimetres).

	A	B	C
Length	17.4	15.2	16.1
Breadth	11.5	10	10.8
Length of aperture	12.3	11.1	11.6
Breadth of aperture	7.4	7.2	7.4
Length of spire (dorsal view)	4.2	2.6	3.3
Breadth of spire (dorsal view)	6.5	5.1	6.4

All the above specimens are from a swamp at Thanga Island in the Loktak Lake.

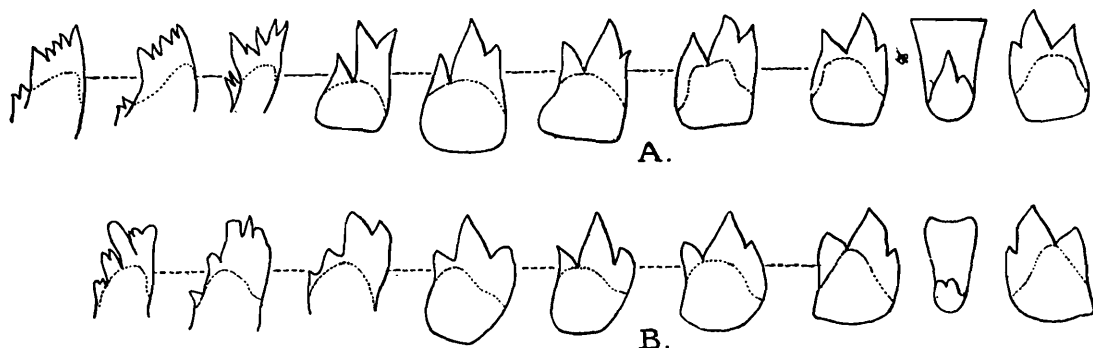


FIG. 13.—Radular teeth of *Limnaea*.

A. *L. ovalior*, Annandale and Prashad.

B. *L. andersoniana*, Nevill.

The animal is of unusually dark colour with the mantle black, unspotted or with faint and relatively small round spots, and with pale margin. As in all Indian species examined by us, the tentacles seem to be shorter than those of some European forms. The cephalic lobes are large and broad and the foot is comparatively small, bluntly pointed behind and somewhat expanded at the antero-lateral angles. The eyes are small.

The mouth is small and the upper jaw stout, semicircular and black. The lateral pieces are slender but well cornified and dark in colour. The radula is short and broad, narrowing abruptly in front and rounded at the tip. The whole buccal mass is relatively small. The dental formula is approximately 19.12.1.12.19. The lateral and marginal teeth are well differentiated and the latter have a deep yellowish tinge. The cusp of the central is stout and relatively large, with a distinct lobe on the right side. The laterals are distinctly tricuspid, but the entocone is much shorter than the other cusps and is apt to be concealed by being turned in under the mesocone. The mesocone and ectocone are long and sharp. The laterals are unusually stout. They are multicuspid

with the outer and inner cusps larger than the others. Their bodies are long, narrow and oblique.

The oesophagus is long and narrow, the gizzard large and powerfully developed, occupying the greater part of the stomach. The genitalia do not differ materially from those of other Indian species. The penis-sheath is large and sausage-shaped, pigmented and of a greyish colour. The spermatheca, which is full of spermatozoa in specimens examined, is pyriform and possesses a duct about half as long as itself.

Type-specimens.—M 11717/2, Zool. Surv. Ind. (*Ind. Mus.*).

Locality, etc.—This species was found in fair abundance in a drying peat-swamp on the east side of the Loktak Lake, Manipur, in February, 1920. It leads an almost amphibious existence in and on the damp mud at the edge of buffalo-wallows and other small pools. There is no true aquatic vegetation in its haunts and it appears to feed on mud and decaying vegetable matter. A specimen was found to be heavily parasitized with sporocysts and cercariae, but unfortunately all those brought living to Calcutta for examination died on the way. Specimens were also obtained in a pool of very foul water in the jungle near Dimapur, Assam.

There can be little doubt about the affinities of *L. ovalior*, which is evidently no more than a final link in the chain of evolution of which *L. andersoniana* with its diverse phases is the predominant component. We will discuss this point further when dealing with that species.

Limnaea andersoniana, Nevill.

(Pl. VIII, figs. 1—6.)

1908. *Limnaea (Gulnaria) simulans*, Preston, *Rec. Ind. Mus.* II, p. 49, fig. 6.

1918. *Limnaea andersoniana*, Annandale, *Rec. Ind. Mus.* XIV pp. 106, 149, figs. 4a, 4b.

In his original description of *L. andersoniana*, as one of us has pointed out in the paper cited, Nevill included, in addition to the central Asiatic form he later recognized as distinct, two that at first sight appear rather different. The view that these represent respectively a pond and a stream phase of a single species is fully borne out by recent observations in Manipur and eastern Assam, in which *L. andersoniana* is abundant. Further particulars may, therefore, now be given.

The *forma typica* of the species, as represented by Nevill's type-specimen (pl. VIII, fig. 1) from Nantin in Yunnan, has a small, rather fragile shell of a pale brownish colour and an ovoid form. The spire is acuminate and exserted, but by no means long. There are $4\frac{1}{2}$ whorls and the spiral is moderately oblique. The suture is impressed and the upper extremity of each whorl is narrowly flattened outside it. The lowest whorl of the spire is much narrower than the body-whorl and is situated on its inner

side. The body-whorl is relatively long and somewhat oblique, about $1\frac{1}{2}$ times as high as broad; its inner outline is distinctly sinuate and its anterior extremity is somewhat narrowly rounded and a little expanded. The channel leading to the umbilicus can be seen from the dorsal view. The ventral surface and the aperture are in every respect very like those of *L. ovalis* and *L. ovalior*, except that they are narrower. The sculpture is very like that of *L. ovalior*, but a little more regular. The height of the type-specimen is 10 mm., the minimum diameter 6.4, the height of the spire 2.5, that of the mouth 7.3 and the maximum diameter of the mouth 4.5 mm.

This description would apply equally well to shells from ponds at Imphal in Manipur, except that they are a little larger and the body-whorl is a little broader. Shells from ponds in the Yawngwe Valley in the Southern Shan States resemble the type-specimen even more closely. Shells from a pond at Dimapur in the plains of Assam immediately north of the Naga Hills show greater individual variation. In some the difference consists merely in an almost imperceptible reclination of the expansion of the anterior margin and a slight broadening of the penultimate whorl. In others, however, which are invariably larger, the spire is decidedly shorter and broader and the body-whorl broader and more oblique. These shells form a connecting link between *L. andersoniana* and *L. ovalior*. We will discuss the conditions in which they were living shortly.

The great majority of Nevill's specimens from Yunnan (including shells from the same locality as the type-specimen) and also one examined by him (and a number examined by us) from the Southern Shan States, represent the other phase hitherto unrecognized, differing in their smaller size, longer and narrower spire, narrower aperture and body-whorl. In other words their spiral is more tightly coiled and they are reduced in size. Specimens from a small muddy stream in the Yawngwe Valley closely resemble these shells.

Shells from a hill-stream with clear water running rapidly over a stony bed near Bishenpur on the west side of the Manipur Valley represent yet a fourth phase. They are still narrower than those from the Yawngwe stream, of more fragile structure and of a rich golden brown colour. Some of them are also considerably larger. Shells, however, from the same and adjacent streams a little lower down, after they have reached the valley, and from rice-fields irrigated from those streams, agree precisely with the Yawngwe phase.

There can, therefore, no longer be any doubt that *L. andersoniana* is a polymorphic species and that its various forms are correlated with different types of habitat. It is possible to recognize four phases, for which it will be convenient to have names, though there is no reason why these names should not be English. We will give a synopsis of the phases and the circumstances in which they have been found.

Phase I (INTERMEDIATE) (pl. VIII, figs. 2-5).—This phase was found in a fairly large swampy pond, evidently connected with a small stream in the rainy season, at Dimapur and in several ponds at Imphal, Manipur, in February and March, 1920. The ponds were well supplied with submerged aquatic vegetation but the molluscs were most abundant (at Dimapur) in a half isolated pool with no vegetation of the kind and evidently forming part of the bed of a sluggish stream for part of the year. They were pairing and ovipositing in March, i.e. some months before it is probable that the stream would be running. In these conditions greater individual variability occurred than among individuals living (at Imphal) amongst dense vegetation in permanent ponds. Imphal (2,600 ft.) is probably situated at a somewhat higher altitude than Dimapur.

This phase, as we have pointed out above, is a connecting link between *L. ovalior* and *L. andersoniana*. Many individuals of it come rather close to the former species, but all are much smaller, have the body-whorl less inflated and the penultimate whorl rather broader. The sculpture is also less coarse and more regular. The shell is usually broader than in the next phase and capable of growing larger.

PHASE II (POND PHASE) (pl. VIII, fig. 1).—This is the *forma typica* of the species and has been found both in Yunnan (in unknown circumstances) and also in ponds full of submerged vegetation in the Southern Shan States, at altitudes of 3,000 feet or over. The shell is narrower and as a rule more fragile than in the former phase. Similar but slightly broader specimens occur in pools at Imphal.

PHASE III (STREAM PHASE).—Specimens have been found in muddy spots at the edge of streams in the Southern Shan States and in the Manipur Valley, also in rice-fields irrigated from the same streams; and in unknown circumstances in Yunnan, Kashgar and Nepal at altitudes between 2,600 and 5,000 feet. They occur, often in large numbers on bare mud in an entire absence of phanerogamic vegetation. The shell is considerably narrower and usually smaller than in the preceding phases, rather thicker and duller in colour. This phase has been described by Preston under the name *Limnaea simulans*.

PHASE IV (HILL-STREAM PHASE (pl. VIII, fig. 6).—Specimens of this extreme phase were collected in a hill-stream near Potsengbam on the west side of the Manipur Valley. The stream has a rapid current, very clear water and a bottom of small pebbles and stones. The specimens of *Limnaea* were found attached to the pebbles in a shady area along the banks. The shell of these specimens is still narrower and more elongate than in the preceding phase, with the spire smaller and less regular, and the callus less indistinctly marked; the mouth is narrower and more pointed. The shell itself is paler and more polished.

Measurements of Shells (in millimetres).

	Intermediate Phase.		Stream Phase.		Hill-stream Phase.
	1	2	1	2	
Length	15'6	12'9	11	10'2	11'5
Breadth	10'7	8	6'2	5'6	6
Length of aperture	11'3	8'4	6'4	6'1	7'1
Breadth of aperture	6'7	4'7	4'9	3'4	3'7
Length of spire (dorsal view)	3'8	3'6	3'6	3'3	3'4
Breadth of spire (dorsal view)	5'6	4'4	3'4	3'1	3'6

We figure the radula (fig. 13, B) of a specimen of the intermediate phase from Dimapur, Assam.

Family PLANORBIDAE.

As the Manipur Valley is rich in species of this family, and as representatives of all the main Indian types occur in it, we have taken the opportunity to carry out, so far as our present knowledge permits, a generic revision of the Indian species.

This revision has had interesting results from a morphological point of view, for it shows that branchial structure and shell-form are not necessarily correlated. In our new genus *Indoplanorbis*, which has a typical discoidal shell, the branchial process is folded, while both in the other Indian genera with shells of the same type and in *Camptoceras*, the shell of which is more or less *Physa*-like, the process is simple as in *Planorbis*, s.s. The contribution we are now able to make to the anatomy of Benson's peculiar genus leaves no doubt that Walker¹ was right in assigning it to the Planorbidae and that its resemblances to the Ancyliidae, on which we previously² laid stress, are hardly more than superficial.

I. Shell flat and discoidal (Planorbiinae). Anal siphon incomplete.

A. Shell relatively large and thick with the whorls convex above and below, both animal and shell clearly sinistral. Penis without a horny stylet.

i. Young shell not as a rule *Physa*-like, animal with a simple branchial process. Radula long and narrow, the cusps of the teeth thin and set on a lower level than their bases. Penis short and swollen when retracted, asymmetrical; penis sheath, with a thick-walled preputium, two retractor muscles present

Planorbis.

ii. Young shell *Physa*-like. Branchial process lobed. Radula relatively large and broad, with the tips of the cusps of the teeth no thinner than the

¹ *Occ. pap. Mus. Zool. Univ. Michigan*, No. 64 (1919).

² *Journ. As. Soc. Bengal* XIV, p. 457 (1919).

- bases. Penis long, a simple cylindrical tube; penis-sheath similar, no retractor muscle ... *Indoplanorbis*.
- B. Shell thin, as a rule small, if more than 1 cm. in maximum diameter with the whorls flattened below. Branchial process simple.
- i. Shell always less than 1 cm. in diameter, apparently dextral (though the animal is sinistral), with the whorls convex above and below but flattened as a whole, usually with a peripheral keel. Radula like that of *Planorbis*. Penis relatively long, provided with a horny stylet; preputium of complicated structure; a single retractor muscle present ... *Gyraulus*.
- ii. Shell small or of moderate size, flattened below, without internal teeth or folds. Radula extremely small with minute teeth; laterals twinned. Penis relatively short and stout without a horny stylet ... *Hippeutis*?
- iii. Shell small, resembling that of last genus but usually with hard enamel-like vertical ridges. Radula as in *Gyraulus* but with the lateral and marginals more numerous. Penis long and narrow, asymmetrical with horny stylet; penis-sheath with a pair of lateral lobes at its upper extremity; preputium well developed with a single retractor muscle... *Segmentina*.
- II. Shell ovate or almost cylindrical, sinistral (Bullininae). Shell small and thin, elongate, with the suture remarkably broad, deep and oblique. Animal with a simple branchial process, and a well developed left epipodial leaf-like lobe, which can be spirally coiled to form a complete anal funnel. Radula like that of *Gyraulus* but with broader denticulations on the teeth. Penis broad and stout, without a stylet ... *Camptoceras*.

Indoplanorbis, gen. nov

1915. *Planorbis*, Preston, *Fauna. Brit. Ind. Freshw.-Moll.*, p. 115.

The adult shell is relatively large and thick and closely resembles that of *Planorbis* (s.s). The whole is discoidal, but the whorls are convex and the suture deeply impressed. The aperture is ear-shaped, with the broader end (morphologically the lower extremity) uppermost when the shell is held with the mouth on the left. The young shell resembles that of *Physa* and is ovate, with the upper extremity flattened and the lower somewhat pointed, the spire being nearly flat.

The animal is sinistral. Its foot is relatively broad and short, leaf-shaped, broadly rounded in front and pointed behind. The head is very broad and has its lower margin expanded and flattened. The tentacles are elongate and filiform. The eyes lie at the inner base of the tentacles and are completely sessile. The mouth opens on the lower surface of the head in front of the foot.

The jaw is narrow and has lateral pieces of the usual type. The radula is broad having more than 20 longitudinal rows of marginals. The central is relatively large and bicuspid. The laterals are tricuspid, short and broad; the free lobe equals the base in length. They closely resemble those of *Limnaea*. The transition between the tricuspid laterals and the pectinate margin-

als is gradual. The denticulations of the teeth are not separated by any sharp line of division from the free lobe, but the whole structure is continuous as in *Limnaea*.

The genital aperture, which is situated some distance behind the left tentacle, is slit-like and relatively large. The vas deferens opens directly without invagination into an elongate cylindrical eversible penis with a bulky lumen. This organ is slender, tubular and of considerable length, extending practically to the end of the penis-sheath when contracted. Its orifice is circular and symmetrical. It is similar in form to the penis-sheath, which is a long, somewhat curved, thin-walled tube. There is no retractor muscle. The whole apparatus is, therefore, much less complicated than any of the types recognized by Simroth. There is no penial stylet. The female genitalia are of the usual type.

Type-species. — *Planorbis exustus*, Deshayes.

This genus differs from the true *Planorbis* of Müller (with the European *P. cornuus*, Linn., as type-species)

in the structure of the branchial process, the radula and the genitalia. The shell also has a characteristic facies, although it is difficult to formulate the differences precisely. The shape of the aperture is noteworthy. The branchial process apparently resembles that of *Bullinus*¹ and *Miratesta*,² while the radular teeth are not unlike those of the subgenus *Galba*³ of the genus *Limnaea*.

As Mons. L. Germain shows in his catalogue of the Planorbidae in the collection of the Indian Museum (now in the press) all of the larger discoidal shells of the family from the Indian Empire that are preserved in the collection belong to *Planorbis exustus*, Desh., the type-species of our new genus. A consider-

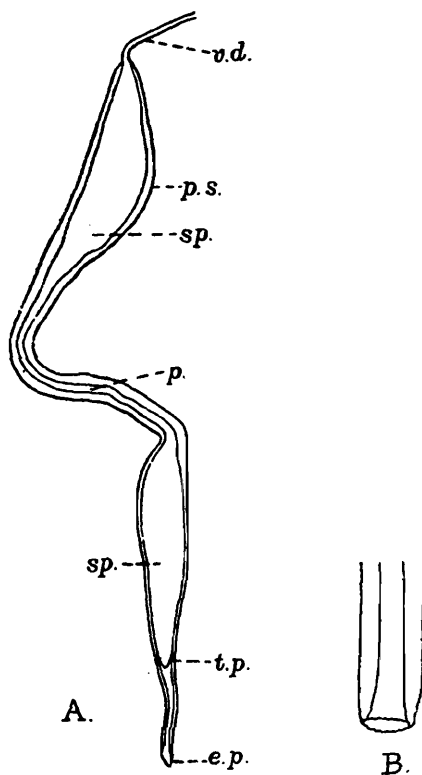


FIG. 14.—A. Penis and end of vas deferens of *Indoplanorbis exustus* (Deshayes).

e.p. external opening; *p.* penis; *p.s.* penis sheath; *sp.* sperm duct; *v.d.* vas deferens.

B. Terminal part of the male duct of *I. exustus*.

¹ Pelseneer, *Mollusca*, in Lankester's *Treatise on Zoology*, p. 186, fig. 175 (1906).

² P. and F. Sarasin, *Sussw. Moll. Celebes*, pp. 72-77, figs. 165, 166.

³ Baker, *Chicago Acad. Sci. Spec. Pub. No. 3*, p. 199 (1911).

able number of specific names have been given to varieties and phases of *I. exustus* and we believe that all those forms, assigned to *Planorbis* (s.s.) by Preston are really synonymous, with the possible exception of *P. hindu*, Clessin. As to this form nothing is known beyond the original description and figure, and we doubt whether it is really Indian. There is, therefore, at present no evidence for the occurrence of the true *Planorbis* in India.

Distribution of the Genus.—The type-species occurs not only throughout the plains of the Indian Empire east of the Indus, but also in Siam, the Malay Peninsula, French Indo-china and Sumatra, whence we have recently examined numerous specimens.

Indoplanorbis exustus (Desh.).

- 1834. *Planorbis exustus*, Deshayes, *Voy. Bell. Indes Orient. Zool.*, p. 417, pl. i, figs. 11-13.
- 1836. *Planorbis indicus*, Benson, *Journ. As. Soc. Bengal* V, p. 743.
- 1856. *Planorbis coromandelicus*, Clessin, *Mart. Chemn. Conch.-Cab., Limnaeacea* XVIII, p. 43, pl. vi, figs. 14-16, 20-22.
- 1918. *Planorbis exustus*, Annandale, *Rec. Ind. Mus.* XIV p. 111, pl. xi, figs. 1, 1a.

In the paper cited above, one of us referred to *I. exustus* as an example of a species which, comparatively speaking, was neither variable nor plastic. When series from many different habitats are examined it becomes evident that this statement should have been qualified by some such phrase as "in normal circumstances." Specimens from ordinary ponds and swamps in India, Siam and Sumatra are very much alike, but those from pools subject to great changes in physical conditions or containing water of very abnormal chemical composition respond readily in peculiarities of shell-structure. In the collection belonging to the Indian Museum Mons. L. Germain has found a number of peculiar phases, some of which he has described as varieties.

An instance has recently come under observation in which a distinct seasonal change has been noted in the shells found in a certain pool situated on a small island and liable to considerable vicissitudes. This pool, which lies in the middle of Barkuda, a rocky island in the Chilka Lake, is a small artificial pond dug in the rock. In the latter part of the rainy season and for some time after it, roughly from the middle of July to December, it contains from 12 to 15 feet of water which is only very slightly brackish and remains fairly cool, but by April has sunk to a small puddle of saline water heated by the sun to a high temperature. The early showers which precede the monsoon in May and June fill up the pond again, not of course to its level in the rainy season, but sufficiently to give a depth of 4 or 5 feet of water and to reduce the salinity very considerably. The pond has no visible aquatic vegetation at any season, but *I. exustus* and a form of *Limnaea luteola* abound on the mud with which its rocky basin is deeply covered. Specimens of the Planorbid taken in August are fairly

normal, but rather small. The measurements of a large shell are $14 \times 11 \times 6$ mm. The colour, when the shell is clean, is a deep uniform chestnut brown, but the surface is usually covered with a black deposit. The aperture is often somewhat contracted and shows a slight tendency to be irregularly folded round the margin, and the vertical sculpture, though by no means strong, is rather irregular. The animal is apparently quite normal.

The shells taken in the middle of April are considerably smaller, the measurements not exceeding $11 \times 9.5 \times 5$ mm. The older part is like that of individuals collected in summer, but the younger part of the body-whorl, often for a length of at least 6 mm. is distinctly abnormal. In this region the shell is very thin, strongly and irregularly sculptured and often somewhat eroded on the surface and as a rule much distorted round the aperture, which is sometimes thrown into strong folds. At this season the soft parts are also abnormal. A greater part of the animal is as a rule protruded from the shell than is usual, and the mantle seems to have shrunk in such a way that the siphon and the branchial process, which is very large, are often completely exposed. The tentacles also are as a rule strongly clavate, having an oval swelling at the tip which, as its tip is densely pigmented, has much the appearance of an eye. Major R. B. S. Sewell has kindly examined specimens of these abnormal tentacles. He finds in the tissues of the swollen tips numerous individuals of a parasitic Protozoon, probably a Gregarine. Specimens taken at the beginning of June had again become normal both as regards their shell and in their soft parts. The tentacles were no longer clubbed and were free from parasites.

At least five factors may enter into the question of the origin of these changes in the shell and soft parts of *I. exustus*, namely (1) changes in the salinity of the water, (2) abnormally high temperature, (3) restricted space, (4) restricted food supply, and (5) parasitism. The production of clavate tentacles is clearly due to the last, but probably the abnormal structure of the youngest part of the shell in April is due mainly to the first two.

I. exustus is common all over the Manipur Valley, in ponds, swamps, sluggish streams and in the Loktak Lake. Specimens are for the most part normal, all the shells are of a deep chestnut brown colour when clean. Some very large specimens with the vertical ridges strongly but not excessively developed and the central region deeply depressed both above and below, were found in small artificial bathing-pools devoid of visible vegetation at the edge of the swamp to the east of the Loktak Lake. The measurements of one of these are $20 \times 16.5 \times 8.2$ mm.

Anatomy.—The foot of *I. exustus* when fully expanded is leaf-shaped, not more than twice as long as broad, very broadly rounded or subtruncate in front and bluntly pointed behind. The head is broad and short, it has an expanded and flattened lower margin and is convex above. The tentacles are not very long and are filiform. The eyes are entirely sessile and lie close to the inner

base of the tentacles. The edge of the mantle is somewhat thickened and the left epipodial lobe is well developed to form an ear-shaped incomplete funnel or pulmonary siphon. Lying externally and posterior to the siphon a secondary pallial branchial process projects outwards and backwards. When fully expanded this process is elongate, band-shaped and bluntly pointed. In longitudinal section it would be coarsely

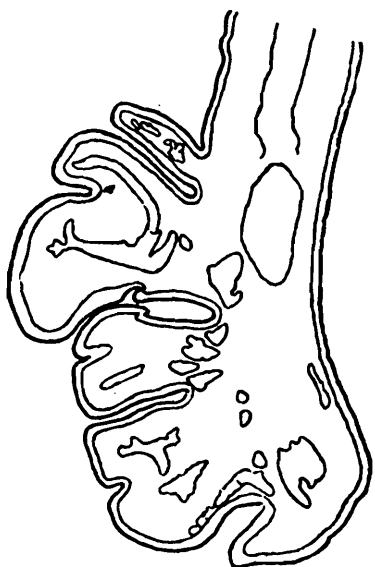


FIG. 15.—Longitudinal section of the secondary branchial process of *Indoplanorbis exustus* (Deshayes).

and strongly sinuate owing to alternate convexities and concavities on its surface. When contracted it has the appearance of a strongly pleated or folded foliate body; in some cases the pleats are large and appear like lamellae.

In the radula there are about 75 longitudinal rows of teeth with the approximate dental formula 26.12.1.12.26. The external marginals are, however, very ill-developed and the transition between the outer laterals and inner marginals is so gradual that

it is difficult to fix the point of separation. The free lobe of the central is large and bilobed. Its base is relatively long and narrow. The marginals have their cusps long, stout and sharp. In other respects the teeth do not offer any peculiarities beyond those noticed in the generic description.

Gyraulus, Agassiz.

1837. *Gyraulus*, Agassiz, *De Charpentier Cat. Moll. terr. fluv. Suisse; Neu. Deu. Schw. Ges. Nat.* I, p. 21.
1919. *Gyraulus*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 52.

We have nothing to add to our recent account of the genus, except that Benson's species *Planorbis cantori* is not a *Segmentina*, as Preston thought, but belongs to this genus.

***Gyraulus convexiusculus* (Hutton).**

1919. *Gyraulus convexiusculus*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 52-54, figs 5E, 7a, 8b.

In the Manipur Valley the species is not so common as it is in other parts of India; and seems to be replaced to a large extent by *G. cantori*.

The only specimens collected in the valley are from a shallow pond in front of the Residency at Imphal and an artificial tank at Mingyang Pukri in the same town.

Gyraulus cantori (Benson).

1850. *Planorbis cantori*, Benson, *Ann. Mag. Nat. Hist.* (2) V p. 349.
 1876. *Planorbis cantori*, Hanley and Theobald, *Conch. Indica*, p. xviii,
 and p. 18, pl. xl, figs. 1-3.
 1878. *Planorbis* (*Segmentina*) *cantori*, Nevill, *Hand-list Moll. Ind.*
Mus. I, p. 246.
 1915. *Planorbis* (*Segmentina*) *cantori*, Preston, *Faun. Brit. Ind.*
Freshw.-Moll., p. 126.

Benson in his original description of the species specifically mentions partitions or lamellae within the shell; these like the ones described by the same author in another species (*Planorbis umbi-*

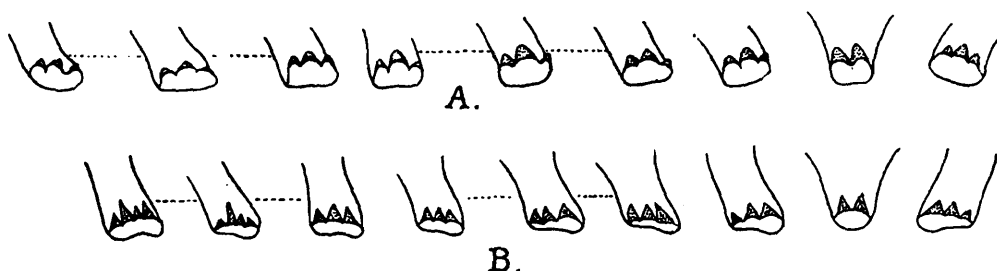


FIG. 16.—Radular teeth of Planorbidae.

A. *Gyraulus cantori* (Benson).

B. *Hippeutis* (?) *umbilicalis* (Benson).

lialis) are not to be seen in the specimens which we assign to this species. It appears likely that Benson mistook external furrows of the shells for internal septa. In other respects our specimens agree closely with his description and with Hanley and Theobald's figures of this species. The shell closely resembles that of *G. euphraticus* but is still more depressed and flattened and has an even stronger peripheral keel.

The animal resembles that of a true *Gyraulus* in all respects. The branchial process consists of a large and well-developed leaf-like pallial outgrowth in continuation of the left epipodial lobe. It is thick and highly vascular. The pulmonary siphon, which is just internal to the branchial process, is not well developed, and is formed by the epipodial lobe itself.

The radula has the dental formula 9.8.1.8.9. The central tooth is bicuspid as other species, but the cusps are rather large and pointed. The lateral teeth are tricuspid with the cusps resembling those of the central. The

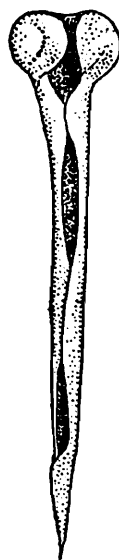


FIG. 17.—Penial stylet of *Gyraulus cantori* (Benson).

marginals differ from those of *G. convexiusculus* described in a previous paper ¹ in having only three or at the most four cusps.

The genitalia resemble those of *G. convexiusculus* (*loc. cit.*) in all essentials. The stylet, however, is better developed and near the tip has the margin on one side produced into a distinct triangular flap. This is one of the common species of Planorbidae in the Manipur Valley and was collected in large numbers in the Loktak Lake, and in the streams and swamps surrounding the lake.

Hippeutis, Agassiz.

1837. *Hippeutis*, Agassiz, *op. cit.*, p. 22.

1886. *Hippeutis*, Clessin, *op. cit.*, p. 34.

The shell of *Planorbis umbilicalis*, Benson, as Bavay and Dautzenberg ² have observed, agrees in generic type with that of the European species of *Hippeutis*, of which *Planorbis fontanus*, Lightfoot, is the type.³ We have been unable to find any account of the anatomy of this mollusc and cannot therefore be certain as to the generic identity of the form here discussed. In both radula and soft parts it differs very widely from the Indian species of *Segmentina* and *Gyraulus*, which agree, at any rate in the genitalia, with *S. nitidus* and *G. albus*, respectively the type-species of the two genera.

In shell-characters *Planorbis caenosus*, Benson, closely resembles *H. umbilicalis*, and the two species are probably congeneric, as also appears to be the case with *Planorbis indicus* of the same author. In the account of the Fauna of the Inle Lake ⁴ an unfortunate confusion between *caenosus* and *trochoideus* has occurred. The latter is certainly a *Segmentina*, while the shell of the former has no internal ridges and, as stated above, is probably a *Hippeutis*.

Hippeutis (?) umbilicalis (Benson).

1837. *Planorbis umbilicalis*, Benson, *Journ. As. Soc. Bengal* V, p. 471.

1876. *Planorbis umbilicalis*, Hanley and Theobald, *Conch. Indica*, p. xviii, p. 18, pl. xl, figs. 7-9.

1878. *Planorbis* (*Segmentina*) *umbilicalis*, Nevill, *op. cit.*, p. 246.

1886. *Planorbis umbilicalis*, Clessin, *op. cit.*, p. 136, pl. xv, fig. 6.

1910. *Planorbis* (*Hippeutis*) *umbilicalis*, Bavay and Dautzenberg, *Journ. Conchyliol.* LVIII, pp. 18, 19.

1915. *Planorbis* (*Segmentina*) *umbilicalis*, Preston, *op. cit.*, p. 125.

No septa are to be seen in the large number of both young and very large specimens of this species in the collection. The shell in other respects closely agrees with Benson's original description and the excellent figures of the species in Hanley and Theobald's work.

The external soft parts generally resemble those of *Gyraulus*

¹ *Rec. Ind. Mus.* XVIII, p. 54, fig. 8B (1919).

² *Journ. Conchyliol.* LVIII, pp. 18, 19 (1910).

³ See also *Journ. Linn. Soc. London* XXXIV p. 213 (1920).

⁴ *Rec. Ind. Mus.* XIV, p. 113; also in *Rec. Geo. Surv. Ind.* L, p. 219.

except that the branchial process and the pulmonary siphon are a little better developed.

The radula is very minute with the dental formula approximately 14.12.1.12.14. The central tooth is comparatively large and bicuspid with sharp cusps. The laterals and marginals both have a peculiar twinned structure, and the line of demarcation between the laterals and marginals is not very sharp. The laterals are tricuspid, the central cusps being much the largest.

The male genitalia generally approximate to Simroth's Typus I,¹ but differ in details. The vas deferens is very long and coiled. The penis-sac is a well developed ovoidal structure with an elongate tubular preputium in continuation of the sac. The penis is massive with a lateral opening and without any stylet.

H. umbilicalis was originally described from Sylhet, Assam, but has also been recorded from Bengal in the plains of the Ganges system; it is, however, a scarce species in India proper. In the Manipur Valley it is the most abundant Planorbis, occurring in the Loktak Lake and in ponds and swamps amidst dense vegetation. In the dry swamp east of the Loktak Lake large numbers of shells, not long dead, were found in little damp pockets under masses of peat. They had evidently migrated there in hundreds as the swamp dried up.

The largest shells obtained in Manipur are from Looshipat, where they were found attached to long grass-blades in ponds with dirty water. One of them is 9.8 mm. in maximum diameter, 8.3 mm. in minimum diameter and 2.9 mm. in height.

Segmentina, Fleming.

- 1817. *Segmentina*, Fleming, *Conchology* in De Brewster's Encyclopedia, 7th ed., VII.
- 1878. *Planorbis* subgen. *Segmentina* (in part), Nevill, *op. cit.*, p. 246.
- 1915. *Planorbis* subgen. *Segmentina* (in part), Preston, *op. cit.*, p. 124.
- 1919. *Segmentina*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 56.

Preston in his account of the subgenus *Segmentina* has merely followed Nevill, and unfortunately at the time of the publication of Nevill's work nothing was known of the anatomy of these forms, shell-characters alone being used for the discrimination of the various subgenera. As a result of the study of a large collection from Manipur of some of these forms in spirit, we find that the positions assigned by Preston to several of the species are untenable. *S. umbilicalis* (Benson) is probably a *Hippeutis* and so are *S. caenosus* and *S. indicus* of the same author (see p. 584), while *S. cantori* is a *Gyraulus*.

Segmentina calathus (Benson).

- 1919. *Segmentina calathus*, Annandale and Prashad, *op. cit.*, pp. 56, 57, figs. 5D (wrongly printed as 5E), 7C.

¹ Simroth, *Bronn's Thier-Reichs* III (supplement), Mollusca, p. 502, fig. (1912).

In the paper cited above some anatomical details are included, there is, however, an unfortunate typographical error in that fig. 5D has the wrong lettering 5F, placed next to it, and vice versa with fig 5F.

A fair number of specimens of this species were collected at Dimapur, Assam, and at Imphal and Mingyang Pukri in the Manipur Valley. Though the shell of all these specimens is beautifully preserved, none of them have the soft parts well preserved. This was previously noticed by us in the case of the specimens from Seistan and the Punjab, and it appears that the internal partitions in the shell are in some way responsible for the poor preservation of the soft parts. The species is widely distributed and we have recently seen some specimens from Sumatra.

Camptoceras, Benson.

1919. *Camptoceras hirasei*, Walker, *op. cit.*, pp. 1-6, pl. i.
1919. *Camptoceras*, Annandale and Prashad, *Journ. As. Soc. Bengal*
XIV, p. 457.
1920. *Camptoceras*, *id.*, *ib.*, XVII, pp. 27-33.

Camptoceras lineatum, Blanford.

1914. *Camptoceras lineatum*, Gude, *Faun. Brit. Ind. Moll.* II, p. 463.

To Blanford's original description of the shell, quoted with a copy of his figures by Gude, we have nothing to add, except that the spiral lines bear minute chaetae when the specimen is quite fresh or in a liquid medium.

The animal agrees with Benson's description of *C. terebra* and with Walker's figures of the Japanese *C. hirasei*. The foot is narrow and tongue-shaped, bluntly pointed behind, relatively small and not extending very much beyond the aperture of the shell. The tentacles are long and filiform but slightly clavate (? always; see p. 581), with the eyes, which are small and sessile, situated at their bases internally, the external base of each tentacle is slightly swollen. The snout is short, broad and blunt. The edge of the mantle is greatly thickened. Some distance behind the left tentacle there is a simple vascular fold—the pallial branchial process—and the opening of the branchial chamber is situated behind it. The aperture is large and, when the animal is in a half expanded condition, patent. A fold arises behind and below it on the side of the body and grows out as it proceeds forward, into a long, almost epipodial process. As the animal expands this process curls up in a spiral to form a complete branchial siphon with an inferior oval orifice, which is directed downwards, outwards and backwards. The faecal pellets are discharged through this orifice which lies immediately behind the anus. The blood is red and gives the whole animal a slightly pinkish tinge. The foot and tentacles are suffused with pale olive and minutely speckled with black and white, each of the latter has in addition an oval black area lying midway between the tips

and the bases. The snout is dark with an irregular stripe of pale specks running forward from each eye.

The radula is of the same type as that of *C. hirasei* and *C. subspinosum*, and has the formula approximately 12.9.1.9.12. The external marginals are very feebly developed. The jaw consists of a small central piece, which is rather narrow and deep, and two lateral pieces, each of which is very long and thread-like. The whole jaw is feebly chitinated. The internal anatomy is of the Planorbis type, but it is impossible for us to go into details owing to only two specimens being available. The penis-sheath, however is broad and stout with a small penis, without any stylet at the end.

Walker's figures of *C. hirasei* show the anal siphon, slightly clavate tentacles and (in a highly contracted state) the left epipodial lobe. They provide no evidence of any generic difference between the species with elongate shells and *C. lineatum*, in which the type of shell-form is much less extreme. As we have shown in another paper (*op. cit.*, p. 28) a species (*C. subspinosum*) occurs in Kashmir with a shell in some respects intermediate between the two types. We see no reason, therefore, to separate *C. lineatum* generically from *Camptoceras*.

Two specimens of this species were found crawling on the underside of floating grass-stems in a small, sluggish muddy stream that runs into the north end of the Loktak Lake near Potsengbam. They were accompanied by numerous individuals of *Ancylus viola*. Though their progression was slow and *Ancylus*-like, doubtless on account of their small foot, they showed great nimbleness in twisting the free part of the body about in the mouth of the shell. They remained submerged when placed in a vessel of clear water. The only other specimens of this species were found many years ago by Col. Godwin-Austen in what is now the Dacca District of Eastern Bengal. They were aestivating in dry weather among herbage at the edge of a partly desiccated pool and had secreted an epiphragm inside the mouth of their shells. Though the structure still remains intact, after nearly half a century, in specimens in Calcutta and London, the soft parts of the animal, at any rate in Calcutta, have completely decayed inside it.

Family ANCYLIDAE.

The taxonomy of this family is rendered difficult by the simple, probably degenerate character of the shell and by the habitual smallness of the animals. Walker, in recent volumes of *Nautilus*, has gone to great lengths in separating the species into genera and even subfamilies on microscopic characters largely in the radula. His classification is, however, impossible to apply without much labour and some residue of doubt in many cases. Some of the genera he recognizes are undoubtedly distinct, but the separation of "Ferrissinae" from the Ancylinae is fraught with more danger than perhaps its intrinsic merit justifies, for the

radular teeth in these little molluscs can only be examined under an oil-immersion lens and even at the great magnification such a lens provides do not give an image beyond the possibilities of error in all cases. Moreover, the differences in the minute structures hardly seem to be supported by other differences of corresponding importance in the anatomy or the shell. We found it very difficult to convince ourselves, for example, that Walker was right in assigning the common Indian *Ancylus verruca* to *Ferrissia*, though there was much less doubt as to the new species here described. We propose, therefore, to retain these species in *Ancylus*, but to recognize *Ferrissia* as a subgenus and assign them to it.

In order to establish their status it was necessary to examine also the named and unnamed collections in the Indian Museum, including the specimens mentioned by Nevill in his "Hand-List." Among these we found considerable confusion. As all the species already known from the Indian Empire were represented in the collection, we take this opportunity to revise them here. Shells only of *A. baconi* and *C. tenuis* are available, but we see no reason to separate either of these species or *A. ceylanicus* from the others subgenerically and therefore assign all the Indian species to the subgenus *Ferrissia*.

The shells of these species may be distinguished by the use of the following key:—

Key to the Indian species of Ancylus.

I.	Apex of shell sharply pointed, very little reflected; shell over 5 mm. long	...	<i>A. ceylanicus.</i>
II.	Apex blunt, reflected to the right; shell less than 5 mm. long.		
	A. Greatest breadth of shell near the middle; outline of shell distinctly asymmetrical bilaterally	...	<i>A. verruca.</i>
	B. Greatest breadth of shell in posterior third; outline of shell almost symmetrical bilaterally.		
	i. Sides of shell not parallel; altitude much less than $\frac{1}{3}$ of length	...	<i>A. baconi.</i>
	ii. Sides parallel; altitude more than $\frac{1}{3}$ of length.		
	a. Shell deep violet internally with minute radiating striae	...	<i>A. viola.</i>
	b. Shell dull yellowish internally, without distinct microscopic sculpture	...	<i>A. tenuis.</i>

Genus *Ancylus*, Geoffroy.

1903. *Ferrissia*, Walker, *Nautilus* XVII, p. 15.

1917. *Ferrissia*, *id.*, *ibid.*, XXXI, p. 3.

Although Walker described *Ferrissia* as a subgenus of *Ancylus* only in 1903, he raised it to the rank of a subfamily under the name Ferrissiinae in 1917, defining it as follows:—"Jaw segmented in plates. Radula with a bicuspid central, laterals obliquely deflected with from two to five cusps arranged somewhat like the teeth of a comb; marginals also comb-like, cusps not (usually) extending to the basal line."

We have examined the radulae of *A. verruca*, *A. viola* and *A. ceylanicus*. Although the teeth differ in certain particulars from those figured by Walker in the second paper cited above, they conform sufficiently well to his description.

***Ancylus (Ferrissia) verruca*, Benson.**

1855. *Ancylus verruca*, Benson, *Ann. Mag. Nat. Hist.* (2) XV, p. 12.
 1876. *Ancylus verruca*, Hanley and Theobald, *Conch. Ind.*, pl. lxxxi, figs. 2, 3.
 1914. *Ferrissia verruca*, Walker, *Nautilus* XXVII, p. 116.
 1915. *Ancylus verruca*, Preston, *Faun. Brit. Ind., Freshw.-Moll.*, p. 105.

Specimens from Imphal, Manipur, agree fairly well with Hanley and Theobald's figures except in being rather higher, narrower and taller. There is considerable variation in these respects, however, and our specimens are smaller than the one figured in the *Conch. Indica*.

The animal closely resembles that of *A. viola*, a new species that we describe in greater detail, but has the left epipodial lobe

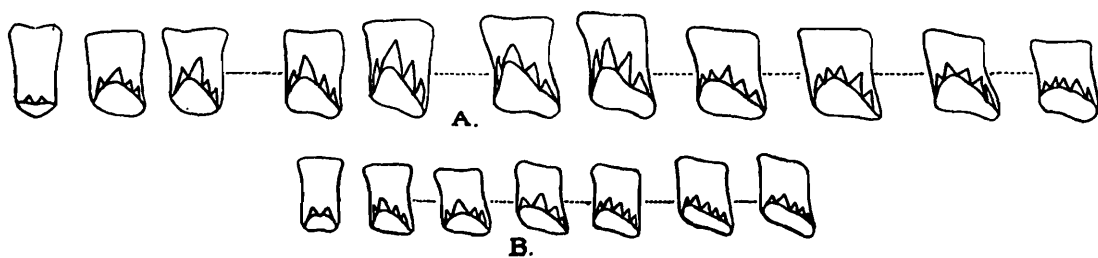


FIG. 18.—Radular teeth of *Ancylus*.

- A. *A. viola*, Annandale and Prashad.
 B. *A. verruca*, Benson.

relatively larger. We figure the radular teeth as seen under an oil-immersion lens. The mouth is a longitudinal slit provided with thin lateral lips and with a minute tongue-shaped process on the floor. The upper jaw is lunate and, though thin and delicate and somewhat broken up, has a concrete character as a whole. The majority of the side-pieces take the form of saddle-shaped denticles arranged in a long single row running parallel to and just inside the lip on either side. The uppermost piece on each side, however, is plate-like and the lowest is large and curved.

A. verruca has a wide range in the Indian Empire and Ceylon but is somewhat sporadic. In the neighbourhood of Imphal we found it not uncommon on the underside of the floating stems of water plants and leaves in ponds.

***Ancylus (Ferrissia) viola*, sp. nov.**

The shell is small and thin but opaque and of a dark brown or blackish colour. It is of suboval form, slightly narrower behind than in front and from $1\frac{3}{5}$ times to twice as long as broad-

The sides are slightly compressed, the anterior slope slightly convex and the posterior slightly concave. The apex, which is slightly eroded in the specimens examined is not greatly elevated, blunt, not at all produced or recurved, but turned a little to the right. It is situated in the posterior third of the shell. The lower margin is very narrowly flattened and sometimes obscurely retroverted. The whole of the external surface is smooth but covered in the specimens examined by a thin minutely rugulose deposit apparently of mineral origin. The interior has a dark violaceous colour owing to a bluish white glaze on the deep brown shell substance. It is marked with numerous concentric rather blunt ridges, one of which, situated about $\frac{2}{3}$ up the shell, is sharp and more prominent than the others. There is usually a band of white pigment immediately below the ridges. A microscopic sculpture of very fine straight longitudinal radiating striae can be detected under a high power, running from the inner surface of the apex to the lip. Near the margin also there are numerous transverse sinuate striae, equally minute, which give the interior of the lip a faint iridescence.

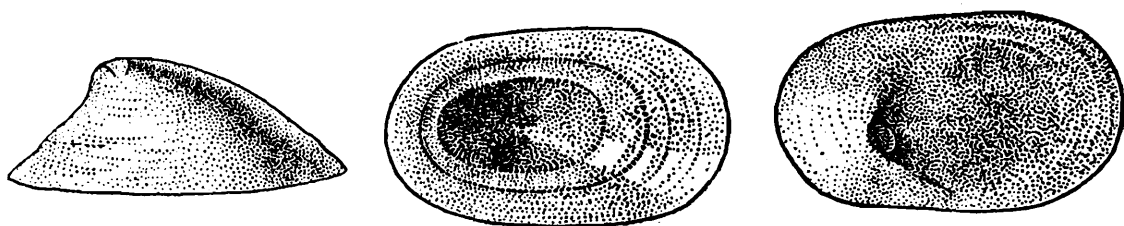


FIG. 19.—Shell of *Ancyclus viola*, Annandale and Prashad.

Measurements of Shells (in millimetres).

	A (Type).	B.	C.	D.	E.
Length	4.7	5.5	4.7	4.2	3.7
Breadth	2.5	2.8	2.5	2.4	2.5
Height	1.7	2.0	1.2	1.4	2.0

The animal is small as compared with the shell and no part extrudes in progression. The whole surface is rather opaque white with a clouding of black pigment on the head. The snout is broad and bluntly rounded in front, the tentacles short, and the eyes, which are black, are relatively large but not at all prominent. The foot is rather narrow and bluntly pointed behind. The left epipodial process is long and narrow.

The buccal mass is stout and broad. The radula is relatively large and as seen in a position of rest from above is band-shaped, narrowing abruptly behind and apparently truncate in front owing to a small anterior portion being bent downwards and inwards. The dental formula is approximately 10.8.1.8.10, but the outer marginals are very imperfectly developed and the inner marginals difficult to distinguish from the outer laterals. The jaw

resembles that of *A. (F.) verruca*, but the central piece is larger and more compact, while the lateral pieces are fewer but larger.

A short but capacious oesophagus leads to the stomach, which is divided into three regions by a very stout band of circular muscles. This band, which is interrupted on the lower surface, forms a kind of gizzard and when constricted gives the lumen of the stomach an hourglass-shape. The intestine has a precisely similar course to that of *A. fluviatilis* as figured by Simroth,¹ but we could not see any processes, in our dissections, at the point where the intestine leaves the stomach; Simroth shows them as well developed in *A. fluviatilis*. The anus is situated a short distance behind the base of the left tentacle.

The genital pore is situated immediately in front of the anus. The genitalia are imperfectly preserved in our material but the female system seems to have been better developed than the male. The hermaphrodite gland is full of large ova. The penis is short and papilliform and a flagellum is present, but considerably shorter than in *Ancylus fluviatilis* as figured by Simroth (*op. cit.*, pl. xxvi, fig. 11).

The kidney is large and occupies the anterior part of the branchial cavity.

The edge of the mantle bears numerous minute conical refractile bodies that do not seem to be of parasitical origin.

Type-specimen.—No. M 11718/2 Zool. Surv. Ind. (*Ind. Mus.*).

Localities, etc.—This species was found in abundance with *Camptoceras lineatum* on the lower side of floating grass-stems in a small, sluggish muddy stream running into the north end of the Loktak Lake, Manipur, in February, 1920. It was also taken in the same situation in a small muddy pond at Dimapur in the plains of Assam just north of the Naga Hills.

The stomach is full of mud containing the tests of numerous diatoms. The animal moves rather quickly on a smooth surface and can float shell-downwards just below the surface-film of the water.

Affinities.—The shell closely resembles that of *A. (F.) tenuis*, Bourg., from South India but may be distinguished by its brilliant internal colour and fine but distinct sculpture.

***Ancylus (Ferrissia) ceylanicus*, Benson.**

1876. *Ancylus ceylanicus*, Hanley and Theobald, *Conch. Ind.*, pl. lxxvi, figs. 1 and 4.

Among a number of specimens of *A. (F.) verruca* from a pond in Imphal we find a single shell that agrees closely with the figures of *A. ceylanicus* in the *Conch. Indica*, which may probably be taken as a correct representation of this species. This specimen is 6 mm. long, 4 mm. broad and 2.5 mm. high.

¹ Bronn's *Thier-Reichs* III (Supplement), Mollusca, p. 338, fig. 113A (1911).

We retain this species as distinct provisionally for the animal and radula are very like those of *A. (F.) verruca*, a species also found in Ceylon, and we are not entirely convinced that it may not be simply a very old phase of the latter species, perhaps only attained occasionally. Much smaller specimens of *A. (F.) verruca* are sexually mature, but this does not preclude the possibility we have suggested.

***Ancylus (Ferrissia) baconi*, Bourguignat.**

1882. *Ancylus baconi*, Clessin, in Mart. and Chem., *Conch.-Cab., Ancylinen*, p. 61, pl. vii, fig. 7.

Among the specimens assigned by Nevill to *A. verruca*, we find a small series from Orissa that differs considerably from shells of that species and agrees well with Clessin's figure and with the original description of *A. baconi*. The species was originally described from Bengal and has since been recorded from the Philippines and Japan.

The following observation is interesting as illustrating a possible mode of dispersion. Some years ago one of us captured in the canal at Cuttack in Orissa a large Dysticid beetle the elytra of which were covered with a species of *Ancylus* in considerable numbers. The specimens were sent to the late Dr. Gwatkin and were apparently lost in transit. We are unable to say whether they belonged to this species or some other.

***Ancylus (Ferrissia) tenuis*, Bourguignat.**

1862. *Ancylus tenuis*, Bourguignat, *Spic. Mal.*, p. 208.

No figure of this species appears to have been published but large numbers of specimens that agree with the original description were recently found by one of us in small streams at the base of the Nilgiri Hills, from which the species was originally described. The specimens from South India assigned by Nevill to *A. (F.) verruca* are similar, but seem to have been completely bleached.

The species probably differs somewhat in habits from other Indian representatives of the genus. It was found on dead leaves in the pools of small hill-streams, specially those just above waterfalls.

THE AMPHIBIOUS PULMONATA (SUCCINEIDAE).

By AMIN-UD-DIN.

Genus *Succinea*, Drap.

The Indian species of *Succinea*, so far as our knowledge extends, seem to fall both anatomically and biologically into two groups; but no separation between these groups can be based on the shell-characters. Until we know more of the anatomy

and habits of the species it seems best not to propose taxonomic names for the groups, but they may be distinguished as follows:—

I. AMPHIBIOUS GROUP.—Species that live at the edge of marshes and lakes and are amphibious in habits. The dorsal wall of the lung is opaque. The radula is comparatively narrow and the number of longitudinal rows of marginals never exceeds 40. The prostate does not show a spiral torsion and the vas deferens is always long and turns up at the end to open at the tip of the penis. The penis possesses a single retractor muscle. There is a vagina and the male and the female ducts open in a common atrium. This group is known to include the following Indian species, *S. indica*, *S. elegantior* and *S. rutilans*.

II. TERRESTRIAL GROUP.—Species found living on the leaves of trees and bushes, at any rate in rainy weather. The dorsal wall of the lung is thin and translucent. The radula is broad and has over 80 longitudinal rows of marginal teeth. The vas deferens is rather short and straight. The penis is small and without a retractor muscle. The prostate has a spiral torsion. There is no distinct vagina or atrium, but the ducts of the receptaculum seminis, the penis and the vagina open separately in a shallow slit-like common aperture on the surface of the body. The only Indian species of this group so far known anatomically is *S. semiserica*.

Of the anatomy of most species of *Succinea* very little is known and practically no work has been done on the Indian species. Von Rieber¹ has given a full description of the genitalia and physiology of *S. putris*, while Ihering² gives a general account of the genitalia of the same species. Jacobi in his paper on Japanese Pulmonates³ also gives a few notes on the anatomy of *S. horticola*, Reinh. Both of these Palaearctic forms belong essentially, at any rate as regards the radula and the generative apparatus, to my Amphibious Group. The small number of marginals, the presence of a retractor muscle and the large thick penis-sac are very alike, but Jacobi in his figure shows the different sexual ducts as having separate external openings.

At first it was intended to describe only the anatomy of *S. elegantior*, but as many interesting points came out in the dissection of other species it was decided to include short notes about them also for comparison and further reference.

Succinea elegantior, Annandale, sp. nov.

A species resembling *S. semiserica*, Gould, externally but with the shell smaller and narrower and having the spire still further reduced.

The shell is rather small, thin but less fragile than in some species, of narrowly ovate form, of a bright golden brown

¹ *Ann. Soc. Roy. Malac. Belgique* XLVII, pp. 125–191 (1912).

² *Fahrh. Dext. Malakozool. Ges.* IV, pp. 136–142 (1877).

³ *Fourn. Coll. Sci. Tokyo* XXI, pp. 82–85 (1898–1900).

colour, highly polished and sculptured with moderately strong, curved and sinuate, somewhat irregular striae. The spire is reduced to a mere tubercle but consists of two distinct whorls and is set on the body-whorl at a slight angle and directed outwards. The apex is minutely rounded and the penultimate whorl, though very small, swollen and oblique. The body-whorl is not at all tumid, but subcylindrical with nearly parallel sides and about twice as high as broad; its anterior extremity is broadly rounded. The aperture, which is almost straight, is narrowly ovate, pointed above and about twice as high as broad. The outer lip is sharp and nearly straight, as is also the columella, which is slightly folded and ridged above. There is a feebly developed callus joining the outer lip to the columella. The shell is imperforate. All these characters are very uniform in a large series of shells.

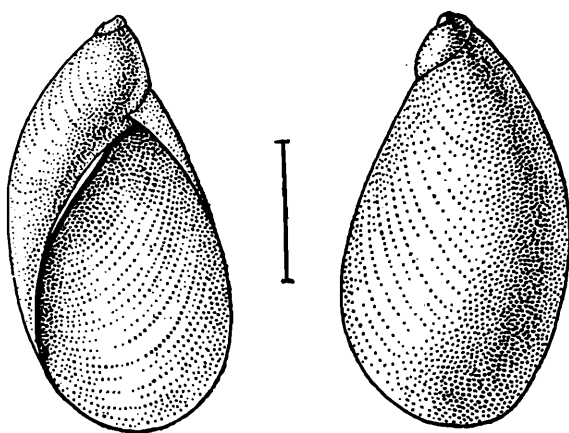


FIG. 20.—Shell of *Succinea elegantior*, Annandale, from Manipur.

Measurements of Shells (in millimetres).

	A (Type).	B.	C.	D.	E.	F.
Height ...	13.3	12.5	14.0	12.9	10.5	11.4
Maximum diameter ...	7.7	7.1	7.1	6.8	5.2	6.2
Height of spire ...	2.0	1.3	1.8	2.5	1.0	1.3
Height of mouth ...	11.4	10.8	11.0	10.0	8.5	9.2
Maximum diameter of mouth ...	5.6	5.4	5.8	5.6	4.2	5.1

Type-specimen.—No. M 11861/2 Zool. Surv. Ind. (*Ind. Mus.*).

The species is, so far as we know, confined to Manipur Valley. It is found in abundance round the Loktak Lake and has also been met with sparsely at other places in the valley. It lives in damp localities, at the edge of the lake and other swamps and attached to various floating objects. Being lighter than water, it was frequently observed floating on the surface of water with its shell downwards and carried about by wind. Living specimens are sluggish on dry land and leave a trail of mucus behind them.

Our station-book gives the following particulars:—“Very common on damp mud. Shell fragile and easily removed. Foot narrow, extending for some distance behind the shell and bluntly pointed posteriorly. Eye-stalks moderately long, tentacles reduced

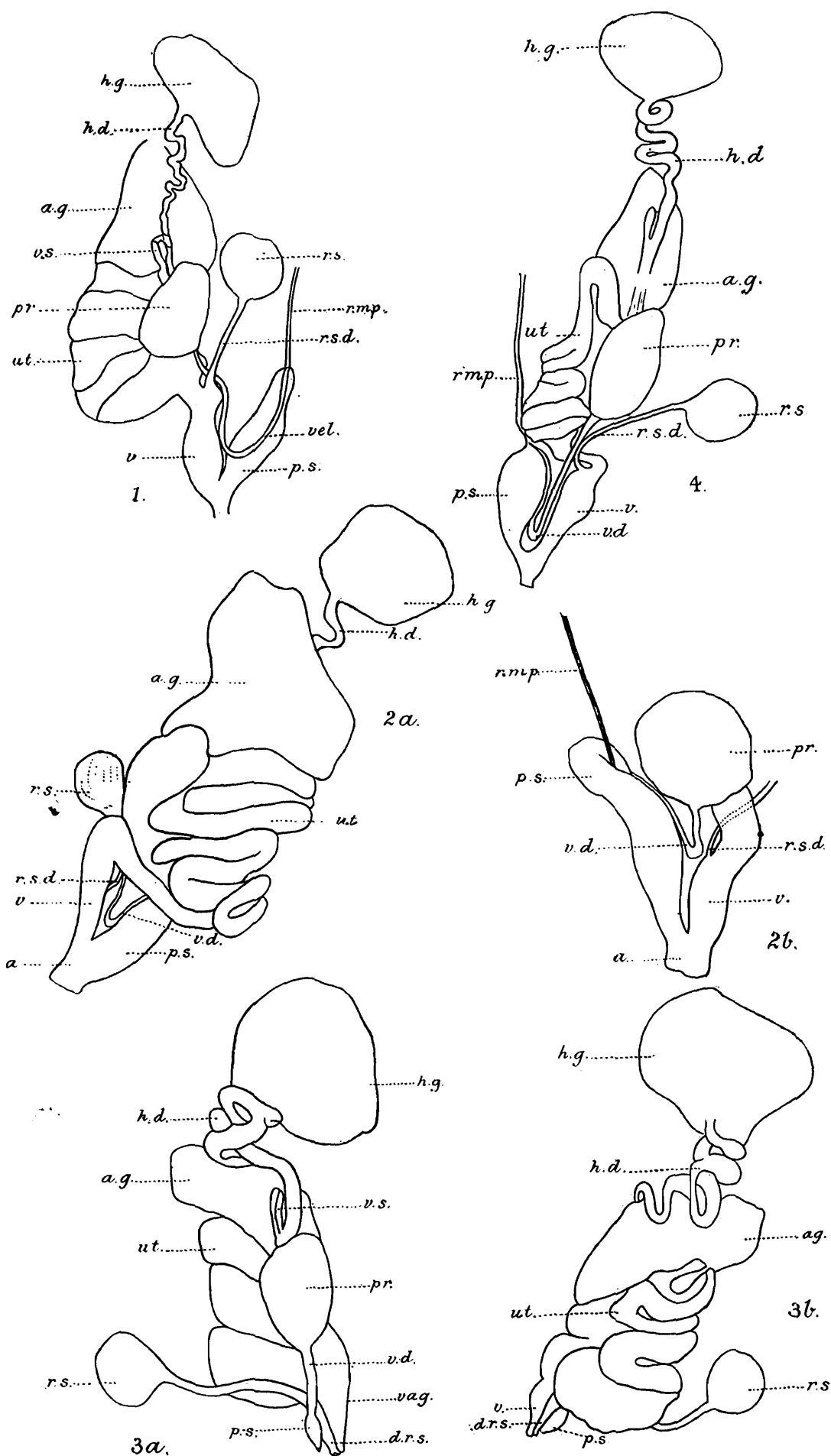


FIG. 21.—Genitalia of different species of *Succinea*.

1. *S. elegantior*, ventral view. 2. *S. rutilans* (a) dorsal view, (b) ventral view of the terminal portion only. 3. *S. semiserica*, (a) dorsal view, (b) ventral view. 4. *S. indica*, ventral view.

a.g. albumen gland; h.d. hermaphrodite duct; h.g. hermaphrodite gland; p.r. prostate; p.s. penis sac; r.m.p. retractor muscle penis; r.s. receptaculum seminis; r.s.d. duct of the receptaculum seminis; ut. uterus; v. vagina; v.d. vas deferens; v.s. vesicula seminis.

to rounded tubercles. Edge of mantle not extending over the shell. Dorsal surface and sides of the body infuscated, with a pale irregular reticulum. A pale groove extending along the body below each eye-stalk. Eye-stalk internally black. Foot whitish with a dark reticulum or spots round the upper margin. Edge of mantle with black specks or spots."

The walls of the mantle are moderately thick and quite dark owing to a suffusion of black pigment. The mantle edge is thick and muscular.

The pulmonary opening is situated a little behind the middle of the body, on the right side. It is placed on the edge of the

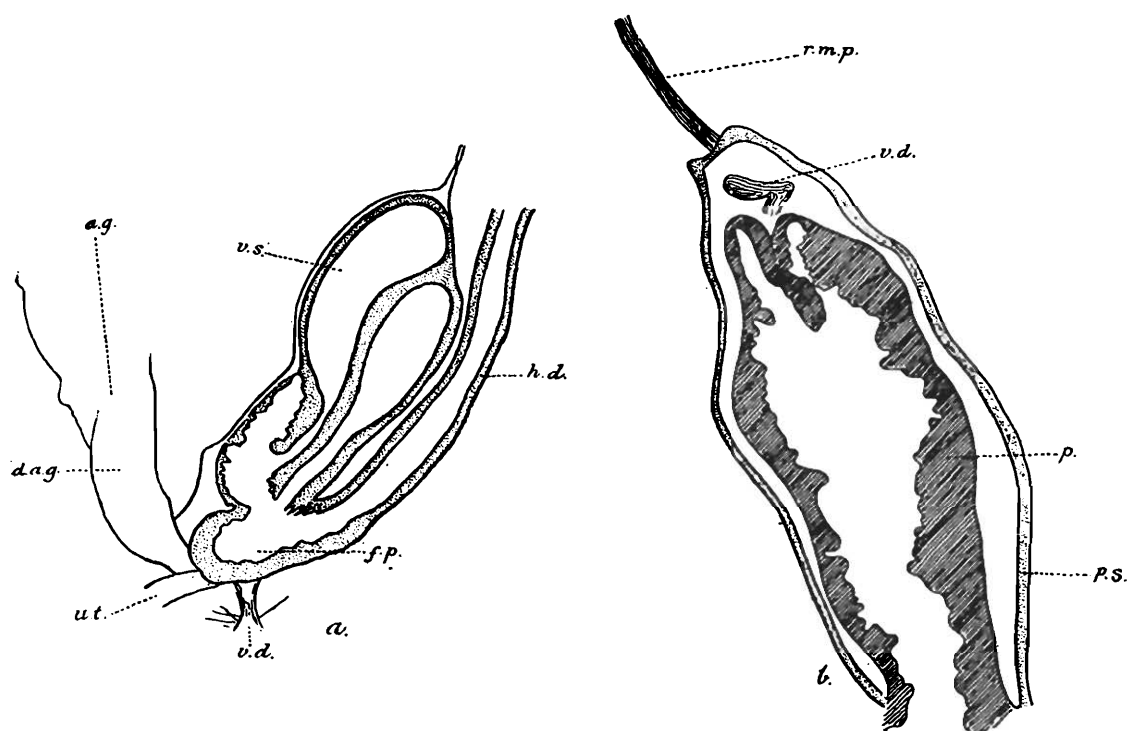


FIG. 22.—*Succinea elegantior*, Annandale.

(a) Horizontal longitudinal section of the vesicula seminalis and adjoining structures.

(b) Longitudinal section of the penis-sac.

a.g. albumen gland; d.a.g. duct of the albumen gland; f.p. fecundation pouch; h.d. hermaphrodite duct; p. penis; p.s. penis sheath; r.m.p. retractor muscle of penis; ut. uterus; v.d. vas deferens; v.s. vesicula seminalis.

mantle and is a circular aperture with prominent edges incomplete below and with a horseshoe-shaped black band outside it. The opening of the ureter is slit-like and lies dorsal to the anus, which opens obliquely under the mantle edge.

It will be convenient to describe the genitalia from above downwards. Within the apex of the shell we find firstly the hermaphrodite gland, a yellowish white mass of irregular shape, embedded in the liver and occupying the greater part of the spire. The hermaphrodite duct is a long tube, much convoluted and made conspicuous by its dark colouration, which is derived from the superimposed pigmented cells of the connective tissue. At the point at which the duct enters the albumen gland two club-shaped

structures open into it. These are the so-called seminal vesicles: they have thick muscular walls, and a narrow lumen containing spermatozoa. The hermaphrodite duct at this place swells up into a small pouch called by Ihering (*loc. cit.*) the fecundation pouch. Its internal walls are thrown into complicated folds. On its exit from the albumen gland the hermaphrodite duct is continued as the uterus on one hand, and the male duct on the other.

Taking first the female elements, we find the uterus descending in numerous coils. Its walls when immersed in water assume a transparent gelatinous appearance. Distally it is somewhat dilated and at the point of its junction with the duct of the receptaculum seminis becomes considerably contracted. It is then continued forwards as a muscular vagina. The receptaculum seminis is subcircular and has a long slender duct. The vagina is short but thick.

The male duct on its exit from the albumen gland bears immediately a rather large, elliptical gland, the prostate, which lies on the right side below the uterus. The vas deferens runs close to the inner side of the vagina and at the point where vagina and penis meet together, it turns up sharply, and, running internally to the walls of the penis-sac, opens finally at the tip of the penis. The penis is a thick muscular organ, the internal walls of which are thrown into complicated folds and are glandular. The penis-sheath is thin and consists mainly of longitudinal muscle-fibres. The retractor muscle is attached close to the point where the vas deferens enters the penis.

The male and the female ducts open separately into the short common atrium, which communicates with the exterior by a narrow slit-like aperture.

The Alimentary System.—The mouth is situated on the lower surface of the extreme anterior end of the snout and is bounded by fleshy lips. The buccal-sac is thick and globular.

The jaw is black and stout. Its cutting edge is broadly concave and has a rounded projection in the middle. The accessory plate is rounded posteriorly and quite broad. The radula is a broad ribbon and has approximately the formula 40.(10-12).1.

(10-12).40. The central tooth has a greatly developed median cusp but the side cusps are sub-obsolete. Its base is horizontal and slightly concave. The margins of the basal discs are thickened or probably folded in, so as to form a vertical ridge on each side. They disappear on the upper part of this region of the tooth. The laterals are tricuspid, the inner cusp being long and nearly reaching the base. Their bases are not horizontal but obliquely truncate, the inner angle being at a considerably higher level than the outer.

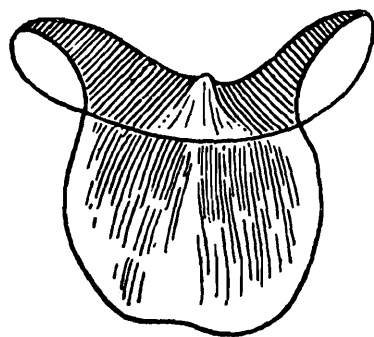


FIG. 23.—Jaws of *Succinea elegantior*, Annandale.

The outer basal angle is lobate and the basal margin bears at least two narrow incisions separating blunt processes. The incisions are sometimes continued upwards on the side of the tooth as vertical grooves. The marginals are relatively small and have four denticulations. The outer cusps are comparatively longer. Their bases are very much reduced.

Opening into the dorsal portion of the buccal mass are the ducts of the salivary glands. These glands are of irregular shape

and lie one on each side of the oesophagus. Their ducts are slender and, passing underneath the cerebral commissure, open dorsally into the buccal-sac. The oesophagus arises from the dorsal aspect of the mass. Its proximal portion is quite short and muscular, while distally it becomes dilated and takes on the structure of the crop. The crop is a long, straight and thin-walled wide tube, filling the greater part of the body cavity. Its distal end is constricted and is in continuity with the bulbous stomach. The stomach turns sharply to the left and upwards. The intestine and the rectum form a narrow tube and lie dorsal to the

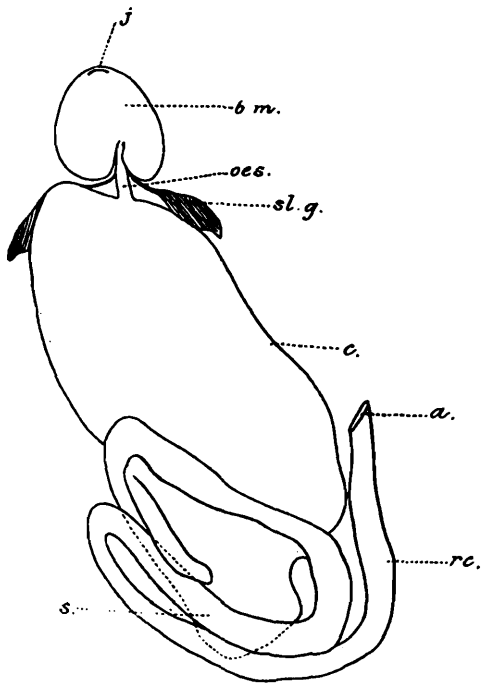


FIG. 24.—Alimentary canal of *Succinea elegantior*, Annandale.

a. anus; b.m. buccal mass; c. crop; j. jaw; oes. oesophagus; r. rectum; s. stomach.

crop and stomach embedded in the substance of the liver. They form a double loop. The rectum bends down towards the right side and opens by a slit-like opening just under the edge of the mantle, near the middle of the body on the right side.

The excretory system does not show any peculiarity. The ureter is closely applied to the dorsal surface of the rectum and opens by a separate aperture dorsally to the anus.

Succinea rutilans, Blanford.

The range of this species also appears to be restricted. It has so far been recorded only from the Khasi Hills in Assam. During our recent tour in the Manipur Valley it was occasionally found, occurring with the more abundant species *S. elegantior*, with which it is identical in habits and habitual environment.

The animal resembles *S. elegantior*, but its tentacles are less developed and the body is white, spotted with irregular black blotches. A black streak runs on each side of the head extending along the eye-stalks.

The male portion of the genital system is somewhat different. The prostate is sub-circular and the vas deferens moderately thick. The penis is elongate and has a recurved tip, which is in continuity with the vas deferens. The retractor muscle is attached at the point of curvature.

In the female organs the uterus is much coiled on itself and becomes considerably narrowed at the point where the duct of the receptaculum seminis joins it. The duct of the receptaculum seminis is long and narrow. The vagina is elongate and thick. The male and the female ducts open in a common vestibulum, which is quite short.

The jaw is slender and has blunt ends. Its cutting margin is without any irregularities, smooth and evenly concave. The quadrate accessory plate is as broad as the jaw itself and rounded posteriorly.

The radula is a long narrow ribbon with only about 35 teeth in a transverse row. The dental formula is 6.II.I.II.6. The teeth are normal as regards shape and structure; it is the small number of marginals that is noteworthy. In the single available radula a very interesting abnormality was noted in that the seventh lateral tooth on the right side throughout the length of the ribbon has assumed to all appearances the form of a central tooth.

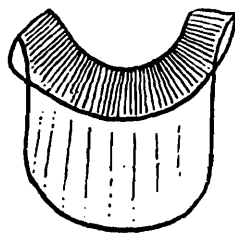


FIG. 25.—Jaw of *Succinea rutilans*, Blanford.

Succinea semiserica, Gould.

This species has a fairly wide distribution. It has been found in Eastern Bengal, at Calcutta, in Pegu in Burma and in the Amherst and Tavoy districts of Tennasserim. Dr. H. H. Marshall of Rangoon, who has kindly sent the preserved specimens on which this study is based, has supplied the following information about its habits and environment:—

“This species is very common during the rains round Rangoon in the islands in Hlewa-ga Lake and in Mr. Taylor’s Island in the Kokim Lake. They are generally found living on the leaves of various plants, bushes and in moss-grown localities. They seem to prefer mangoes, plantain and palm leaves.”

From the above statement it will be seen that the animal lives mainly on fresh leaves and does not frequent dirty marshy places like those of the other group, which seem to prefer decaying vegetable matter as food. This species was found, moreover, in the rainy season, from June to September, while those of the other group have been commonly met with during the months of December to March.

The animals I have examined are very much contracted and probably bleached owing to preservation in strong spirit. The body is bulky and the foot is narrowly tongue-shaped. The ven-

tral surface of the foot is white. The dorsal surface of the body is speckled with black blotches, which are absent on the left side. The dorsal wall of the pulmonary chamber is thin and transparent and the cavity itself is large. The edge of the mantle thins down on the side of the body and lies on it as a thin flap-like membrane. This may be a useful adaptation for the storage of moisture.

The reproductive organs are interesting in many respects, and belong essentially to a different type from those of the other species examined.

The prostate as a whole appears to be sub-elliptical and to have an oblique cleft across its dorsal surface. This is due to the fact that the gland is twisted spirally round the vas deferens which issues from the cleft and, proceeding forwards as a stout, straight tube becomes swollen distally to form the penis. The penis when retracted lies obliquely in a thin-walled sac. It is a short muscular organ, sub-triangular in longitudinal section. Its lumen is narrow but swells up in the middle and again continues its course as a narrow tube, so that a cross-like appearance is produced. The penis has a thin muscular sheath but there is no retractor muscle. It opens into the shallow slit on the right side of the body common to it, the duct of the receptaculum seminis and the female duct.

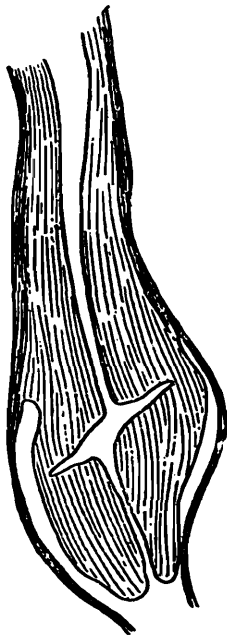
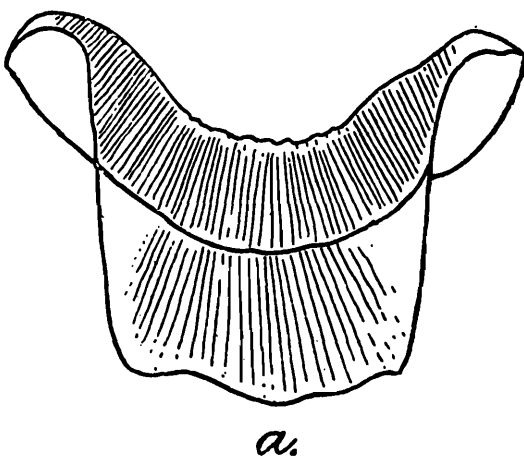


FIG. 26.—Penis of *Succinea semiserica*, Gould.

The female organs are also somewhat peculiar. The uterus is much coiled and at its distal end becomes constricted and narrow. The receptaculum seminis has a long stout duct, as thick as the terminal portion of the uterus. The pores of the ducts of the male and female organs and of



a.



b

FIG. 27.—*Succinea semiserica*, Gould.
(a) Jaw. (b) Radular teeth.

the receptaculum seminis are contiguous and open in a common slit situated on the right side of the body, below the right tentacle.

The jaw is stout and has a deeply concave cutting edge. The margin of this edge is not smooth, but under a low power of the microscope shows small irregularities. The quadrate plate is broad and truncate behind.

The radula is broad and moderately long. The teeth are normal and do not show any structural peculiarity. The dental formula, however, is 85.15.1.15.85, while in all the other species examined the marginals do not exceed 40. The large number of teeth in a single row may possibly be due to the food requiring a broad radula in order that a sufficient quantity of material may be rasped from the comparatively hard surface of growing leaves.

Succinea indica, Pfeiffer.

This species has hitherto been recorded from Kashmir, the Kumaon Hills and the Southern Shan States. It has now been

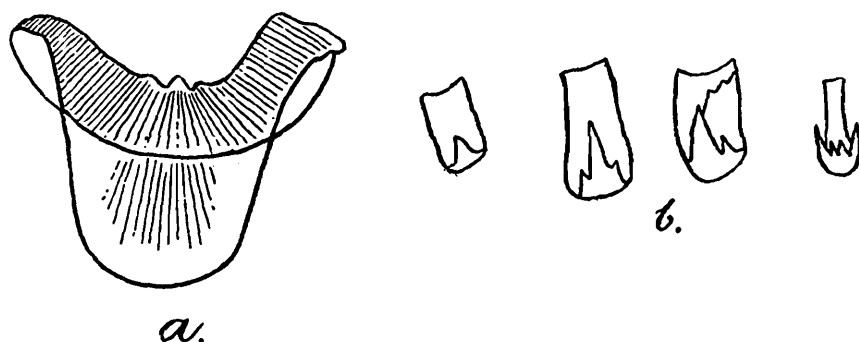


FIG. 28.—*Succinea indica*, Pfeiffer.
(a) Jaw. (b) Radular teeth.

found abundantly by Dr. Annandale in the North-West Frontier Province near Peshawar, and in the Punjab at Gurdaspur. In its general habits it resembles *S. elegantior*. Near Peshawar it was found on decaying reeds in the water of a swamp with very little sub-aquatic vegetation.

Dr. Annandale's field-book gives the following particulars about the living animal:—

“Animal as a rule dark in colour, almost black, with white longitudinal lines on the dorsal surface of the exposed parts of the body. Ventral surface of the foot grey, speckled with black. Mantle with pale spots. Tentacles reduced to small rounded tubercles. Exposed surface irregularly tuberculate. Foot narrow, tongue-shaped, broadly rounded in front and narrowly rounded behind. Young individuals paler than old ones.”

The generative organs are slightly different from those of *S. elegantior*. The penis sac is elongately pear-shaped and acuminate distally. The prostate is narrowly elliptical.

The jaw is small and has rounded extremities. The cutting edge is concave and is provided with a central blunt projection and a subobsolete accessory projection on either side. The quadrate plate is narrow and rounded posteriorly.

The radula is fairly long and broad and has the formula 28. 12.1.12.28. The bases of the marginals are rather short and concave.

LITERATURE.

1. Annandale, N.,—Jaw and radula of *Succinea indica*. *Rec. Ind. Mus.* XIV, pl. xi, figs. 5, 6 (1918).
2. Binney, W. G.,—On the jaw and lingual membrane of North American terrestrial Pulmonata. *Proc. Acad. Nat. Sci. Philadelphia* XXVII, pp. 230–232 (1875).
3. Cooke, A. H.,—*Mollusca*, in *Cambridge Natural History*, London (1895).
4. Fischer, P.,—Observations anatomiques sur divers Mollusques des Antilles attribués au genre *Succinea*. *Journ. Conchyliol.* XXII, pp. 137–155, pl. v (1874).
5. Ihering, H. von,—Ueber den Geschlechts-apparat von *Succinea*. *Jahrb. Deut. Malakozool. Ges.* IV, pp. 136–142 (1877).
6. Jacobi, A.,—Japanische Pulmonaten. *Journ. College. Sci. Tokyo* XII, pp. 82–85, pl. vi, figs. 116–119 (1899).
7. Rieper, H. von,—Studien an *Succinea*. *Ann. Soc. Malacol. Belgique* XLVII, pp. 125–191, pl. iii, iv (1912).

THE PELECYPODA.

By B. PRASHAD.

The collection of Lamellibranchs from Manipur described in the following pages is of special interest, in that most of the species are represented by large series of both dry shells and specimens preserved in spirit. This has enabled me to describe the soft parts of most of the species investigated. I have also included here the description of a new species of the genus *Trapezoideus*, Simpson, collected by Mr. Sunder Lal Hora at Dimapur in Assam.

In the collection this class is represented by the two families Unionidae and Cyrenidae. Of the former, specimens of the genera *Indonaia*, *Lamellidens* and *Trapezoideus* are represented, and of the latter there are specimens of *Corbicula*, *Sphaerium* and *Pisidium*. The most common genera in the valley are *Indonaia* amongst the Unionidae and *Corbicula* and *Sphaerium* amongst the Cyrenidae.

Family UNIONIDAE.

Genus *Indonaia*, Prashad.

1918. *Indonaia*, Prashad, *Rec. Ind. Mus.* XV, pp. 146–148, fig. 2.

In the Manipur Valley the genus *Indonaia* is represented by five species. Of these *I. theobaldi* is apparently confined to the

Manipur Valley, not being known from elsewhere, *I. scobina* and *I. lima* are found in Burma, Assam and Eastern Bengal, while *I. bonneaudi* and *I. occatus* have a very wide range.

Indonaia occata (Lea).

1914. *Nodularia* (*Nodularia*) *occata*, Simpson, *Descr. Cat. Naiades*, p. 985.
 1915. *Nodularia* (*Nodularia*) *occata*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, pp. 138, 139.

The specimens from the Manipur Valley closely resemble those of this species from other parts of India and I have no hesitation in assigning them to it.

The soft-parts resemble those of *I. caerulea* var. *gaudichaudi* described by me in the paper cited, but differ in having the palps much longer and ellipsoid in outline, in the anal being comparatively larger, but of about the same size as the supra-anal and in the mantle connection between the supra-anal and anal being very small. None of the specimens are gravid but all the four gills have a marsupial structure.

Preston (*loc. cit.*) gives "Bengal" as the range of distribution of this species. There are, however, specimens from various localities in the United Provinces, the Central Provinces, Bengal, Assam and Burma in the Indian Museum collection. The species, therefore, has a very wide range in India and Burma.

Indonaia bonneaudi (Eydoux).

1914. *Nodularia* (*Nodularia*) *bonneaudi*, Simpson, *op. cit.*, p. 988.
 1915. *Nodularia*, (*Nodularia*) *bonneaudi*, Preston, *op. cit.*, pp. 140, 141.

Preston has referred to the great variation exhibited by this species both as regards shape and in colour, and this is well brought out in the series before me.

The soft parts resemble those of *I. occata* except that the branchial aperture is much larger, and the anal and supra-anal, which are of the same size, are about one half of its length. The palpi are very elongate, somewhat triangular in outline and have a sharp tip. Only the outer pair of gills are fully charged with glochidia, and the inner pair have only a small number in them.

There are only two specimens of this species in the collection, one from the Thobal Stream near Phaidai and the other from Sikmai stream six miles from Kakchin on the Manipur-Burma Road.

Indonaia scobina (Hanley).

1856. *Unio scobina*, Hanley, *Recent Biv. Shells*, p. 382, pl. xxiii, fig. 40.
 1876. *Unio scobina*, Hanley and Theobald, *Conch. Indica*, p. 22, pl. xlv, fig. 2.
 1914. *Nodularia* (*Nodularia*) *scobina*, Simpson, *op. cit.*, p. 996.
 1915. *Nodularia* (*Nodularia*) *scobina*, Preston, *op. cit.*, pp. 142, 143.

This species was originally described from a unique specimen from Assam. Hanley and Theobald have given a good figure of the

shell, but the specimen from Belgaum, Deccan (pl. xlv, fig. 3), which they consider as a link between *I. occatus* and *I. scobina* does not appear to belong to either species. *I. scobina* has a restricted range in Assam, Manipur and probably Burma, and does not occur in Peninsular India. The only two specimens in the Indian Museum collection are from Sibsagar, North Eastern Assam, and the record of the specimens from the Manipur Valley greatly extends the known range of this species.

Most of the shells collected by Mr. S. L. Hora from the Sikmai stream are much larger than the Sibsagar specimens; one of the largest is 27.8 mm. long, 17 mm. high and 11.5 mm. in thickness.

The animal differs from that of the other species in having the outer pair of gills shorter in both length and breadth than the inner pair and in the palps being rather small.

Indonaia theobaldi (Preston).

- 1912. *Nodularia* (*Nodularia*) *theobaldi*, Preston, *Rec. Ind. Mus.* VII, p. 292.
- 1914. *Nodularia* (*Nodularia*) *theobaldi*; Simpson, *op. cit.*, p. 1002.
- 1915. *Nodularia* (*Nodularia*) *theobaldi*, Preston, *op. cit.*, pp. 143, 144, fig. 8 (1-3).

Preston described this species from two specimens in the Indian Museum collection from Manipur. The exact locality, however, whence these specimens were collected is not known. The species is one of the largest of the Indian forms of the genus *Indonaia*.

Mr. S. L. Hora collected four specimens in the Sikmai Stream in the Manipur Valley. All these specimens, though a little smaller than the type-specimen, are quite like it in other respects. In all the specimens the umbones are much eroded.

The soft parts resemble those of the other species of the genus. None of the specimens are gravid.

Indonaia lima (Simpson).

- 1900. *Nodularia* (*Radiatula*) *lima*, Simpson, *op. cit.*, p. 820.
- 1914. *Nodularia* (*Radiatula*) *lima*, Simpson, *op. cit.*, p. 1018.
- 1915. *Nodularia* (*Radiatula*) *lima*, Preston, *op. cit.*, pp. 147, 148.

Simpson in 1900 established a new section *Radiatula* of the genus *Nodularia* for the two Indian species *Unio crispisulcatus* and *Unio radula* of Benson, he also changed the name of the latter to *Nodularia lima* owing to the specific name *radula* being preoccupied. In his later work, however, he expressed a doubt as to whether *N. lima* did not really belong to the *I. caerulea* group. The sculpture of the shell of this species differs from that of the type-species of the *Radiatula* section and is very like that of *occatus* and *scobina*. The soft parts also resemble those of the two species in all essentials. I therefore place *N. (R.) lima* of Simpson, with species like *occatus* and *scobina*, in my genus *Indonaia*.

Preston's *siliguriensis*, which is a variety of *L. lima* will also have to be removed from the *Radiatula* section.

It is not possible to decide definitely the exact position and relationships of *I. crispisulcatus*, the only other species left in the *Radiatula* section, as we know nothing of its anatomy, but its very characteristic sculpture alone might entitle it to a sectional rank.

The shells collected by Mr. S. L. Hora are from the Sikmai Stream on the Manipur-Burma Road. The specimens are quite typical of the species but have the umbones much eroded.

The soft parts resemble those of *I. occatus*.

Genus *Lamellidens*, Simpson.

- 1900. *Lamellidens*, Simpson, *op. cit.*, p. 854.
- 1912. *Lamellidens*, Ortmann, *Ann. Carnegie Mus.* VIII, p. 277.
- 1914. *Lamellidens*, Simpson, *op. cit.*, p. 1165.
- 1915. *Lamellidens*, Preston, *op. cit.*, p. 174.
- 1918. *Lamellidens*, Prashad, *Rec. Ind. Mus.* XV, pp. 144, 145.
- 1919. *Lamellidens*, *id.*, *ib.*, XVI, p. 293, fig. 4.

Simpson in the two works cited has greatly cleared up the synonymy of the various Indian species, but owing to the limited material at his disposal his descriptions are not quite accurate in all cases. At the time of the publication of his first work nothing was known about the animal of any of the species and the position assigned by him to this genus in his classification was not correct. In his second work, though he included a reference to Ortmann's paper, he still stated that the soft parts were not known. Preston has unfortunately created a great deal of confusion as to the nomenclature of the various species and varieties by indiscriminately combining many good species without assigning any reasons and in other cases by describing already known species as new. In my papers on the anatomy of the genus *Lamellidens*, I followed Preston's nomenclature and my description of the soft parts of the genus was based on specimens which could, according to Preston's identifications, hardly be separated from *L. marginalis* subsp. *corrianus*. Having now carefully studied the large collection in the Indian Museum and the fresh collection from Manipur I find that the above conclusions were not justified. Preston's identifications of the Indian Museum collection are quite unreliable in many cases, the same species having been identified differently on different occasions. In this paper I do not attempt any more than to assign the Manipur shells to their proper species and to add notes on the distinctive characters of these forms.

On examining fully gravid specimens of the typical *L. marginalis*, it was found that the marsupium in this species is not formed by the outer pair of gills only but by all the four gills. In *L. consobrinus* and *L. corrianus* on the other hand only the outer pair of gills is marsupial. The soft parts of all these species are quite similar in other respects. It appears, therefore, that in

the genus *Lamellidens* we have probably two groups of species, in one of which the marsupium is formed by all the four gills and in the other by the outer pair only. This may possibly be correlated with the conditions under which the two groups of species are found. *L. marginalis* is a stream-form while *L. corrianus* is commonly found in ponds or very sluggish streams. In the case of typical stream-forms it may be necessary to produce as large a number of glochidia as possible as the chances of their being washed away are very great, and probably in response to this necessity all the four gills have taken on the marsupial function in these forms.

The formation of the marsupium by all the four gills in *L. marginalis* does not in any way affect the position assigned to the genus by Ortmann and myself in the subfamily Unioninae of Ortmann's classification, as the marsupium in this subfamily is stated to be formed either by all the four gills or by the outer pair of gills only.

Lamellidens marginalis (Lamarck).

1914. *Lamellidens marginalis*, Simpson, *op. cit.*, pp. 1166-1168.

1919. *Lamellidens marginalis*, Prashad, *op. cit.*, p. 293, fig. 4.

In the paper cited above my description and figure of the animal of *L. marginalis* was based on specimens which I, with Preston, considered doubtfully to represent a variety of this species. As a result of a careful study of the whole collection in the Museum I find that these specimens really belong to *L. corrianus*, which I consider to be a distinct species.

The description of the shell of this species in Simpson's monograph is fairly complete, but the following distinctive characters may be noted. The shell is sub-elliptical with slightly inflated but not greatly elevated beaks. The dorsal slope is in most specimens a little curved and the posterior wing is very narrow. The hinge (fig. 29A) is formed by two lamellar pseudo-cardinals in the right valve; these are situated one below the other and the lower is better developed, both, however, are in continuation of the laterals; in the left valve there is only a single pseudo-cardinal like a feebly developed ridge, simple in most specimens but in a few becoming cut up by a notch into two. In the latter case, owing to the inclined nature of the notch and the unequal development of the two component parts of the ridge of the anterior edge, the posterior of the two teeth comes to lie at a slightly lower level than the anterior tooth and this results in the production of two distinct pseudo-cardinals in the left valve also. The gradual evolution of the two teeth can be traced in a large series. The lateral teeth are somewhat curved, there being two in the left and a single one in the right valve. A trace of a second lateral in the form of a minute ridge at the base of the lamellar lateral of the right valve can also be seen in some fully grown specimens.

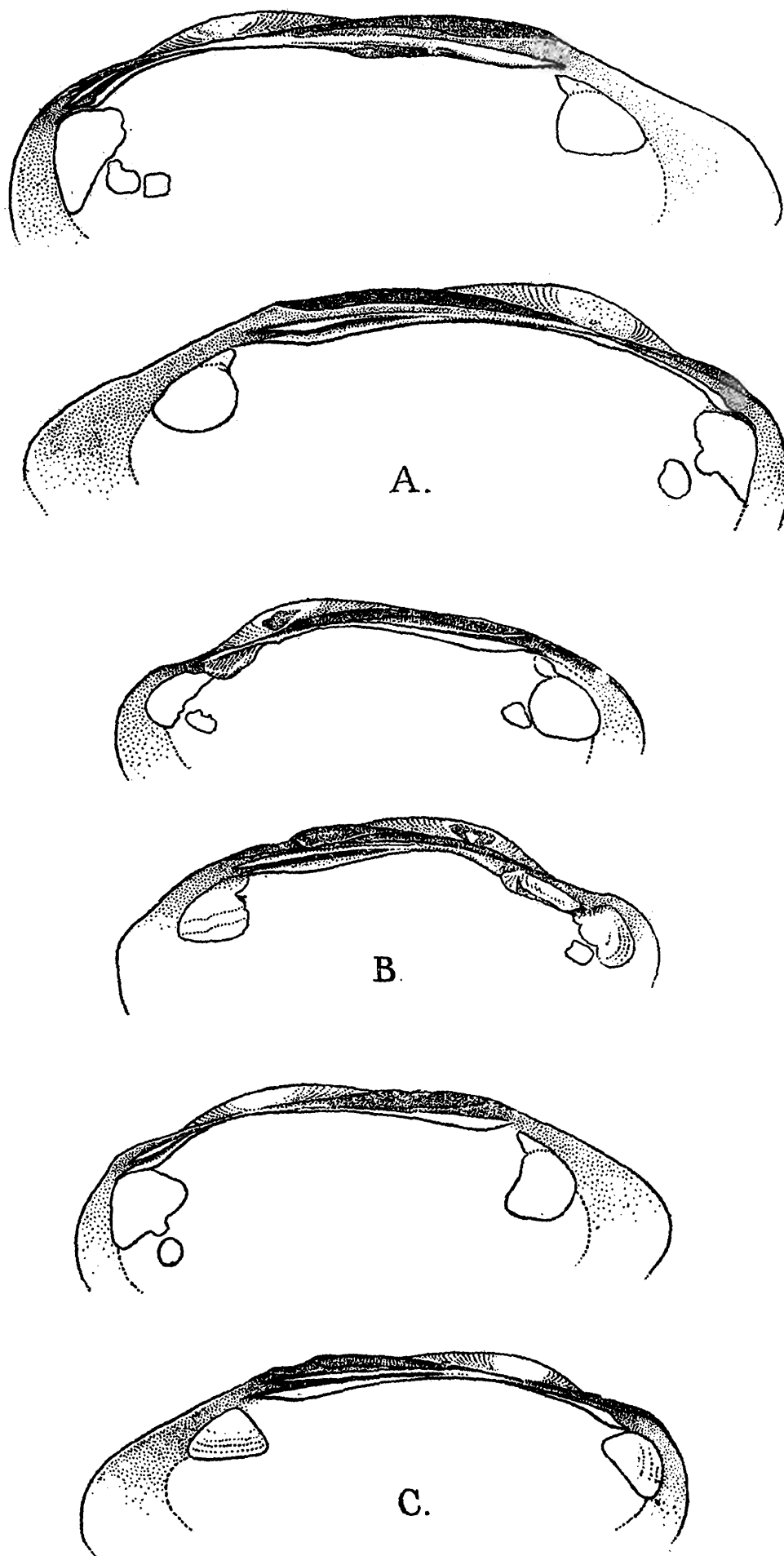


FIG. 29.—Hinge-teeth of *Lamellidens*.
A. *L. marginalis* (Lam.). B. *L. consobrinus* (Lea). C. *L. corrianus* (Lea).

The animal differs from that of *L. corrianus* described in the paper cited in the following characters :—The inner pair of gills is broader than the outer throughout its length. Both pairs of gills are marsupial and when fully charged with glochidia are of a dull brownish colour. The palpi are comparatively larger and elliptic in outline. The foot is better developed, being a powerful burrowing organ in this species. The branchial aperture is about one and a half times the size of the anal and has the papillae along its border more numerous and much larger.

Half a dozen specimens of this species were collected by Mr. S. L. Hora in a small rapid-running stream at Mara Khong at a distance of about six miles from Imphal on the Bishenpur Road. The shells of these specimens are quite typical of the species in shape but are rather thin.

Lamellidens consobrinus (Lea).

- 1911. *Lamellidens consobrinus*, Ortmann, *Nautilus* XXIV, p. 106, pl. vii, fig. 4.
- 1914. *Lamellidens consobrinus* (in part), Simpson, *op. cit.*, pp. 1171, 1172.
- 1915. *Lamellidens marginalis* subsp. *consobrina*, Preston, *op. cit.*, p. 180.

Preston considers *L. consobrinus* to be a subspecies of *L. marginalis*. After a careful comparison of large series of the two species I do not consider that this conclusion is justified. Preston was probably led to it by mixing up specimens of the two species while identifying the Indian Museum collection. Simpson includes *L. mainwaringi* (Nevill MS.), Preston, as a synonym of *L. consobrinus*. Unfortunately Preston's figures of the hinge of this species are very poor and his description of the shell also lacks precision in some important details. It may be noted briefly here that *L. mainwaringi* is a distinct species, not at all allied to *L. consobrinus*, its nearest relation amongst the Indian forms being *L. corrianus*.

The shell in this species is rhomboidal, rather solid, with the beaks more inflated and elevated than in *L. marginalis*. The dorsal slope is curved and obliquely truncate. The hinge (fig. 29 B) is very different from that of *L. marginalis*. In the right valve there are two widely separated pseudo-cardinals lying one below the other, of these the lower is much larger, thicker and better developed than the upper. The left valve has two somewhat ragged pseudo-cardinals more or less in the same line; the anterior of the two is very much larger and better developed. The laterals are distinctly arched, there being a single well developed and the rudiment of a second in the right and two fully developed ones in the left valve.

In a single male specimen in spirit the animal conforms to Ortmann's description.

The species is represented in the Manipur collection by a single specimen collected in the Sikmai Stream about six miles

from Kakching, on the Burma-Manipur Road, and many empty shells from the banks of the Amambi stream some eight miles from Imphal. The shells of this species are locally known as *Shuni-kongrein*, and are utilised for the manufacture of lime.

Lamellidens corrianus (Lea).

1914. *Lamellidens corrianus*, Simpson, *op. cit.*, pp. 1174, 1175.

1915. *Lamellidens marginalis*, subsp. *corrianus*, Preston, *op. cit.*, pp. 183, 184.

This species is not a form of *L. marginalis*, as Preston thinks, but quite distinct, for not only are the shells different but the marsupium also is formed quite differently in the two species.

The shell of *L. corrianus* is very thin and delicate, elongate-elliptical in form, with the beaks only slightly inflated and not at all elevated. The dorsal slope is comparatively long and straight, or nearly so, and the posterior wing is much broader than in *L. marginalis*. There are two pseudo-cardinals (fig. 29C) in the right valve, the upper of the two being rather small and thin; in the left valve also the two pseudo-cardinals are distinct, but the upper and posterior one is feebly developed. The lateral teeth, which are two in the left and one in the right valve, are only slightly arched.

The soft parts have already been described and figured by me as those of a form of *L. marginalis*. In the Manipur specimens also the glochidia were found in the outer pair of gills only, the inner pair being purely respiratory in function.

This is the commonest Unionid in the Manipur Valley and is the only one found in the Loktak Lake. Large numbers of dead shells of this species were found by the Manipur Survey party in the swampy area at the north end of that body of water. Mr. S. L. Hora also collected specimens of it in various streams in the valley.

Genus Trapezoideus, Simpson.

1900. *Trapezoideus*, Simpson, *op. cit.*, p. 858.

1914. *Trapezoideus*, Simpson, *op. cit.*, p. 1180.

1915. *Trapezoideus*, Preston, *op. cit.*, p. 193.

Simpson established this genus in 1900 for a number of rather peculiar Burmese, Siamese, Cambodian and Sumatran Unionids and also included in it Benson's species *Unio theca* from the Cane River, Bundelkhand, Central India. I have not seen specimens of this latter species but from the description it is doubtful whether the species is congeneric with the Burmese forms.¹ A few specimens from the Koyna Valley, Satara District, Bombay Presidency in the collections of the Zoological Survey, which had been wrongly identified as *Trapezoideus foliaceus* (Gould), do not belong to this genus, but are specimens of the interesting form

¹ Simpson also on p. 1186 of his Catalogue (*loc. cit.*) expresses a doubt as to the exact systematic position of Benson's species.

Arcidopsis footei (Theobald). The genus therefore appears to be a true Eastern one confined to Assam, Burma, Siam, Cambodia and Sumatra.

In the collection the genus is represented by a single shell of *T. misellus* (Morelet) from the Manipur Valley and by many specimens of a new species from the base of the Naga Hills, Assam. Living specimens of the new species were brought to Calcutta by Mr. S. L. Hora and from these I am able to describe the hitherto unknown animal of this genus.

Animal with the outer and inner gills of nearly the same width posteriorly, but the outer shorter in length than the inner; inner lamellae of the inner pair of gills united in the anterior $\frac{2}{3}$ of their length to the abdominal mass on each side while in the posterior third the lamellae of the two sides are united with each other to the end. Palpi large. Mantle entire with quite simple margin. Branchial aperture large, of a light brownish colour, with many

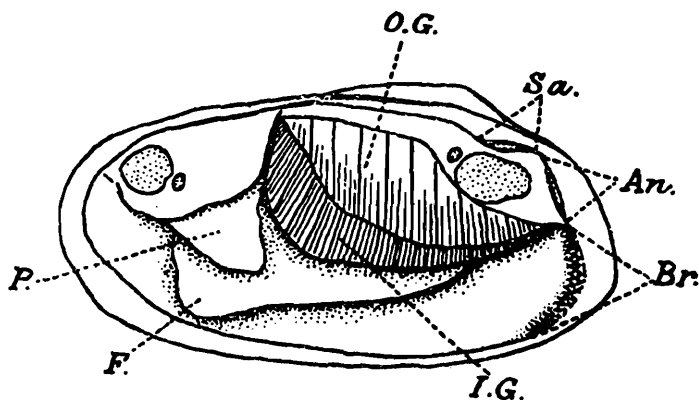


FIG. 30.—Soft parts of *Trapezoideus dhanushori*, Prashad.

An. Anal aperture; Br. branchial aperture; F. foot; I.G. inner gill; P. palp; O. G. outer gill; Sa. supra-anal aperture.

rows of elongate papillae along the border. Anal aperture about $\frac{3}{4}$ the size of the branchial, dark brown in colour and with a single row of minute papillae on its margins, supra-anal distinct, smaller than the anal and separated from it by a mantle connection about half the size of the anal. Marsupium formed by all the four gills.

Trapezoideus misellus (Morelet).

- 1900. *Trapezoideus misellus*, Simpson, *op. cit.*, p. 859.
- 1914. *Trapezoideus misellus*, Simpson, *op. cit.*, pp. 1182, 1183.
- 1915. *Trapezoideus misellus*, Preston, *op. cit.*, p. 194.

Mr. S. L. Hora picked up a dead shell of a half-grown specimen of this species at the edge of a swamp about five miles from the Thoubal Stream in the Manipur Valley.

The shell is quite typical in shape and hinge, but does not show any sculpture owing to the umbones being eroded.

The species was previously known from Siam, Tenasserim and Burma only.

Trapezoideus dhanushori, sp. nov.

This interesting species was found by Mr. S. L. Hora in a stream known as Dhanushori at a distance of about a mile from Dimapur, Assam, and is not a Manipur species. It may be described as follows:—

Shell (fig. 31) rather small, thin, trapezoidal, somewhat compressed, with a low posterior ridge and narrow wing. Umbones small, slightly tumid and deflexed inwards, sculptured with vertical ridges radiating outwards, more marked on the two sides than in the middle where they are less distinct. Anterior margin obliquely truncated rounded above, sharply curved backwards below; broadly rounded posteriorly. Ventral margin straight but slightly curved in near the middle. Surface concentrically sculptured with deeply impressed lines, a few radial lines are also to be

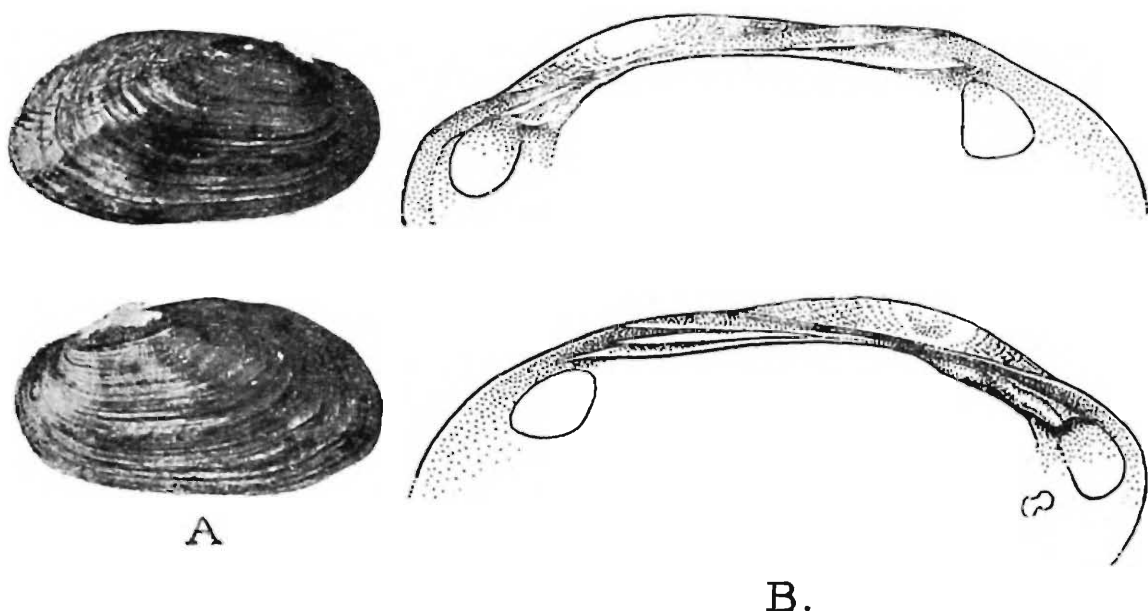


FIG. 31.—*Trapezoideus dhanushori*, Prashad.

- A. Photographs of the two valves of the type-shell.
B. Hinge-teeth.

seen on the posterior region. Epidermis brownish yellow. Right valve with two pseudo-cardinals, of which the outer is feebly developed, and a single slightly arched lateral; left valve with two pseudo-cardinals, of these the inner situated under the beak and continuous with the outer of the two laterals. Muscle-scars fairly impressed, anterior ones separate, posterior confluent; nacre greyish-yellow tinged with blue, under the beaks markedly yellow; slightly iridescent.

Measurements of Shells (in millimetres).

	1	2	3
Length	35.5	34.1	35.4
Breadth	19.7	17.3	18.2
Height	13.2	11.6	13.4

Type-series.—No. M 11962/2 in the Zool. Surv. Ind. (*Ind. Mus.*)

The soft parts conform to the description of the genus given already.

The type-series was collected in the Dhanushori stream in Assam.

T. dhanushori bears some superficial resemblance to *T. foliaceus* (Gould), but differs in the comparatively more elongate shell, more evenly rounded anterior margin, poorly developed posterior wing and more prominent umbones. The hinge also is different in the two species.

Family CYRENIDAE.

Genus *Corbicula*, Megerle.

This genus is represented in the collection by three species. Of these *C. striatella* is common throughout India and Burma, *C. occidens* has a wide distribution in the Central Provinces, United Provinces, Bengal, Bihar and Orissa. Sikkim and Assam, while the exact habitat of *C. subradiata* was hitherto unknown.

The only account of the anatomy of any of the Indian species is contained in a recent paper¹ by myself on the soft parts of *C. fluminalis*—the type-species of the genus. The soft parts of the three species here discussed are very like those of *C. fluminalis*; the differences from it are included in the notes on the different species.

Corbicula occidens, Deshayes.

1854. *Corbicula occidens*, Deshayes, *Cat. Brit. Mus. Conchifera*, p. 223.

1900. *Corbicula occidens*, Preston, *op. cit.*, p. 216.

The range of distribution of the species according to Preston is "Sikkim, Moradabad, Bengal," but in the collections of the Indian Museum there are specimens from various places in the Central Provinces, Bihar and Orissa, and Assam in addition to the localities given by Preston.

The only point of interest to note in connection with the shell is the slightly discontinuous pallial line. The line runs down as a vertical straight line from the lower edge of the impression of the posterior adductor muscle, and this part forms a little more than a right angle with its horizontal continuation forwards to the scar of the anterior adductor muscle. This condition is a little more advanced than that in *C. largillierti* figured by Prime² and is correlated with a better development of the siphonal muscles.

The soft parts generally resemble those of *C. fluminalis* described in the paper cited, but differ in having the siphonal muscles, the siphons and the foot a little better developed, in the inner pair of gills being much broader (about one and a half times)

¹ *Rec. Ind. Mus.* XVIII, pp. 209–211 (1920).

² *Ann. Lyceum Nat. Hist. N. York* VIII, d. 420, fig. 4 (1867).

than the outer and the outer pair being a little shorter in length. The palpi, however, are comparatively larger.

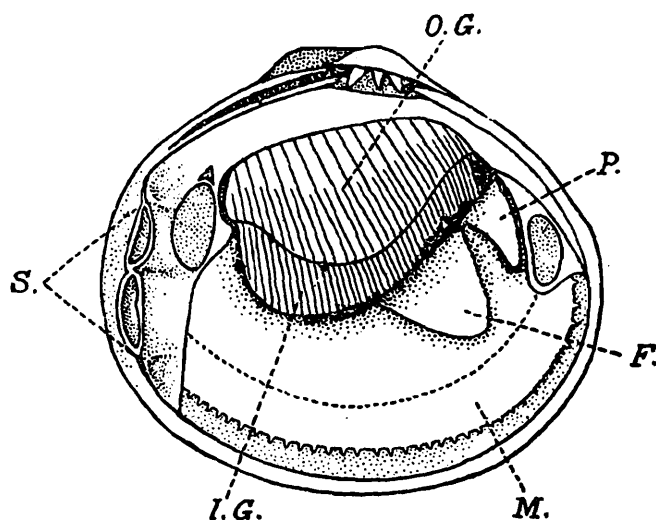


FIG. 32.—Soft parts of *Corbicula occidens*, Deshayes.

F. foot ; *I.G.* inner gill ; *M.* mantle ; *O.G.* outer gill ; *P.* palp ; *S.* siphons.

Many specimens of this species were obtained by the Manipur Survey party from a muddy channel flowing into the Loktak Lake near Potsengbam Bungalow. Specimens were also collected from various other streams in the Manipur Valley.

Corbicula striatella, Deshayes.

1854. *Corbicula striatella*, Deshayes, *Proc. Zool. Soc. London* XXII, p. 344.

1867. *Corbicula striatella*, Prime, *Ann. Lyceum Nat. Hist. N. York* VII, p. 74, fig. 22.

This species is not confined to Pondicherry and Sind as Preston states, but is fairly common all over India. The only specimens in the present collection are from a small stream near Waikhong on the Manipur-Burma Road.

The sinus of the pallial line is much better marked in this species than in *C. occidens*, and the siphons and siphonal retractor muscles are accordingly much better developed and distinctly marked off from the pallial muscle. I hope to elaborate this point for the other Indian species in another place.

The soft parts, except for the differences noted above, are like those of *C. occidens*.

Corbicula subradiata, Prime.

1867. *Corbicula subradiata*, Prime, *op. cit.*, p. 75, fig. 23.

1915. *Corbicula subradiata*, Preston, *op. cit.*, p. 213.

The precise locality from which the type-specimens of this species were obtained is not given by Prime. In the *Conchologia Indica* Hanley and Theobald state that they never obtained any specimens of this species and consider it and *C. agreensis* to be prob-

ably based on immature specimens. In the Manipur collection there are specimens from small streams near Potsengbam and from a large shallow artificial tank called Ningyang Pukri at Imphal. All these specimens closely agree with Prime's description and figures and are sexually mature. The shell in this species is rather small and apparently does not grow larger than 15 mm. in length. The pallial line is a regular curve and does not show any sinus.

The soft parts resemble those of the other two species described already, but differ in the poor development of the siphonal retractor muscles and the siphons.

Genus *Sphaerium*, Scopoli.

1900. *Sphaerium*, Preston, *op. cit.*, pp. 223, 224.

Three species of this genus have hitherto been described from India; of these *S. indicum* is a widely distributed species both in



FIG. 33.—Hinge teeth of *Sphaerium*.

A. *S. indicum*, Deshayes.

B. *S. austeni*, Prashad.

the plains and in the Himalayas, while *S. avanum* is only known from Ava and Pegu in Burma. The third species, *S. montanum*, Tapparone-Canefri,¹ is only known from Burma but the original description is not sufficient to identify this species. In the collections of the Indian Museum I have found specimens of an undescribed species from the Naga Hills and Manipur, probably from the collections made in these parts by Lt.-Col. H. H. Godwin-Austen. The three species before me may be distinguished from one another by the use of the following key:—

1. Shell large, 9.5 mm. in length, much swollen, with very prominent umbones and with strongly impressed concentric sculpture *S. avanum*.
2. Shell smaller and not so much swollen as in *S. avanum*.
 - a. Shell ovato-rhomboid, thin and translucent, with the umbones only slightly prominent and with very faint sculpture *S. indicum*.

¹ *Ann. Mus. Civ. Stor. Nat. Genova* (2) VII, p. 356 (1889), see Addendum, p. 630.

- b. Shell elongate-ovate, rather thick and opaque, with the umbones more prominent than in *S. indicum*, but much less so than in *S. avanum*; sculpture better marked than in *S. indicum* ... *S. austeni*.

***Sphaerium indicum*, Deshayes.**

1854. *Sphaerium indicum*, Deshayes, *Proc. Zool. Soc. London* XXII, p. 342.

1915. *Sphaerium indicum*, Preston, *op. cit.*, p. 224.

Preston is certainly mistaken in assigning this species to A. Adams and in considering Deshayes' name as a manuscript name only, for the reference to the original description of the species cited above and noted by Preston is a paper by Deshayes on new species of shells in Cumming's collection, and not by A. Adams as Preston states. A paper by A. Adams is published immediately preceding that of Deshayes and Preston apparently confused them when citing the references.

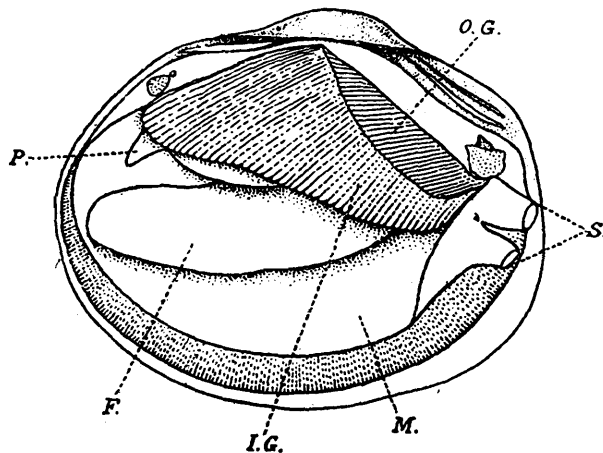


FIG. 34.—Soft parts of *Sphaerium indicum*.

F. foot; *I.G.* inner gill; *O.G.* outer gill; *M.* mantle; *P.* palp; *S.* siphons.

The hinge of this species differs from that of my new species, described further on, in the laterals being much better developed and less curved and in there being a single well-developed cardinal in the right valve, the second cardinal of this valve is much reduced or even absent in some specimens.

The soft parts of this species are described in detail below as no account of the anatomy of Indian species has been published before.

The animal conforms in shape to that of the shell and is of a whitish colour. Of the adductor muscles, the anterior is rather small and rounded while the posterior is much larger and somewhat quadrangular in outline. The posterior retractor pedals are well developed and lie above the posterior adductors. The pallial muscles consist of radiating muscle-fibres starting from just below the pallial attachment and are continued in the inwardly reflected region of the mantle. No siphonal retractors can be distinguished from the pallial fibres.

The mantle is very thin and without any papillae on the edge. Its flaps differ from those of the genus *Corbicula* in having a fairly broad portion of the free edge reflected inwards towards each other. The siphonal and pedal orifices are formed in the same way as in *Corbicula* by the union of the flaps of the two sides.

The two siphons, anal and branchial, are quite separate tubular structures capable of a fair amount of elongation; of the two the branchial is much better developed. Both siphons have smooth edges for the external openings, there being no papillae encircling them. Jacobsen¹ describes the siphons as having "filaments encircling the apertures," this seems to be a mistake as none are present in *S. indicum* and none are shown for the American species described and figured by Gilmore;² Fischer³ also describes the orifices of the siphons in this genus as simple.

Jacobsen's account of the gills in *S. cornea* is inaccurate when he says that "the interior gills overlap the exterior ones," and a good deal of what he says further on is not easy to follow. F. Leidig's⁴ and Oscar Schmidt's⁵ papers contain very little on the structure of the gills of the European species dealt with by them. I have not seen Drew's paper⁶ on the anatomy of *S. sulcatum* but from the summary in Gilmore's paper cited already these two accounts seem to be the best ones available. Gilmore's description of the attachment of the inner lamellae of the inner gills, however, does not appear to be accurate when he says "the inner lamella of the inner gill is attached to the body," for in *S. indicum*, as is usual in other Cyrenids, at least a portion of the inner gills (in this case nearly one-fourth of the total length) projects beyond the posterior limit of the body-mass. This posterior part of the inner lamella is not fused with that of the corresponding part of the lamella of the opposite side but is quite free. The two pairs of gills differ in length and width. The inner pair of gills is more than twice as broad as the outer throughout, while in the anterior region it is still broader, anteriorly it also extends a little further than the inner pair of gills.

In the specimens examined the marsupium was found to be formed by the cavities of the filaments of the inner pair of gills only, as was observed by Gilmore in the American species. The Manipur specimens were collected during February and March, 1920, and it appears, therefore, from the stage of development of the embryos in the brood-pouches that the breeding season of this species in Manipur starts some time in January if not earlier.

The labial palps are triangular, slightly elongate structures partly covered over by the anterior portion of the inner pair of

¹ *Proc. Roy. Dan. Soc. Nat. Hist.* III (1828), translated by Prime in *Bull. Mus. Comp. Zool. Harvard* V, pp. 49-54, pl. iii (1878).

² *Nautilus* XXXI, pp. 16-31, pls. v, vi (1917).

³ *Man. de Conchotirol.*, p. 1093 (1887).

⁴ *Müller's Arch. Anat. Physiol.* pp. 47-66, pl. vi, figs. 8-18 (1855).

⁵ *Ibid.*, pp. 428-439, pl. xvi (1854).

⁶ *Proc. Iowa Acad. Sci.* III (1895).

gills. The oesophageal region is short and curves back to open into the spacious stomach. The intestinal region is comparatively short without any loops, and after a postero-dorsal course curves back to form the rectum, which after passing through the pericardium curves down to open at the anus just behind the posterior adductor muscle. The liver is large and well developed, the greater part of it lying within the umbonal region. The foot is a very elongate, tongue-shaped structure in continuation of the abdominal mass and has the statocyst lying just a little below the boundary line between the abdominal mass and the foot.

The nervous and reproductive systems are quite similar to those of *Calyculina* figured by Gilmore.

The species is quite common in the Manipur Valley, and a large number of specimens was collected by the Manipur Survey party from various streams and ponds in different places.

Sphaerium austeni, sp. nov.

Shell elongate-ovate, swollen, sub-equilateral, comparatively thick, opaque; anterior margin small, broadly rounded; posterior margin truncated, nearly straight; lower border somewhat curved. Umbones prominent, somewhat swollen, incurved and nearly touching each other in the middle. Epidermis rather smooth in young, with closely situated concentric striae in full-grown specimens; of a dark horny to a yellowish-brown in colour, shining, and with a distinct pale band along the margin.



FIG. 35.—Shell of *Sphaerium austeni*, sp. nov.

Nacre whitish to light blue. Right valve with two lamellar laterals, of which the lower is better developed and has a broad triangular flange projecting inwards and upwards, and with two cardinals, of which the anterior is large and triangular and the posterior small and rounded. Left valve with a single lateral on each side and two cardinals, the anterior rounded and pad-like and the posterior small, thin and lamellar.

Measurements of Shells (in millimetres).

	A.	B.	C.
Length	9.4	7.5	5.8
Breadth	7.3	5.6	4.6
Thickness	5.7	3.4	2.9

Type-series.—M 7141-8/1 Zool. Surv. Ind. (*Ind. Mus.*).

The type-series is from the Naga Hills, Assam, and was probably collected by Lt.-Col. H. H. Godwin-Austen, with whose name I have associated the species. There is also another series of this species from Manipur in the Indian Museum.

The species though closely allied to *S. indicum* differs from it in the relative length and breadth of the shell, in the umbones being more swollen, in hinge-structure and the sculpture of the shells.

Genus *Pisidium*, Pfeiffer.

1913. *Pisidium*, Woodward, *Cat. Brit. Species of Pisidium*, pp. 1, 2.
1915. *Pisidium*, Preston, *op. cit.*, pp. 224, 225.

The Indian species of this genus are very imperfectly known, the descriptions of older authors being incomplete. A revision of the Indian species is in preparation and will be published separately; here I have only assigned the Manipur specimens to their proper species.

Pisidium clarkeanum, G. and H. Nevill.

1871. *Pisidium clarkeanum*, G. and H. Nevill, *Fourn. As. Soc. Bengal* XL, p. 9, pl. i, figs. 4, 4a-d.
1915. *Pisidium clarkeanum*, Preston, *op. cit.*, p. 225.

The original description of the species by G. and H. Nevill, as was pointed out by Theobald,¹ is inaccurate in that the authors have wrongly described the posterior side as longer instead of the anterior; their figures, however, show the posterior side as the shorter of the two.

In the Manipur collection there is a single specimen of this species collected by the Survey Party at Potsengbam near the edge of the Loktak Lake. I assign this single specimen to this species with confidence as I have compared it with the types, which are in the collection of the Indian Museum.

Pisidium hydaspicola, Theobald.

1878. *Pisidium hydaspicola*, Theobald, *Fourn. As. Soc. Bengal* XLVII, p. 147.
1915. *Pisidium hydaspicola*, Preston, *op. cit.*, p. 225, fig. 27.

The species was originally described from Shupion in Kashmir, but there is a specimen of it from Bhagalpur, Bihar, and Mr. S. L. Hora also collected many specimens in a stream near the Yaribuk Bungalow and also from small streams on the road to Shugui from Wai-khong in the Manipur Valley.

Most of the specimens are very small. Of those in spirit some are gravid. An account of their anatomy will be published along with the revision of the genus.

¹ *Fourn. As. Soc. Bengal*, XLV, pt. ii, p. 188 (1876).

GEOGRAPHICAL AND ECOLOGICAL DISTRIBUTION,
PLASTICITY AND VARIATION.

By N. ANNANDALE.

GEOGRAPHICAL DISTRIBUTION.

It will be as well for me to begin this section of our paper with a list of the species we have discussed.

List of the Aquatic and Amphibious Mollusca of the Manipur Valley.

GASTROPODA.

Order PECTINIBRANCHIATA.

HYDROBIIDAE.

1. *Amnicola (Alocinma) orcula* (Frauenfeld).
2. *Digoniostoma pulchellum* (Benson).
3. *Digoniostoma textum*, Annandale.

VIVIPARIDAE.

4. *Vivipara crassispiralis*, Annandale.
5. *Vivipara oxytropis* (Benson).
6. *Vivipara micron*, Annandale.
7. *Lecythoconcha lecythis* (Benson).

MELANIIDAE.

8. *Melanoides tuberculatus* (Müller).
9. *Acrostoma variabilis* (Benson).
10. *Paludomus pustulosa*, Annandale.

AMPULLARIIDAE.

11. *Pachylabra maura* (Reeve).

Order PULMONATA.

SUCCINEIDAE.

12. *Succinea rutilans*, Blanford.
13. *Succinea elegantior*, Annandale.

LIMNAEIDAE.

14. *Limnaea acuminata*, Lamarck.
15. *Limnaea ovalis*, Gray.
16. *Limnaea andersoniana*, Nevill.
17. *Limnaea ovalior*, Annandale and Prashad.

PLANORBIDAE.

18. *Indoplanorbis exustus* (Deshayes).
19. *Gyraulus convexiusculus* (Hutton).
20. *Gyraulus cantori* (Benson).
21. *Hippeutis* (?) *umbilicalis* (Benson).
22. *Segmentina calathus* (Benson).
23. *Camptoceras lineatum*, Blanford.

ANCYLIDAE.

24. *Ancylus* (*Ferrissia*) *viola*, Annandale and Prashad.
25. *Ancylus* (*Ferrissia*) *verruca*, Benson.
26. *Ancylus* (*Ferrissia*) *ceylanicus*, Benson.

PELECYPODA.

UNIONIDAE.

27. *Indonaia occata* (Lea).
28. *Indonaia bonneaudi* (Simpson).
29. *Indonaia scobina* (Hanley).
30. *Indonaia theobaldi* (Preston).
31. *Indonaia lima* (Simpson).
32. *Lamellidens marginalis* (Lamarck).
33. *Lamellidens consobrinus* (Lea).
34. *Lamellidens corrianus* (Lea).
35. *Trapezoides misellus* (Morelet).

CYRENIDAE.

36. *Corbicula occidens*, Deshayes.
37. *Corbicula striatella*, Deshayes.
38. *Corbicula subradiata*, Prime.
39. *Sphaerium indicum*, Deshayes.
40. *Sphaerium austeni*, Prashad.
41. *Pisidium clarkeanum*, G. and H. Nevill.
42. *Pisidium hydaspicola*, Theobald.

Twenty-two genera and subgenera are mentioned in this list of forty-two species. Of the genera and subgenera only six call for any special comment, the remaining fourteen being of wide and general distribution in the Oriental Region if not over the whole world. The six are *Alocinma* (subgenus of *Amnicola*), *Digoniostoma*, *Lecythoconcha*, *Camptoceras*, *Indonaia* and *Trapezoides*. The first of these is known from Mesopotamia, Seistan, all parts of Peninsular India, Upper Burma and Manipur. Its headquarters are in Peninsular India. The genus *Digoniostoma* has recently been described to contain certain Peninsular Indian species. It is common all over India proper and Assam, but has not been found west of the Indus or in Burma. *Lecythoconcha*, on the other hand, is an eastern genus, the range of which extends from Manipur (and

possibly Sylhet) in the west across Upper Burma and China to the Philippines, Formosa and Japan. The precise geographical range, which at present appears discontinuous, is probably unknown. Species have been found in Kashmir, the valleys of the Ganges and Brahmaputra, Manipur and Japan. Our present knowledge of the anatomy of the Oriental Unionidae is too incomplete to render it possible to lay down exact geographical boundaries for the genera, *Indonaia* is apparently characteristic of the eastern parts of the Indian Empire, but extends well into Peninsular India, while *Trapezoideus* probably does not occur west of Eastern Assam and has its headquarters in the Indo-chinese peninsular area.

The genera of aquatic molluscs found in Manipur do not, therefore, provide any very clear guidance as to the origin of its aquatic fauna, except in so far as they indicate the presence of a distinct Far Eastern element. *Lecythoconcha* is the most noteworthy in this respect. It is also noteworthy, however, that the characteristic Burmese genera *Hydrobioides*, *Taia* and *Temnotaia* have not been found in Manipur.

In analysing the list of species from a geographical point of view it will be as well to consider the Gastropoda and the Pelecypoda separately, for they follow different rules in their dispersal. There are twenty-six names of Gastropod species on the list. Three of these have a very wide range in the Oriental Region namely *Indoplanorbis exustus*, which is common all over the plains of the Indian Empire east of the Indus, Siam, the Sunda Isles, etc.; *Melanoides tuberculatus*, distributed practically all over the Ethiopian and Oriental Regions (except at high altitudes) and found also in adjacent parts of the Palaearctic and Australasian Regions, and *Gyraulus convexiusculus*, the range of which extends on the mainland from Mesopotamia to Eastern China and includes a considerable part of the Malay Archipelago.

Nine species may be called "Indian," being found both east and west of the Bay of Bengal but not, or only a short distance beyond, the eastern boundaries of the Indian Empire and not or hardly west of the Indus. They are:—

<i>Amnicola orcula.</i>	<i>Hippeutis (?) umbilicalis.</i>
<i>Acrostoma variabilis.</i>	<i>Segmentina calathus.</i>
<i>Limnaea acuminata.</i>	<i>Ancylus verruca.</i>
<i>Limnaea ovalis.</i>	<i>Ancylus ceylanicus.</i>
<i>Gyraulus cantori.</i>	

The first of these species is essentially Gangetic and is replaced in Peninsular India and Ceylon by a closely allied species or race, *A. stenothyroides* (Dohrn). It has not been found in Burma. *Limnaea acuminata* and *L. ovalis* are found all over the Indo-Gangetic plain and Peninsular India. The former is known from Upper Burma; the latter has not previously been recorded from any place east of the Bay of Bengal, and is very rare in Manipur. *Gyraulus cantori* is a scarce species, closely related to the widely distributed *G. convexiusculus* and at present known

only from the Ganges Valley and Manipur. *Hippeutis* (?) *umbilicalis* has a similar range but was described from Sylhet. It is the most abundant Planorbis in the Manipur Valley, but is scarce in that of the Ganges. The range of *Segmentina calathus* extends from Seistan, beyond the western frontiers of the Indian Empire, to Upper Burma and Sumatra. The two species of *Ancylus* have both been found in Ceylon as well as in Peninsular India. The origin of most of these species is probably to be sought in the Gangetic plain or Peninsular India, but the species assigned doubtfully to *Hippeutis* may be of Assamese origin. This is still more probable of *Acrostoma variabilis*, which is common throughout the plains of Burma and Assam but in India west of the Bay of Bengal extends only for a short distance up the Gangetic system, where its numerous varieties and phases have usually a dwarfed facies and do not exhibit the same sturdy appearance that they do further east.

The "Indian" element among the freshwater Gastropods of Manipur may thus be regarded as of mixed origin, partly Indian in a strict sense, partly immigrant into India proper from further east. But on the whole the former element predominates.

The aquatic fauna of Assam has less of an indigenous element than that of the Ganges Valley and is, indeed, largely compounded of a mixture of that of India proper and that of Burma. The indigenous element, however, is not wholly wanting in the Brahmaputra watershed, and to this element we must assign three of the Manipur Gastropods, viz. *Digoniostoma pulchellum*, which is hardly more than a local race of the Gangetic *D. cerameopoma*, *Pachylabra maura*, which bears much the same relationship to the Gangetic *P. globosa*, and *Camptoceras lineatum*. This last species was originally discovered in what is now the Dacca District of Eastern Bengal, at a place beyond the political frontiers of Assam, but within the limits of the Brahmaputra system. It is noteworthy as the only species of its genus that has been found at more than one place, and its rediscovery in Manipur has, therefore, some interest. The species is abundantly distinct from any other. Its nearest ally is *C. subspinosum* from the valley of Kashmir in the western Himalayas.

Two Gastropod species on our list have as yet been found only in the Manipur Valley and at Dimapur in the plains of North-eastern Assam just north of the Naga Hills. They are *Limnaea ovalior* and *Ancylus viola*.

The isolation of the Manipur Valley renders the existence in it of endemic species by no means surprising. So far as our knowledge goes, five Gastropod species on our list belong to this category, namely *Digoniostoma textum*, *Vivipara crassispinalis*, *V. micron*, *Paludomus pustulosa*, *Succinea elegantior*. Half of these belong to the genus *Vivipara* and it is worthy of mention that each of the two species belongs to a different section¹ of the

¹ *Rec. Ind. Mus.* XIX, pp. 112-114 (1920).

genus, *V. crassispiralis* to the Viviparae bengalenses and *V. micron* to the Viviparae dissimiles. Each species, however, is quite distinct from any other, as are also *D. textum* and *S. elegantior*, the resemblance between the shell of the latter and that of the Indo-Burmese *S. semiserica* being superficial. The *Paludomus*, on the other hand, is closely allied to *P. conica*, a remarkably plastic Assamese species with many local races, amongst which the Manipur form might perhaps be included.

Considered as a whole the Gastropod molluscs of the ponds, swamps and streams of Manipur are thus remarkable from a geographical point of view in only one feature, in the small evidence they afford of a close connection with those of Burma such as might have been postulated from the fact that the river-system of the Manipur Valley, in which the great majority of them live, is directly connected with the largest tributary of the Irrawadi and completely isolated from all other systems.

We may now consider the geographical distribution of the bivalve molluscs of Manipur. Among these six genera are represented, *Indonaia*, *Lamellidens*, *Trapezoides*, *Corbicula*, *Sphaerium* and *Pisidium*. The first three genera belong to the Unionidae, the last three to the Cyrenidae. As the two families have different means of dispersal and also different limitations in their dispersal, we may consider them separately. The parasitic period in the life of the Unionidae and the fact that the different species are attached to different species of fish in this period give the members of the family a peculiar means of progression from one part of a river-system to another and at the same time correlate their geographical distribution with that of their hosts. We might expect, therefore, that the Unionidae of the Manipur Valley would be more exclusively Burmese than either the Gastropods or the Cyrenidae. Mr. Sunder Lal Hora, who has worked out the large collection of fish he made in Manipur, tells me that he finds among them a large proportion of Burmese species and that he obtained evidence, direct and indirect, that certain species migrate up the Imphal River at certain seasons. That such fish should bring with them from Burma the glochidia of Burmese Unionidae would be what might be expected. But the evidence for this is not very strong. The genus *Trapezoides* is certainly in the main a Burmese and Indo-chinese genus and the only species found in Manipur (*T. misellus*) is a Burmese and Indo-chinese species, but the occurrence of another, hitherto undescribed species (*T. dhanushori*, Prashad) north of the Naga Hills considerably discounts the value of this piece of evidence, though it does not run counter to it. *Indonaia*, although it has its headquarters in the north-eastern part of the Indian Empire, is by no means exclusively Burmese. Three of the four species found in Manipur have also been found in Assam if not in India proper, and only two of these in Burma, while the fourth is known only from the Manipur Valley.

Even from the Unionidae, therefore, evidence for any but a

recent connection with Burma is by no means strong, and the Asamese and Bengali element in the fauna is clearly shown.

The three genera of Cyrenidae represented in the Manipur fauna are all of exceedingly wide range, *Sphaerium* and *Pisidium* being almost cosmopolitan, while *Corbicula* is found in the warmer parts of all regions.¹ The species of these genera known from Manipur, with two possible exceptions, have a wide range in northern India, the two exceptions being *C. subradiata*, for which the Manipur Valley is the only precise locality recorded, and *S. austeni* which is only known from Manipur and the Naga Hills. Of the others, *C. occidens* and *C. striatella* occur all over the plains of India, while *S. indicum*, *P. clarkeanum* and *P. hydaspicola* have been found at considerable altitudes in northern India as well as in widely separated localities in the Indo-Gangetic plain.

The Cyrenidae, indeed, provide as little evidence for long-established connection between the Manipur Valley and Burma as any other family of aquatic molluscs.

To sum up, therefore, the geographical affinities of the aquatic and amphibious Mollusca of Manipur as revealed by the distribution of genera and species, it may be stated briefly that these affinities are rather with the molluscs of Assam and the Gangetic Valley than with those of the valley of the Irrawadi or the Salween and that the Burmese element is much smaller than might be expected from the close connection between the river-system of the Manipur Valley and of the Irrawadi.

ECOLOGICAL DISTRIBUTION.

As might be expected in a swampy valley like that of Manipur, the aquatic fauna is largely paludine. Even in the Loktak Lake there has been no evolution of a true lacustrine fauna, and, indeed, the number of species of aquatic molluscs is comparatively small. The species found actually in the lake are—

<i>Vivipara oxytropis.</i>	<i>Gyraulus cantori.</i>
<i>Lecythoconcha lecythis.</i>	<i>Hippeutis (?) umbilicalis.</i>
<i>Limnaea acuminata.</i>	<i>Lamellidens corrianus.</i>
<i>Indoplanorbis exustus.</i>	<i>Sphaerium indicum.</i>
<i>Pisidium clarkeanum.</i>	

The majority of these species are common in small ponds in the Gangetic Delta and none of them have been found in a true lake, except *Indoplanorbis exustus*, which in the Inlé Lake haunts only the swampy marginal zone and in the Talé Sap in Siam is found only among beds of weeds near the shore. The only species that are in any way characteristic of the Loktak Lake are the two Viviparidae. These attain their maximum development only in the deeper part of the swamp, but both are found also in ponds and smaller swamps throughout the valley. No definite zones of life can be recognized here, but *Lamellidens marginalis* and *Pisi-*

¹ It occurred in England in Tertiary times.

dium clarkeanum, burrowing species, were found only at the extreme edge of the northern part of the lake where the vegetation is less congested, while the third bivalve (*Sphaerium indicum*), which swarms freely among the branches of water-weeds, was most abundant in the deeper parts.

Limnaea ovalior probably occurs in the Loktak Lake when it is full as we found it in small pools that would be included at that season, but it is even more of an exclusively paludine species than those discussed as inhabitants of the lake. Indeed, it seems to be almost amphibious in habits and thus from an ecological point of view may almost be classed with *Succinea elegans*, a species found in abundance at the edge of the northern part of the lake.

Only a few species were found in running water, but here it is necessary to recognize a fundamental difference between the rapid-running streams of the hills, with their clear water and stony bed, and the sluggish, turbid rivers of the valley. In hill-streams the only Gastropods commonly observed were *Paludomus pustulosa* and the narrowest phase of *Limnaea andersoniana*. Bivalves were rather more common and included the following species, *Corbicula occidens*, *Indonaia bonneaudi*, *I. theobaldi* and *I. lima*, all thick-shelled forms, as is also *P. pustulosa*. At least two other species make their way into muddy, comparatively still pools in such streams, viz. *Melanoides tuberculatus* and *Acrostoma variabilis*.

In the larger rivers of the valley the muddy bottom is favourable to these two Melaniidae and also to the thin-shelled Unionidae of the genus *Lamellidens*, while in small, sluggish streamlets and water-courses *Ancylus viola*, *Limnaea acuminata*, *Corbicula occidens* and *Pisidium clarkeanum* are sometimes not uncommon. It was in such a streamlet also that we found *Camptoceras lineatum*.

Generally speaking, the species of *Paludomus*, *Acrostoma* and *Indonaia* are inhabitants of running water. *Paludomus* is found as a rule in mountain streams or at any rate in running water near the base of hills and on a stony bottom, while *Acrostoma* and *Indonaia* need mud and therefore less rapid water. As is suggested in Dr. Baini Prashad's part of this paper, the genus *Lamellidens* can probably be divided into two sections from an ecological point of view, one, which produces very large numbers of embryos and as a rule frequents running water, the other, with a smaller number of embryos, that affects ponds and swamps. These observations, to which there are of course exceptions, are on the whole substantiated in Manipur, but in applying them it must be remembered that conditions in a very sluggish, weed-choked stream often approximate closely to those in a swamp and attract paludine forms.

VARIATION AND PLASTICITY.

It is particularly interesting to contrast the Manipur Valley with that of the Inlé Lake in reference to the variability and plasticity of the aquatic molluscs. As I have pointed out in the Introduction to this paper, the two valleys have certain physical fea-

tures in common, others, which are perhaps more important, widely divergent. Comparatively few species of molluscs are identical in the two localities, and the general facies and composition of the fauna is very different. In the Inlé Valley the two families of molluscs most remarkable for their plasticity are the Viviparidae and the Limnaeidae. As this is also so in the Manipur Valley, it will greatly simplify my comparison if I confine my remarks to these two families. I will begin to do so by drawing up in tabular form the main differences between the Viviparidae of the Inlé Lake and those of the Manipur Valley.

	INLÉ VALLEY.	MANIPUR VALLEY.
Genus represented	<i>Taia</i> , <i>Lecythoconcha</i> .	<i>Vivipara</i> , <i>Lecythoconcha</i> .
Predominant genera	<i>Taia</i> .	<i>Vivipara</i> .
Number of living species	<i>Taia</i> 5, <i>Lecythoconcha</i> 1.	<i>Vivipara</i> 3, <i>Lecythoconcha</i> 1.
Fossil forms known	Four (<i>Taia</i>).	None.
Number of species with highly sculptured shells	5 recent, 4 fossil (<i>Taia</i>).	2 recent (<i>Vivipara</i>).
General character of shell-sculpture in such forms	Nodular, squamose or spinose ridges.	Smooth ridges.

In considering the meaning of the differences thus summarily expressed we have to take into account not only the differences in environment but also the idiosyncracies of the different genera represented, for there is no fact more evident in the study of the freshwater molluscs than that different genera have different tendencies in the matter of variation and plasticity. At present we have three genera to consider, *Vivipara*, *Lecythoconcha* and *Taia*. It will be convenient to take *Lecythoconcha* first.

Although this genus is present in both valleys it is so scarce in the Inlé Valley, and I know so little about it there, that I must confine my remarks, so far as my own observations go, to its peculiarities in Manipur. I have selected this genus as the protagonist in my argument because its case is not complicated by the production of an abnormal and exuberant shell-sculpture. We may indeed, so far as Manipur is concerned, regard *Lecythoconcha* as a smooth-shelled genus. Further east, especially in Japan, we find shells presumably of this genus with a type of sculpture very like that of *Vivipara oxytropis*, but we know nothing of their anatomy and they must for the present be ignored. It is probable that their case is similar to that of the species of *Vivipara* already mentioned and to be discussed further.

The one species of *Lecythoconcha* found in Manipur extends the range of the genus a considerable distance westwards from its

headquarters in China, but it has colonized the Manipur Valley successfully and is at home in practically every part of its waters except in streams and rivers. Its plasticity is remarkable, and has probably aided it in taking possession of a very large territory. In the Manipur Valley we found no less than four phases common, each in its proper environment, and, so far as I know, only one of these phases has been found outside the valley, unless the locality "Sylhet" is correct for the *forma typica*, which I doubt greatly. Should my doubt prove unfounded it will not alter my argument. Of the four phases the largest and best developed is the one found in the central parts of the Loktak Lake, amidst dense submerged vegetation but in comparatively clean water of relatively considerable depth. The shell in this phase provides less evidence of interrupted growth than any of the others, less individual variation and as a rule a greater symmetry in proportions. It is, indeed, of just such a type as might be expected to occur in conditions in every respect favourable to the species. The only approximation, however, to a true lacustrine type exhibited by it is its comparative thinness. It has no tendency whatever to assume the elongate conical outline of the lacustrine species of *Taia*. Indeed, it is more globose than the shell of either the phase found at the edge of the great swamp or that found in ponds. The rice-field phase, on the other hand, is still more globose than the deep-water one, but does not possess its symmetry or constancy to type.

It is evident that we are here dealing with plasticity of a somewhat different type from that illustrated by the genus *Taia* in the Shan States, and with one in which the direct result of environment on the individual may be more safely postulated.

Indirectly the structure and post-embryonic development of *L. lecythis* cast an interesting sidelight, though the adult shell is smooth or nearly so, on the question of the development of prominent spiral sculpture on the shells of the Viviparidae in certain circumstances, but this point can be discussed more clearly after the facts about *Vivipara oxytropis* have been summarized.

Of the three species of *Vivipara* found in Manipur two are very scarce and have not been seen by me in their natural surroundings. The third (*V. oxytropis*) is, however, abundant and shares with *L. lecythis* the position of a dominant species throughout the valley. Two points have to be considered in reference to this species, its plasticity and its peculiar sculpture, the latter not so much for its own sake as for the light it throws, taken with certain facts in the life-history of *L. lecythis*, on larger questions.

V. oxytropis is not quite so abundant or so universally distributed in the Manipur valley as *L. lecythis*. It is very nearly if not quite as common in the Loktak Lake, but much scarcer in most ponds and practically absent from the smaller swamps. This may perhaps be correlated with two facts, firstly that it is not nearly so plastic (i.e. cannot adapt its external form to different types of environment so well), and secondly that it is so largely parasitized not only by a trematode (*Leucochloridium* encysted in its mantle,

as is also *L. lecythis*) but also by a leech of the genus *Glossosiphonia* (against which the *Lecythoconcha* has a special protection, p. 549) that it is probably able to survive only in favourable circumstances. Moreover, we may correlate with these phenomena also the fact that the species has a very limited range, not having been found outside the valley except in one swamp in Tenasserim. That it is a highly specialized form there can be no doubt. The main features in which it differs from the majority of its congeners and of the species of *Lecythoconcha* are the uninterrupted conical outline of its shell, the prominent but hollow spiral ridges on the shell and the great relative length of the processes on the edge of its mantle. Its large size is also a characteristic feature.

The conical outline of the shell is a specific, or rather group character, not subject to marked individual variation or to plasticity. *V. oxytropis* shares it with the much smaller and less highly specialized *V. microchaetophora* from the plains of Eastern Assam. The spiral ridges on the shell are evidence of higher specialization and are not shared with *V. microchaetophora*; but they are remarkably constant in the species and are certainly correlated with the third anatomical character already mentioned.

The processes on the edge of the mantle, though exceptionally well developed in *V. oxytropis*, are not peculiar to that species, but are found, in a less highly developed or rather more degenerate condition, in *V. bengalensis*, in which they correspond in position with the dark spiral bands on the shell just as they do with the prominent ridges, which are also deeply pigmented, in *V. oxytropis*. Moreover, similar processes are present in young individuals even of smooth-shelled species such as *L. lecythis* and then correspond with spiral rows of chaetae on the shell which disappear as maturity is attained. In the young mollusc, whether of *L. lecythis* or of *V. oxytropis*, there are three such processes, but whereas they disappear altogether in the adult of the former species, they become more numerous both in that of *V. oxytropis* and of *V. bengalensis*. In the adult *V. bengalensis* they are quite short even when fully expanded and project from the edge of the mantle, but in *V. oxytropis* they are much longer and are bent back into the grooves on the internal surface of the shell that corresponded with the raised ridges on the external surface. The primary reason for their hypertrophy is probably, as I have pointed out on p. 549, that they function as an accessory breathing organ. The ridges on the shell in which they are lodged serve to protect them and have thus a definite use, unlike the sculpture on the shells of *Taia* or *Margarya*.

As these processes and ridges on the surface of the shell of *V. oxytropis* are constant they have little direct reference to either variability or plasticity. Indeed, the species is neither remarkably variable nor remarkably plastic. Male and female shells differ somewhat in outline, and individuals from ponds vary more, have not quite the same regularity of outline and do not as a rule grow so large as those from the Loktak Lake, but no more can be said.

The importance of *V oxytropis* in the study of these phenomena only becomes apparent when we compare the structure of its mantle and shell with those of the mantle and shell of *Taia* and contrast the constant character of the Manipur species with the plasticity and variability of such a species as *T naticoides*. This I have done in another paper¹ in the *Records of the Indian Museum*.

We may now turn to the Limnaeidae of the Inlé and Loktak Lakes. In the former body of water three species have been found, namely *Limnaea shanensis*, Annandale, *L. andersoniana*, Nevill and *L. mimetica*, Annandale. The last is a small and highly peculiar species only known from the Inlé Lake and not exhibiting noteworthy variability or plasticity, except in so far that it is probably as a species the product of plasticity in some form of the *L. acuminata* group. *L. shanensis* is not, strictly speaking, a variable species, and we only know that it is or has been highly plastic through the existence of fossil or subfossil phases. With *L. andersoniana* I will deal presently.

In the Loktak Lake the only species of *Limnaea* collected was *L. acuminata*, but we may consider with it two other species found in swamps or ponds in the Manipur Valley. These are *L. ovalior*, sp. nov., and *L. andersoniana*, Nevill.

L. acuminata provides us with one of the best examples of true or individual variability to be found in the genus. In some districts (see fig. 12, p. 569) there is a very great difference in the shape of different shells from the same environment, but this is not so, apart from aberrations or monstrosities, in the Loktak Lake. A slight plasticity, however, is to be found in that individuals from the less congested parts of the swamp have a distinctly smaller shell and a shorter spire than those from the margin, while those from a small sluggish stream in the vicinity have remarkably pale and fragile shells with a strong but irregular external sculpture.

An interesting aberration is represented in our collection by a single specimen. It is remarkable for the very poor development of its spire, a feature common in lacustrine forms of the genus.

L. ovalior is known only from the swamps that surround the Loktak Lake and from Dimapur in the plains of Assam, north of the Naga Hills. In the latter locality it was found in a single pool of very foul water. Shells from this situation differ from those from the Manipur swamps in the same way as, but to a greater extent than, those of *L. acuminata* from the more congested part of the Loktak Lake do from those of the same species from its open region.

It is in *L. andersoniana*, however, that plasticity occurs in the most highly developed state. In the Inlé Valley two forms of

¹ Vol. XXII, pp. 243-266 (1921).

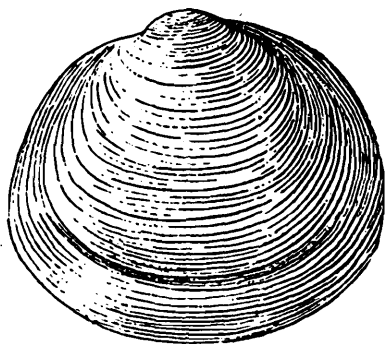
this species have been found—a broad form in ponds and a narrow form in a small stream. In the Manipur Valley and at Dimapur no less than four such phases occur. Two of these are almost identical with the two from the Shan States and inhabit similar types of environment. A third phase, still narrower than that found in rapid running water in the valley, inhabits higher parts of the same streams, where they have the character of mountain torrents. Perhaps, however, the most interesting phase is that found at Dimapur in small cattle-ponds. It may be described as both intermediate in some individuals between the pond phase and the ordinary stream phase, and also, in other individuals, as a more extreme form of the pond phase. A partial explanation is probably to be found in the fact that the ponds it frequents are connected in the rainy season with small streams. The narrower individuals may be those that have grown up in these temporary streams, while the broader individuals are those that have never left the ponds.

We thus see that whereas the type of plasticity characteristic of *L. andersoniana* is essentially similar in the Inlé and Manipur Valleys, that observed in the Viviparidae is different in kind in the two localities. We do not find any species of mollusc in Manipur that exhibits the extreme variability in shell-sculpture of *Taia naticoides*, in the Shan States, and even in *L. acuminata* variability in shell-form is much less marked in the Loktak Lake than it is in many other localities. In the present state of our knowledge it is as well not to speculate further as to the meaning of these observations.

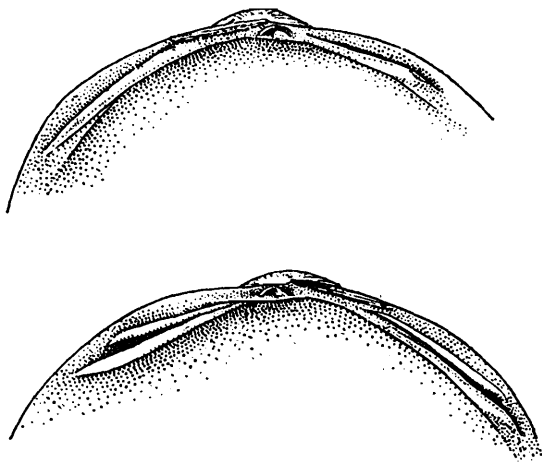
ADDENDUM.

Note on *Sphaerium montanum*, Tapparone-Canefri.

Since this paper went to press I have, through the kind offices of Dr. R. Gestro of the Genova Museum, had an opportu-



TEXT-FIG. 36.—Type-shell of *Sphaerium montanum*, Tapparone-Canefri.



TEXT-FIG. 37.—Hinge of the same.

nity of examining the unique type-specimen of Tapparone-Canefri's *Sphaerium montanum* from Tenasserim, Burma, which I had

been unable to include in my revision of the Indian species of the genus *Sphaerium* (*supra*, p. 614) owing to insufficient information. As a result of my examination of the unique type I am now able to confirm the author's opinion of his species from Burma being a distinct species. In the Indian Museum I was also fortunate in finding a specimen in Theobald's Burmese collections of Unionidae which is referable to this species. Unfortunately the exact locality of Theobald's specimen is not known.

I have nothing to add to Tapparone-Canefri's description, but give below the measurements of the type-shell and of Theobald's specimen. I have also taken this opportunity to publish a figure of the shell and the hinge-teeth of the type-specimen.

Measurements (in millimetres).

	Type-specimen.	Theobald's specimen.
Length	8·2	8·1
Breadth	7·3	7·4
Thickness	4	3·9

Tapparone-Canefri compared his species with *S. indicum*, Deshayes, but was doubtful as to its possible identity with *S. avanum*, Theobald. The species, however, has no relationship with *S. avanum*, and forms a distinct group with *S. indicum* and *S. austeni*. From either of these species it is easily distinguished by its subquadrate shape, less tumid shell, less prominent umbones, which do not project so far upwards and inwards as in the other two species, proportionately larger lateral teeth and in having the two lamellar cardinals of the right valve distinctly separated from each other by a fairly deep notch.

[B. PRASHAD.]



EXPLANATION OF PLATE IV

All the figures are from direct photographs of natural size.

Vivipara crassispiralis, sp. nov.

FIG. 1.—Type-specimen, from the Manipur Valley.

Vivipara oxytropis (Benson).

FIG. 2.—Male shell from the Loktak Lake, Manipur.

„ 3.—Female shell from the same locality.

„ 4.—Normal female shell of pond phase, from Imphal, Manipur.

„ 5.—Very large male shell of the same phase, from the same locality.

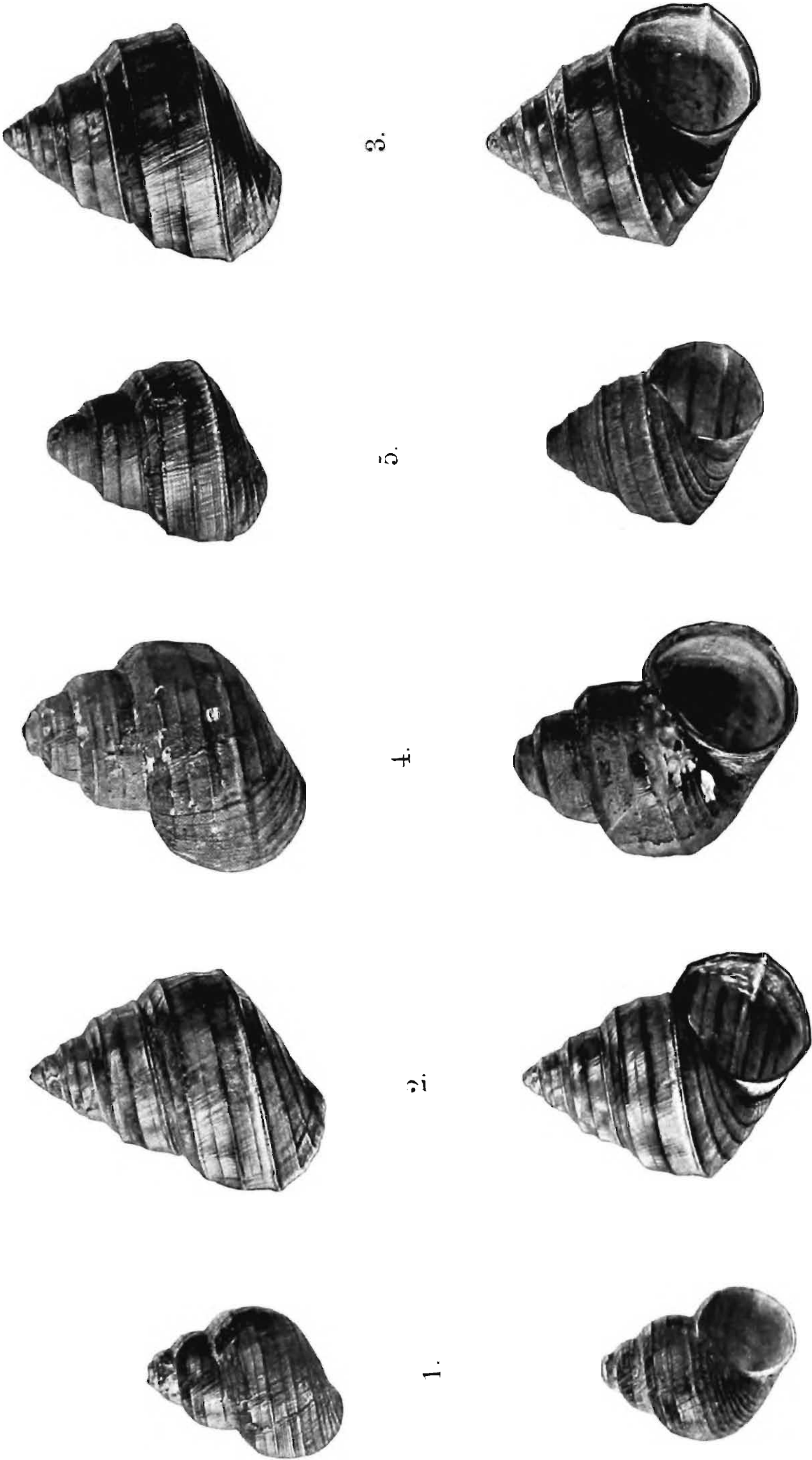


FIG. 1. VIVIPARA CRASSISPIRALIS. FIGS. 2-5. V. OXYTROPIS.

S. C. Mondul, photo.

EXPLANATION OF PLATE V

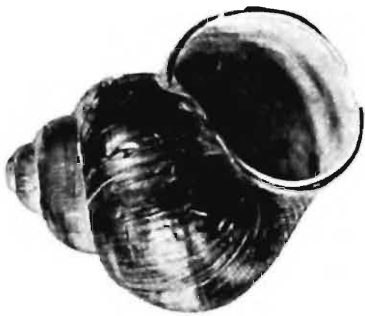
All the figures are from direct photographs of natural size.

Lecythoconcha lecythis (Benson).

- FIG. 1.—Male shell of open-water phase (*forma typica*) from the central part of the Loktak Lake, Manipur.
- „ 2.—Female shell of the same phase from the same locality.
- „ 3.—Large shell (? ♂) of the marginal phase from the edge of the Loktak Lake, Manipur.
- „ 4.—Exceptionally large shell of the rice-field phase (= *ampulliformis*, Eydoux and Souleyet) from the Manipur Valley.



4.



3.



2.



1.



LECYTHOCONCHA LECYTHIS.

EXPLANATION OF PLATE VI.

All the figures are from direct photographs of natural size.

Lecythoconcha lecythis (Benson).

FIGS. 1, 2.—Large shells of pond-phase from Imphal, Manipur.

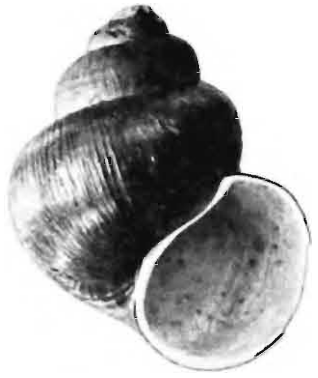
Acrostoma variabilis (Benson).

FIG. 3.—Type-specimen of var. *laevis*, nov., from Sylhet.

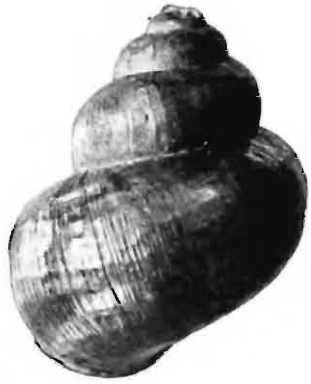
„ 4.—Another specimen of the same variety, from the Manipur Valley.

„ 5.—Cotype of var. *semilaevigata*, Nevill, from Sylhet.

„ 6.—Cotype of var. *subspinata*, nov., from the Manipur Valley.



1.



2.



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4.



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6.

S. C. Mondul, photo.

FIGS. 1. 2. *LECYTHOCONCHA LECYTHIS*. FIGS. 3-6. *ACROSTOMA VARIABLE*.

EXPLANATION OF PLATE VII.

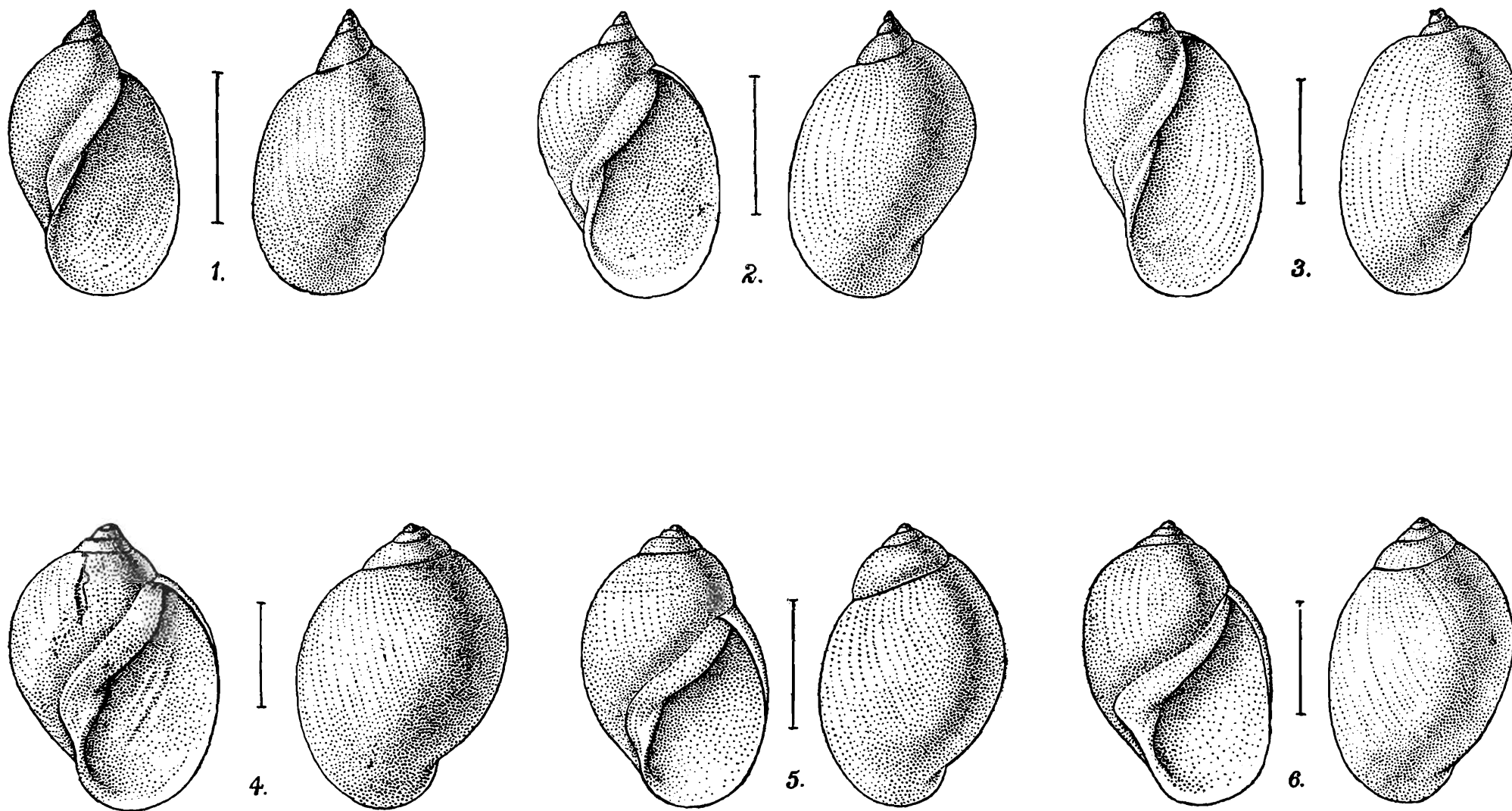
The line between the two views of each shell shows the actual height of the specimen.

Limnaea acuminata, Lamarck.

- FIG. 1.—Shell from the edge of the Loktak Lake, Manipur.
,, 2.—Normal shell from a patch of *Potamogeton* near the outflow of the same lake.
,, 3.—Abnormal shell from the same habitat.

Limnaea ovalior, sp. nov.

- FIG. 4.—Shell from a pool of foul water in the jungle near Dimapur, E. Assam.
FIGS 5, 6.—Shells of the type-series, from a buffalo-wallow at the edge of the Loktak Lake, Manipur.



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Figs. 1—3. *LIMNAEA ACUMINATA*, Lam. Figs. 4—6. *L. OVALIOR*, sp. nov.

EXPLANATION OF PLATE VIII.

The line between the two views of each shell shows the actual height of the specimen.

Limnaea andersoniana, Nevill.

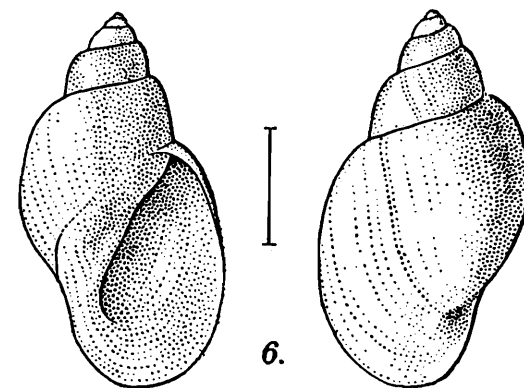
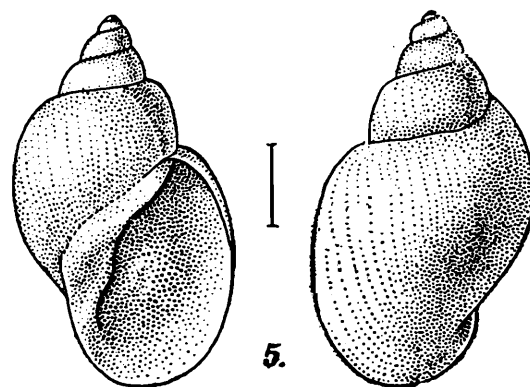
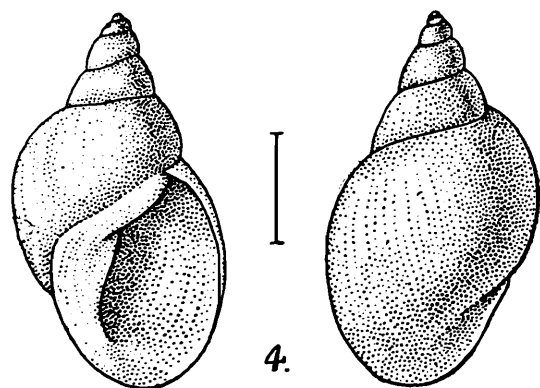
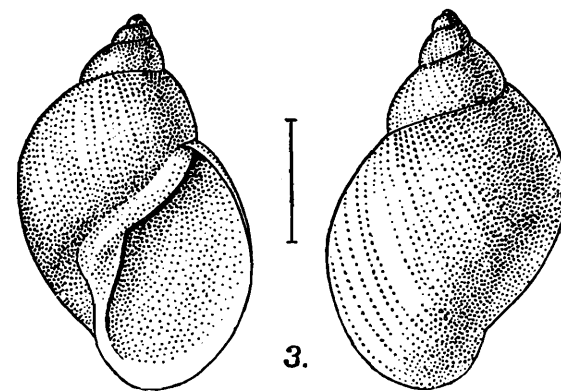
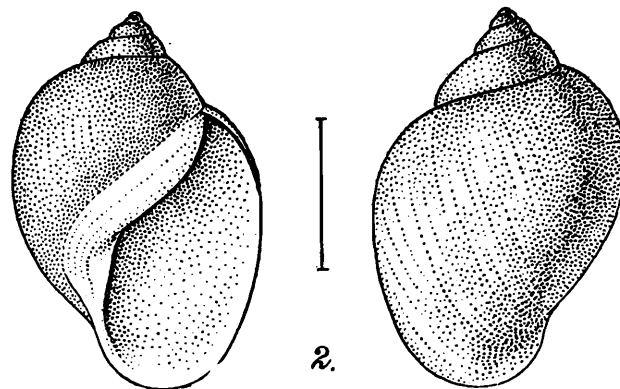
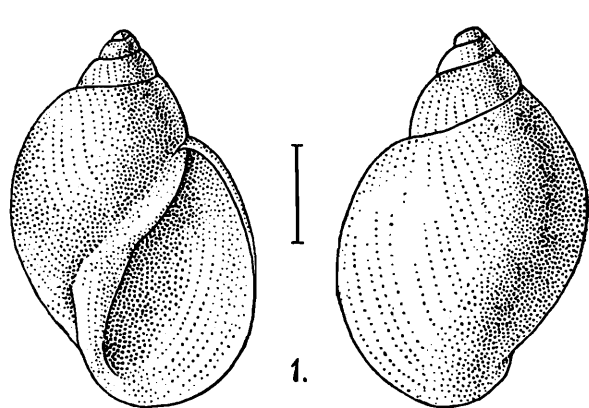
FIG. 1.—Type-specimen (pond-phase) from Nantin, Yunnan (*Anderson*).

FIGS. 2, 3.—Shells of the intermediate phase from a pool at Dimapur, Assam.

FIG. 4.—Shell of stream-phase from the Manipur Valley, Assam.

„ 5.—Shell of same phase from Yarkand (*Stoliczka*).

„ 6.—Shell of hill-stream phase from the Pagla Nadi near Bishenpur, Manipur.



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LIMNAEA ANDERSONIANA, Nevill.