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[*N.B.*—An asterisk (*) preceding a line denotes a new variety or subspecies ; a dagger (†) indicates a new species ; a double dagger (‡) a new genus or subgenus ; synonyms are printed in italics.]

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I. MATERIALS FOR A GENERIC REVISION OF THE FRESHWATER GASTROPOD MOLLUSCS OF THE INDIAN EMPIRE.

No. 3. The Freshwater Genera of Hydrobiidae.

By N. Annandale, *D.Sc.*, *F.A.S.B.*, *Director, and* B. Prashad, *D.Sc.*, *Assistant Superintendent, Zoological Survey of India.*

The small size and insignificant appearance of the members of this family have caused them to be generally neglected, and the classification of the Indian forms in the official *Fauna of British India* seems to be based on no principle at all. Indeed, one of the genera is even placed in the Littorinidae, apparently through inadvertence. The recent attempt[1] of one of us to revise the species assigned to *Bithynia*, Leach, was not, as Mr. A. S. Kennard has pointed out in a letter, sufficiently drastic, for some species distinct from it had been retained in the genus. For these species the name *Digoniostoma* has been already[2] proposed. We include here a detailed description of this new genus.

It will be convenient to begin our discussion of the genera with a key, in which we will ignore their distribution into subfamilies, the diagnostic features of which are concealed in some species by secondary modifications in such a way that it is sometimes easier on first examination to recognize the genus than the subfamily. The subfamilies, nevertheless, seem to be founded on good anatomical as well as conchological characters. We do not propose at present to discuss the estuarine and maritime genus *Stenothyra*, Benson, which calls for a special revision, or the brackish-water species called *Bythinella* or *Belgrandia miliacea* by Nevill[3] and *Bithinella canningensis* by Preston.[4] The true generic position of this species will be considered best in reference to *Stenothyra*.

Key to the Indian Freshwater Genera of Hydrobiidae.

I. Shell very small, thin, elongate, narrowly perforate or imperforate, with the columellar callus poorly developed and the lip thin. Operculum thin, horny, paucispiral. Central tooth of radula without basal denticulations. Male organ without lateral process ... ... *Tricula.*

II. Shell thick, globose, with the spire directed backwards and outwards, with the mouth broad and the columellar

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[1] *Rec. Ind. Mus.* XIX, pp. 41—46 (1920).
[2] *Ind. Journ. Med. Res.* (paper in the press).
[3] *Hand-List Moll. Ind. Mus.* II, p. 52 (1885).
[4] *Ann. Mag. Nat. Hist.* (7), XIX, p. 216, fig. in text (1907), and *Fauna Brit. Ind. Freshw.-Moll.*, p. 66 (1915).

callus flattened and plate-like, occluding the umbilicus. Central tooth of radula with basal denticulations.

A. Lip of shell thickened. Operculum thick, calcareous, concentric. Male organ with a lateral process — *Paranerita.*

B. Lip of shell not or slightly thickened. Operculum horny, spiral ... ... — *Lithoglyphus.*

III. Shell more or less elongate, thick or moderately so, with the main axis of the spire and the body-whorl in the same straight line, and the mouth comparatively narrow. Operculum thick, calcareous. Male organ with a lateral process.

A. Shell turbinate, conspicuously perforate, ornamented with prominent spiral ridges. Operculum concentric externally. Central tooth of radula with a vertical lateral process on each side, but without basal denticulations ... ... — *Mysorella.*

B. Shell not turbinate, without (in Indian species) prominent sculpture. Central tooth of radula with basal denticulations.

1. Shell almost trochiform, shallowly but openly umbilicate, ornamented with spiral incised lines. Operculum concentric externally ... ... — *Sataria.*

2. Shell ovate, narrowly umbilicate or imperforate, with sculpture microscopic, except for a varix in some species.

a. Lip of shell distinctly thickened. Operculum concentric externally.

α. Columellar callus more or less flattened and plate-like; no channel proceeding downwards from the umbilicus; inner lower extremity of lip rounded ... — *Hydrobioides.*

β. Columellar callus ridge-like; a distinct channel proceeding downwards from the umbilicus; inner lower extremity of lip angulate and produced . . — *Digoniostoma.*

b. Lip of shell not distinctly thickened.

α. Operculum concentric ... ... — *Bithynia.*

β. Operculum spiral ... ... — *Amnicola.*

i. Operculum horny ... — subgenus *Amnicola* (s.s.)

ii. Operculum calcareous ... ... — subgenus *Alocinma.*

We divide these genera into four subfamilies, viz. Hydrobiinae (or Paludestrinae), Bithyniinae, Mysorellinae and Lithoglyphinae.

Subfamily *HYDROBIINAE.*

The representatives of this subfamily are small or minute. They may be recognized by their horny, paucispiral operculum, undivided foot, unbranched male organ[1] and by the absence of denticulations at the base of the central tooth of the radula. Their shells are never thick or inflated.

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[1] In the European *Hydrobia* or *Paludestrina jenkinsi* males are seldom or never produced and the females are parthenogenetic. See Robson, *Ann. Mag. Nat. Hist.* (9), V, pp. 425—431, pl. xv (1920).

Genus **Tricula**, Benson (1843).

1843. *Tricula*, Benson, *Calcutta Journ. Nat. Hist.*, p. 467.
1851. *Bithinella* (in part), Moquin-Tandon, *Journ. Conchyliol.* II, p. 239 (footnote).
1892. *Bithinella* (in part), Kobelt in Rossmässler's *Icon. Land- u. Süsswass. Moll.* (2), V, p. 36.

We can find no generic difference between the shell of the Himalayan species on which Benson founded his genus *Tricula*, and those assigned by most recent authors to *Bithinella*. Some of the figures published by Kobelt are very like the shells of *T. montana*, the type-species, and we have been able to examine a considerable number of European specimens. There is nothing, moreover, in Benson's brief description of the animal to contradict this view.

T. montana is the only described Indian species that can be assigned to this genus, but we have a second from the Central Provinces as yet undescribed. Nevill's *Bithinella miliacea* is not a *Tricula*. It is, however, an inhabitant of brackish water and need not be discussed here.

Subfamily *BITHYNIINAE*.

The great majority of the Indian genera and species belong to this subfamily, in which (except in *Amnicola*) the operculum is thick and calcareous, the male organ has a lateral appendage, the foot is simple (as it is in all Indian genera of the family) and the central tooth of the radula is provided with several basal denticulations.

Genus **Bithynia**, Leach (1818).

1920. *Bithynia* (in part), Annandale, *Rec. Ind. Mus.* XIX, p. 41.

In the recent notes on the Indian species of the genus *Bithynia* by one of us, certain characters in the mouth of the shell were overlooked. These, as Mr. A. S. Kennard suggests in a letter, call for reconsideration of the generic position of *cerameopoma* and other true Indian species. For these the new name *Digoniostoma* has recently been proposed. There can be no doubt, however, that the Kashmir forms assigned provisionally to *B. tentaculata* (Linné) and *B. troscheli* (Paasch) have been placed in the correct genus. In *Bithynia* the lip of the shell is sharp and not at all thickened and the columellar margin is narrow and ridge-like.

The type-species is *Helix tentaculatus*, Linné.

Genus **Hydrobioides**, Nevill (1884).

1885. *Hydrobioides* (subgenus of *Bithynia*), Nevill, *Hand-List Moll. Ind. Mus.* II, p. 42.
1918. *Hydrobioides*, Annandale, *Rec. Ind. Mus.* XIV, p. 117.
1920. *Hydrobioides*, *id.*, *ibid.*, XIX, p. 44.

Fully formed shells of this genus are easily distinguished from those of *Bithynia* by their thickened lip and much broader and flatter columellar margin. The channel leading from the umbilicus is also practically absent.

The type-species is *Fairbankia*? (an *Bithynia*?) *turrita*, Blanford, a form with a very narrow elongate shell. The genus is Burmese. Mr. Kennard tells us that he has seen a fossil (tertiary) species from the Loess of Lei Chung, west of Shun Le-fu, N. China.

Genus **Paranerita**, Annandale (1920).

1920. *Paranerita* (subgenus of *Hydrobioides*), Annandale, *op. cit.*, p. 45.

The structure of the animal and operculum in *P. physcus*, the only known species, is too close to that of *Hydrobioides* to permit of its expulsion from the Bithyniinae, but that of the shell is perhaps too different to allow its retention in the genus.

P. physcus is only known from the Shan Plateau in Upper Burma.

Genus **Digoniostoma**, Annandale (1920).

1920. *Bithynia* (in part), Annandale, *op. cit.*, p. 41.
1920. *Digoniostoma*, Annandale, *Ind. Journ. Med. Res.* (in the press).

The shell of this genus differs from that of the true *Bithynia* in the structure of the mouth. The lip is somewhat thickened, though usually less so than in *Hydrobioides*, and more or less laminate. It is produced and angulate at the inner lower extremity. The columellar callus is broad and stout and as a rule distinctly laminate, but not so flat as in *Hydrobioides*. Otherwise the two genera are closely related.

The type-species is *Paludina cerameopoma*, Benson, a common and widely distributed Indian mollusc.

Genus **Amnicola**, Gould and Haldeman (1841).

This genus is American and is distinguished from the other Bithyniine genera by its horny, spiral operculum and by the presence of only a single denticulation on each side of the base of the central tooth of the radula. Hutton's *Paludina parvula*[1] must be assigned to it provisionally as he says, "Operculum horny," and Hanley and Theobald[2] say that the shell is that of an *Amnicola*; but the species needs further investigation. It was found near Chaman, which is now on the Northern Afghan frontier of Baluchistan, and is not represented in the collection of the Indian Museum. Mr. G. C. Robson has kindly informed us that the opercula are no longer present in the two specimens figured by Hanley and Theobald, originally from Hanley's collection, and now preserved in the British Museum.

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[1] *Journ. As. Soc. Bengal*, XVIII, p. 655, pl. ii (1849).
[2] *Conch. Ind.*, p. 61, pl. cli, figs. 8, 9 (1876).

The type-species of the genus is *A. porata*, Say, from Massachusetts, United States of America.

Subgenus **Alocinma**, Annandale and Prashad (1919).

1919. *Alocinma* (subgenus of *Amnicola*), Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 23, 24.
1920. *Alocinma*, Annandale, *ibid.*, XIX, p. 43.

This subgenus was recently established for *A. sistanica* and its Indian and Mesopotamian allies. Its distinguishing characters are noted in the two papers cited above.

The type-species of *Alocinma* is *A. sistanica*, Annandale and Prashad.

Genus **Sataria**, Annandale (1920).

1920. *Sataria*, Annandale, *Rec. Ind. Mus.* XIX, pp. 45, 46.

The genus *Sataria* was recently established for the species described by Blanford as *Bithynia everzardi* from Mahableshwar in the Satara district and from Khandalla in the Poona district of the Bombay Presidency. The shell is almost trochiform, ornamented with spiral incised lines, and is shallowly but openly umbilicate. The operculum is calcareous and externally marked with strong concentric ridges. The radula resembles that of *Bithynia*, but has blunter denticulations and there is a quadrate process on the disc of the central tooth.

S. everzardi is the only known species of the genus.

Subfamily *LITHOGLYPHINAE.*

The shells of this subfamily are among the very few freshwater forms that have the main axis of the spire not quite in the same straight line as that of the body-whorl. This, with their globose outline and plate-like columellar callus, gives them an almost neritiniform appearance. The true diagnostic features of the subfamily are, however, to be found in the structure of the operculum (see key) and possibly in that of the male organ, about which there is some conflict of evidence; their shell-characters are closely analogous to those of the genus *Paranerita*, which we see no reason to separate from the Bithyniinae.

Genus **Lithoglyphus**, Mühlfeldt (1821).

1821. *Lithoglyphus*, Mühlfeldt in Sturm's *Fauna* (*fide* Kobelt).
1892. *Lithoglyphus*, Kobelt, *op. cit.*, p. 28.

Lithoglyphus martabanensis, the only species known from the Indian Empire, seems to be, so far as can be judged from the shell only, a normal species of the genus, to which the Chinese *L. liliputanus*, Gredler, certainly belongs.

The type-species of the genus is *L. eburneus*, Mag. v. Mühlfeldt.

Subfamily *MYSORELLINAE.*

Genus **Mysorella,** Godwin-Austen (1919).

1919. *Mysorella*, Godwin-Austen, *Rec. Ind. Mus.* XVI, p. 431.
1920. *Mysorella*, Annandale, *Rec. Ind. Mus.* XIX, p. 46.

In the second paper cited above, one of us has recently discussed the relationships of the genus and the subfamily and we have nothing to add to this account.

The genotype is *Paludina costigera* var. *curta*, Nevill. There are two local races of the only known species, the typical form from the plains of the southern part of the Madras Presidency and Ceylon, and the variety or subspecies *curta* from the Mysore Plateau. It is possible that the latter will ultimately be regarded as a distinct species.

II. MATERIALS FOR A GENERIC REVISION OF THE FRESHWATER GASTROPOD MOLLUSCS OF THE INDIAN EMPIRE.

No. 4. The Indian Ampullariidae.

By N. Annandale, *D.Sc., F.A.S.B., Director, and* B. Prashad, *D.Sc., Assistant Superintendent, Zoological Survey of India.*

The Indian species of this family present great difficulties to the systematist. A large number of species have been described, but between many of them annectant forms occur and some of them exhibit considerable individual variability. Hitherto all have been placed in a single genus, which has been variously called *Ampullaria*, *Pila* and *Pachylabra*, but recently one of us has expressed the belief [1] that Reeve's *Ampullaria nux* was probably worthy of generic distinction. Unfortunately very little is yet known of the anatomy of this species, but both the shell-characters and those of the radula certainly offer conspicuous differences from those of Swainson's *Ampullaria globosa* (the type-species of both *Pila*, Bolten and *Pachylabra*, Swainson) and its allies. Indeed the only difficulty in the way of granting generic rank to *A. nux* lay in the existence of the form referred to by Nevill [2] as "*Ampullaria nux*, var. (? n. sp.)" As we have been able to examine the radula of this form and find that it belongs to the normal *Pachylabra*-type, while that of *A. nux* shows distinct differences, we now feel justified in regarding the latter as the genotype of a new genus, for which we propose the name *Turbinicola* in reference to its habits. We describe this genus here and also the apparently intermediate form, which we regard as an undescribed species, calling it after Nevill, *Pachylabra nevilliana*.

Genus **Pachylabra**, Swainson.

The shell is dextral,[3] large or very large, moderately thick, with a short globose spire and itself subspherical or broadly but irregularly ovoid. Its mouth is large but not greatly expanded, with a complete or almost complete but not very prominent peristome, and with the outer lip as a rule slightly thickened. The columellar callus is never expanded or incrassate. The sculpture

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[1] Annandale, *Journ. Nat. Hist. Soc. Siam* IV, p. 2 (1920).
[2] Nevill, *Hand List Moll. Ind. Mus.* II, p. 4 (1885).
[3] Abnormal sinistral shells occur very rarely.

is never prominent and the surface of the shell always has a smooth appearance. The periostracum is of some olivaceous tint, often with dark spiral bands. The interior of the shell is pale but still more frequently with dark spiral bands.

The *operculum* is thick and testaceous with an outer horny layer, more or less flame-shaped in outline. It exhibits no trace of spiral sculpture, but bears on the internal surface a large elongate sculptured scar. Its nacre is polished but not iridescent.

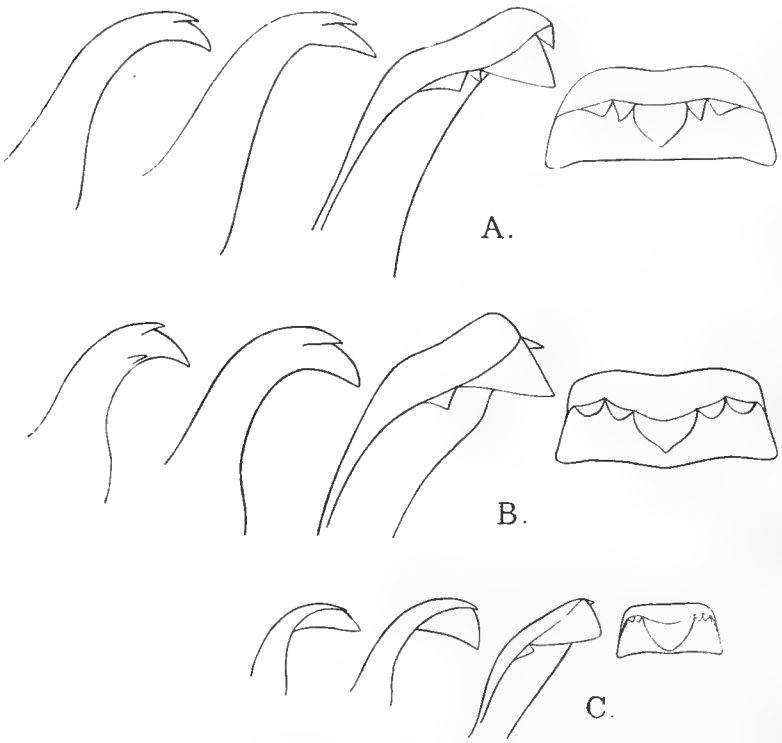

FIG. 1.—Radular teeth of Ampullaridae, × 50.

A. *Pachylabra globosa.*
B. *Pachylabra nevilliana.*
C. *Turbinicola nux.*

The *radula.*—Owing to the poor figures published by Troschel [1] and Fischer [2] great confusion has been caused as to the exact structure of the radular teeth of *Pachylabra.* One of us has recently (*loc. cit.*) figured the radular teeth of some of the Siamese species. We now figure those of *P. globosa,* the type-species of the genus. Without giving a detailed description we may note that the marginal teeth have three denticulations, of these the middle one is the largest and best developed and is always sharply pointed,

[1] Troschel, *Gebiss der Schnecken,* I, p. 88, pl. vi, fig. 5 (1856—1863).
[2] Fischer, *Man. Conchyliol.* p. 736, fig. 505 (1887).

while the outer one is usually much reduced and may even be absent. The lateral teeth have five cusps, of these the third or central one is the largest and the innermost cusp is very much reduced.

Soft parts.—The right epipodial lobe is prominent and well developed. The inhalent siphon, which is formed by the left epipodial lobe, has, when contracted, the form of a prominent fold, forming part of a circle, but with its extremities widely separated. When expanded it is funnel-shaped and much broader than long.

Type-species.—*Ampullaria globosa*, Swainson.

Geographical Range and Habitat.—The genus is found all over the Oriental Region except in mountainous country. No recent species are known from the Punjab, but sub-fossil remains have been found in the Salt Range. At present no characters are known by which African species can be distinguished from Asiatic forms.

The species are found in ponds, rice-fields and backwater swamps in which there is abundant submerged vegetation of a succulent kind.

Turbinicola, gen. nov.

The *shell* is dextral, comparatively small, regularly ovate and less globose than in *Pachylabra*. Its mouth is relatively high and narrow. The outer lip is thin, the peristome is complete and the callus of the columellar region is, though narrow, flat and porcellaneous. The umbilicus is closed.

The *operculum* is precisely like that of *Pachylabra*.

The *radula* has the following peculiarities: the lateral cusps of all the teeth are reduced, while the main cusp is extremely large and broad forming a scoop-like organ, more particularly on the laterals and the marginals. Only two cusps remain on the laterals and marginals and the inner cusp is vestigial, while the outer is expanded and obliquely truncate. We figure the radular teeth of the type-species, with that of *P. nevilliana* for comparison.

The soft parts have not been studied in detail, but it has been noted that the foot is short, broad and rounded behind and with the antero-lateral angles but slightly produced.

Type-species.—*Ampullaria nux*, Reeve.

Geographical Range and Habitat.—Only known from the northern part of the Western Ghats in the Nasik and Poona districts of the Bombay Presidency.

The type-species lives on rocks in small pools in mountain streamlets. The peculiar structure of its radular teeth doubtless permits it to scrape the algae from stones or to scoop up mud containing nutritious substances.

Turbinicola nux (Reeve).

1856. *Ampullaria nux*, Reeve, *Conchologia Iconica* X, *Ampullaria*, pl. xxviii, fig. 132.

1876. *Ampullaria nux*, Hanley and Theobald, *Conch. Ind.*, pl. cxv. fig. 1.

1877. *Ampullaria nux* (typical), Nevill, *Cat. Moll. Ind. Mus.* Fasc. E., p. 5.
1885. *Ampullaria nux, id., Hand List Moll. Ind. Mus.* II, p. 3.
1918. *Ampullaria nux*, Annandale and Prashad, *Rec. Ind. Mus.* XVI, pp. 149, 150, pl. v, fig. 8.

The shell is very small compared with other species of the family (not more than 30 mm. high), and has $4\frac{1}{2}$ whorls. The apex is bluntly pointed and the first $2\frac{1}{2}$ whorls, which are always slightly eroded, are minute. The third whorl is much larger but shallow, band-shaped and much narrower than the body-whorl. Its outlines are feebly convex. The suture is linear and slightly impressed; the whorls are not or very slightly flattened outside it. The body-whorl is narrowly heart-shaped with the upper extremity nearly straight and the lower pointed and turned inwards; its outer outline as seen from above forms a regular curve and is relatively short, while the inner outline is long and sinuate. The whorl as a whole is by no means greatly swollen. The aperture is oblique, rather narrow and pyriform. It extends upwards for at least $\frac{3}{4}$ of the height of the shell. The incrassate columellar margin is narrow and is joined to the upper lip above by a thin porcellaneous deposit; it is considerably produced below the umbilicus, which is closed or rimate. The aperture as a whole projects outwards from the body-whorl and also forwards below the umbilicus. In the latter region the surface of the whorl slopes inwards and forwards. The surface has a matt appearance owing to the minute sculpture which consists of minute longitudinal and spiral lines crossing one another very regularly and closely, and of coarse longitudinal sinuate striae. The periostracum is of a pale yellowish olivaceous tint with ill-defined longitudinal streaks of a darker shade, and in some shells obscure narrow spiral bands of a pale brownish colour can be detected on the external surface. The mouth is pure white, but the interior of the shell is sometimes tinted with brown.

The outline of the operculum resembles that of the mouth. The external surface is slightly concave and is covered with a delicate brown periostracum. The scar on the internal surface is relatively large; it is divided longitudinally by a narrow ridge and surrounded completely by a groove; its sculpture is lobose. The nacre has a pinkish tinge.[1]

The characters of the radular teeth[2] are well shown in the figure. Unfortunately we have no detailed description of the animal. The following notes on its colouration were made from a living specimen at Khandalla. The foot and mantle are yellowish,

[1] Reeve's original figure and description are somewhat misleading. The former gives the impression, owing to the position of the operculum, that the outer lip is thickened, while the description, in stating that the columellar lip is unusally callously reflected, does not indicate that it is in close apposition to the surface of the shell.

[2] The figure of the radular teeth, in our paper cited already, is rather poor. It was unfortunately drawn from worn out teeth and does not show their real characters.

tinged and clouded with black above; the free edge of the mantle is bright yellow. The tentacles are leaden grey on the dorsal surface, paler at the base and below. The eye-stalks are bright yellow.

Geographical distribution.—The species is only known from small streams near Khandalla and Igatpuri (Poona and Nasik districts) in the Western Ghats and from altitudes between 2500 and 3000 feet.

We may now give a description of the new species *Pachylabra nevilliana*. The shell characters are so similar to those of *T. nux* that we can best do so by means of a short comparison.

FIG. 2.—Photographs of the type-shell of *Pachylabra nevilliana*, natural size.

Pachylabra nevilliana, sp. nov.

1877. *Ampullaria nux*, var. (? n. sp.), Nevill, *op. cit.*, p. 5.
1885. *Ampullaria nux*, var. (? n. sp.), *id.*, *op. cit.*, p. 4.

The species is considerably larger, stouter and more globose than *T. nux*, the spire is more swollen, the body-whorl more transverse, the aperture broader above, the suture more oblique and the sculpture of the shell coarser and less regular. The external colour is deep chestnut, with which the interior is also tinged. The peristome is white. The scar of the operculum is relatively smaller and its central ridge broader and flatter.

We have extracted the radula from one of the shells examined by Nevill, which have been in Calcutta for at least 60 years, but still in several instances contain the dried animal in a fairly good state of preservation.

Type- specimens.—No. M 11864/2 Z. S. I. (*Ind. Mus.*)

Measurements of shells (in millimetres).

	T. nux.			*P. nevilliana.*		
Total height ..	26	23	17	35	37	34
Maximum diameter ..	20·5	19	14·5	28·5	33	29·5
Oblique height of mouth	18	16·5	13·5	25·5	27	25·5
Maximum diameter of mouth.	10	8·5	7	16	16	14·5

Locality.—The specimens are labelled, in writing on each shell, as being from Tranquebar, which is on the east coast of Southern India, and it is stated in the old catalogue of the A.S.B. collection that they were collected by Captain Lewis. Nevill, however, was of opinion that the "locality can only be accepted with considerable reserve." We have seen no other specimens, but Nevill's doubt as to the provenance of the type-series was probably due to his belief in its apparent specific identity with *T. nux.*

III. NOTES ON FISHES IN THE INDIAN MUSEUM.

1. On a New Genus of Fish closely resembling *Psilorhynchus*, McClelland.

By Sunder Lal Hora, *M.Sc., Research Assistant, Zoological Survey of India.*

While sorting out the fish of the genus *Garra* in the unnamed collection of the Indian Museum, I happened to mistake the specimen described below for one of *Garra*. On closer examination it has turned out to be an interesting species of a new genus, which I propose to describe in this paper.

Parapsilorhynchus, gen. nov.

The new genus consists of small hill-stream Cyprininae closely resembling *Psilorhynchus*, McClell., from which it differs in the following characters:—

(i) There are two blunt, cylindrical barbels on the snout in the new genus, while in *Psilorhynchus* barbels are absent.

(ii) In *Psilorhynchus* the air-bladder [1] is always more or less reduced, while in this genus it is large and is of the normal Cyprinid type.

(iii) In *Psilorhynchus* the upper lip is exposed, and the lower lip, though it may be glandular, is never prominent, while in *Parapsilorhynchus* the upper lip is concealed by a fringed, plicate, labial fold which is densely covered with minute tubercles; the lower lip is very prominent, and usually there is either an indication of or a rudimentary disc behind it.

(iv) In *Parapsilorhynchus* the origin of the dorsal is almost opposite to that of the ventrals, while in *Psilorhynchus* it is in advance of the ventrals.

Of this genus I regard *Psilorhynchus tentaculatus*, Annand.,[2] as the type-species. I assign to it also the new species described below. While dealing with the genus *Psilorhynchus* in a recent paper, I provisionally included Dr. Annandale's species in it, but the discovery of the second species in the same range of mountains makes it desirable to lay stress on the differences between the forms found in the north-east of India, and those inhabiting the hills in the western part of Peninsular India. Dr. Annandale tells

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[1] Hora, *Rec. Ind. Mus.* XIX, p. 209 (1920).

[2] Annandale, *Rec. Ind. Mus.* XVI, pp. 128-129 (1919).

me that he considers these forms to be probably convergent; but in describing *Psilorhynchus tentaculatus* preferred not to set up a new genus on a monotypic basis.

My new genus has some points in common with *Garra*; the main characters that distinguish it from this genus are the following:—

(i) The presence of two characteristic blunt barbels in a position quite different from that in any species of *Garra* with two barbels.

(ii) The gill-openings extend to the ventral surface, whereas in *Garra* they are usually restricted to the sides.

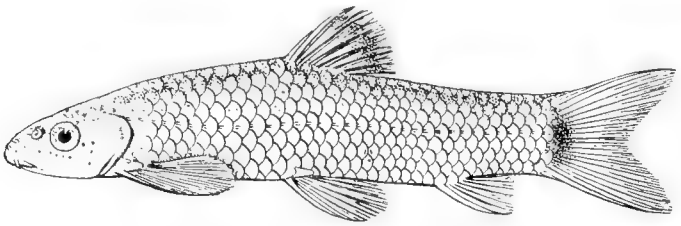
(iii) In *Parapsilorhynchus* the mouth is very small, while in *Garra* it is usually much wider.

Parapsilorhynchus discophorus, sp. nov.

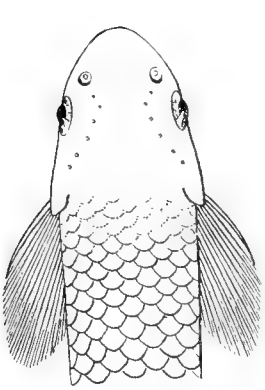
D. 2/6. V. 7. A. 7. P. 16.

This is a small-sized fish, with the back moderately elevated. The dorsal profile rises gracefully from the tip of the snout to the origin of the dorsal, beyond which it slopes imperceptibly down to the base of the caudal fin. The ventral surface is somewhat flattened and its profile is almost straight and horizontal. The length of the head is contained $4\frac{1}{8}$ times, the depth of the body near the origin of the dorsal fin $4\frac{1}{8}$ times, and the length of the caudal fin $3\frac{1}{5}$ times in the total length without the caudal fin. The eyes are of a moderate size and are situated slightly nearer to the posterior margin of the operculum than to the end of the snout; their diameter is contained $3\frac{3}{5}$ times in the length of the head, twice in the interorbital width and $1\frac{1}{2}$ times in the length of the snout. The gape of the mouth is $1\frac{1}{3}$ times the diameter of the eye. The head is short and narrow; its greatest width is contained $1\frac{1}{4}$ times in its length. There are definite rows of open pores on the sides and upper surface of the head and also along the opercular borders on the under surface. The greatest height of the caudal peduncle is equal to its length. The vent is situated in the beginning of the last fourth of the distance between the end of the snout and the base of the caudal fin. There is a pair of short barbels on the snout. The barbels are thick and stumpy and are not pointed distally; they are situated ventrally, a short distance behind the anterior end of the snout and are partly visible from above. There is a deep groove on either side running from the base of the barbel to the angle of the mouth. The mouth is small and crescentic, and is situated on the ventral surface considerably behind the anterior end of the snout. The upper labial fold is long and fringed and is covered with minute tubercles. The lower lip forms the anterior free border of the mental disc and is studded with fairly big tubercles. The labial fold tapers towards the angle of the mouth and partially covers the lateral borders of the lower lip. The most significant point about this species is the presence of a small, rudimentary disc behind the lower lip. The

disc consists of an oval callous portion in the middle, with its longest diameter at right angles to the length of the fish and a well-



A.



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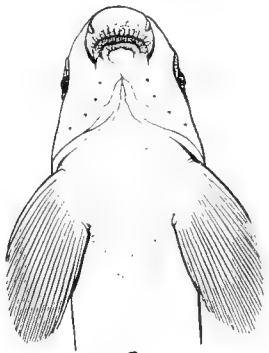

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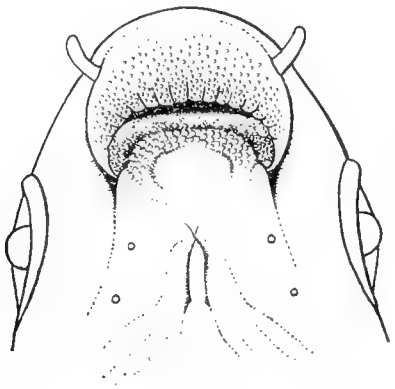


D

Parapsilorhynchus discophorus, sp. nov.

A. Lateral view of the type-specimen, × 2.
B. Dorsal surface of head of the same, × 3.
C. Ventral surface of head of the same, × 3.
D. Anterior part of the ventral surface of head of the same, × 9.

defined tubercular border anteriorly, but becoming obscure behind. The opercular borders meet a short distance behind the mental

disc. The scales are small and are totally absent from the ventral surface; there are 34 scales along the lateral line and 9 rows between the bases of the dorsal and the ventral fins. The dorsal fin is $\frac{3}{4}$ as high as the depth of the body below it; it is situated nearer to the base of the caudal than to the end of the snout and its origin is equidistant from the nostrils and the base of the caudal. The origin of the ventrals is almost opposite or slightly behind that of the dorsal fin. The pectorals are shorter than the head and are separated from the ventrals by a considerable distance. The caudal is forked and both the lobes are pointed. The ventrals are provided with a short fleshy appendage. The air-bladder is of the normal Cyprinid type.

The sides and the upper surface of the head are dusky; while the ventral surface is white. There is a dark bar across the dorsal fin near its free border and a short black bar at the base of the caudal

Type-specimen.—F. 9952/1. *Zool. Survey of India* (Ind. Mus.).

Locality.—Only one specimen was obtained by Dr. F. H. Gravely at Pophli in the Vashishti valley, in the Western Ghats, Ratnagiri district, Bombay Presidency, at an altitude of 400 ft.

Measurements in millimetres.

Total length excluding caudal	33·0
Depth of body in front of dorsal	8·0
Length of head	8·0
Width of head	6·5
Diameter of eye	2·2
Length of snout	3·3
Interorbital width	4·5
Gape of mouth	3·0
Length of caudal peduncle	5·5
Least height of caudal peduncle	5·0
Height of dorsal fin	6·5
Length of pectoral	7·5
Length of ventral	6·5
Length of anal	5·0
Length of caudal	8·5
Distance of vent from end of snout	24·0

The new species is closely related to *Parapsilorhynchus tentaculatus* (Annand.), recently described from the adjacent Poona and Satara districts of the Bombay Presidency. The fundamental points of resemblance are the presence of two short, stumpy and blunt barbels on the snout and also the presence of a well-defined air-bladder. The species are also alike in having a narrow and pointed operculum which is sharply marked off and bluntly truncate above. In both the species there is a black bar across the dorsal and a black spot at the base of the caudal fin. The

general facies in the two is similar as is also the position of the mouth and the structure of the labial fold. The points of differences are, however, numerous and important. In a well-preserved specimen of *P. tentaculatus* a small pad can be made out just behind the bilobed lower lip, while in the new species there is a distinct callous disc and the lower lip is not bilobed. In *P. discophorus* the ventral surface is more rounded and is absolutely devoid of scales, the head is shorter and narrower and the eyes are distinctly visible from below. The two species also differ in proportions and number of scales. The paired fins in *P. discophorus* are not so expanded as in *P. tentaculatus* and are not provided with muscles on their ventral aspect.

IV. NOTES ON FISHES IN THE INDIAN MUSEUM.

II. On a new species of *Nemachilus* from the Nilgiri Hills.

By Sunder Lal Hora, *M.Sc., Research Assistant, Zoological Survey of India.*

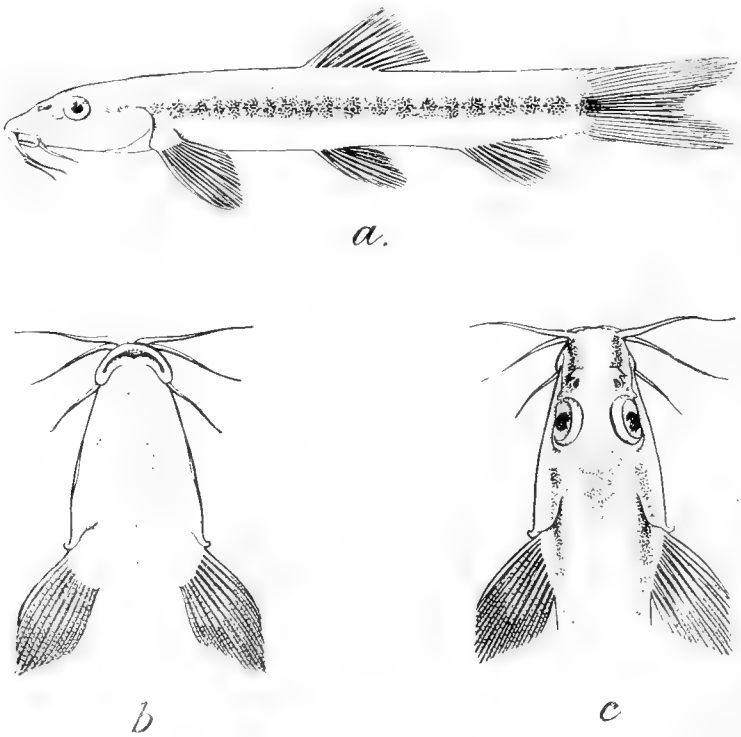
In this paper I give a description of a small loach, obtained by Dr. N. Annandale from the Bhavani River in the Nilgiri Hills. The species is easily distinguished from all previously known by the peculiar moniliform band of black pigment on either side.

Nemachilus monilis, sp. nov.

D. 3/7. P. 10. V. 8. A. 2/5. C. 19.

In this little loach the head and body are slightly depressed and are almost flat on the under surface; the dorsal profile rises from the tip of the snout to the base of the dorsal fin beyond which it is almost straight; the ventral is straight and horizontal throughout. The head is sharp and bluntly pointed; its length is contained four times in the length of the body without the caudal. The height of the head near the occiput is less than its greatest width and is half the length of the head. The length of the caudal fin is equal to the length of the head and the depth of the body near the origin of the dorsal fin equals its width. The eye is large and its diameter is contained almost four times in the length of the head; it is dorso-lateral in position and is invisible from below. The length of the snout is greater than the post-orbital length of the head and is almost twice the diameter of the eye. The interorbital width is 1·3 times the diameter of the eye. The nostrils are situated considerably nearer to the eye than to the tip of the snout. Close to the antero-inferior border of the orbit there is a short pad-like process covering a pit; it is probably a secondary sexual character of the male. There are three pairs of long, thread-like barbels; the longest is twice the diameter of the eye. The mouth is an inferior, crescentic opening bordered by well-developed prominent lips. The upper lip is raised into a short proboscis in the middle and the lower lip is interrupted in the same region. The origin of the dorsal fin is nearer to the base of the caudal than to the tip of the snout; it is higher than the depth of the body below it. The ventral commences almost below the dorsal

and is likewise in the posterior half of the body. The pectorals are shorter than the head and are separated from the ventrals by a considerable distance. The ventrals do not reach the anus which is situated in the beginning of the last third of the distance between the origin of the ventral and the anal fins. There is a prominent tube running from between the bases of the ventrals backwards and posteriorly ends as the opening of the anus. The caudal fin in emarginate; the lobes are subrounded and equal. The height of the caudal peduncle is slightly less than its length.



Nemachilus monilis, sp. nov.

a. Lateral view of type-specimen × 1½
b. Ventral surface of head of same × 2.
c. Dorsal surface of head of same × 2.

Nemachilus monilis possesses a characteristic colouration and can be easily distinguished from the rest of the species in the genus. There is a well-developed moniliform black band along the lateral line in the middle of the body from the base of the caudal fin to the tip of the snout, interrupted by the eye in its course; those of the two sides meet across the tip of the snout anteriorly. The last of the component spots in the series is more prominent. The band is continued as a black streak along the middle of the caudal fin; otherwise the body is of a dirty white colour

somewhat infuscated along the back. The fins are whitish and some of the barbels are streaked with black.

Type-specimen :—F 9981/1 Zoological Survey of India (*Ind. Mus.*)

Locality :—Two specimens of this species were collected by Dr. N. Annandale in August 1918, at the edge of the Bhavani River, 10 miles from Mettupalaiyam, near the base of the Nilgiri Hills at an altitude of 1,800 ft.

Measurements in millimetres.

	A	B
Length of fish excluding caudal ..	50·0	25·0
Length of caudal	12·5	6·0
Depth of body near origin of dorsal ..	7·5	3·7
Length of head	12·5	7·0
Depth of head	6·0	3·6
Width of head	7·5	4·1
Diameter of eye	3·0	1·8
Length of snout	5·5	2·8
Interorbital width	3·7	2·5
Length of caudal peduncle	7·6	4·0
Minimum height of caudal peduncle ..	6·6	3·4
Longest ray of dorsal	9·0	4·5
,, ,, of anal	7·8	3·6
Length of pectoral	9·0	5·5
,, of ventral	8·5	4·0

V. NOTES ON CRYPTOSTOME BEETLES.

By S. MAULIK, *Professor of Zoology, Calcutta University.*

I published two papers on the Cryptostome beetles of the Indian Museum in this Journal, (1) in Vol. IX, Part II, June 1913, page 105, and (2) in Vol. XI, Part V, September 1915, page 367. In July, 1919, I published in the Fauna of British India series a complete review of the Cryptostome beetles of India, Burma and Ceylon, so far as they were known up to that date. In this work the results of my study of the material of these groups sent to me from the Indian Museum were incorporated. It will therefore be unnecessary to report separately on that collection. I shall, however, give here a list of types and cotypes of Hispinae and Cassidinae deposited in the Indian Museum.

The following is the list :—

HISPINAE.

Macrispa krishnalohita, Maulik (cotype).
Anisoderopsis nigra, Maulik (type of ♀).
Leptispa rufithorax, Maulik (cotype).
Prionispa himalayensis, Maulik (type).
Wallacea dactyliferae, Maulik (cotype).
Downesia ratana, Maulik (cotype).
Monochirus sthulaçundus, Maulik (type).
Rhadinosa laghua, Maulik (type).
Rhadinosa girija, Maulik (type).
Asamangulia cuspidata, Maulik (cotype).
Dactylispa krishna, Maulik (type).
Dactylispa peregrina, Maulik (type).
Dactylispa harsha, Maulik (type).
Dactylispa sadonensis, Maulik (type).
Dactylispa bindusara, Maulik (type).
Dactylispa lohita, Maulik (type).
Dactylispa variabilis, Maulik (type).
Dactylispa pitapada, Maulik (cotype).
Dactylispa asoka, Maulik (cotype).
Dactylispa kamarupa, Maulik (type).
Dactylispa parbatya, Maulik (type).
Dactylispa kunala, Maulik (type).

CASSIDINAE.

Epistictia fulvonigra, Maulik (type).
Aspidomorpha chandrika, Maulik (type).
Cassida stupa, Maulik (type).
Cassida belliformis, Maulik (type).
Cassida cherrapunjiensis, Maulik (type).
Cassida circumdata var. *dentata*, (type Maulik of var.).
Chirida hina, Maulik (type).
Chirida binduta, Maulik (cotype).

During the European war (1914-1919) I was unable to communicate with workers on these groups except Dr. R. Gestro of the Genoa Museum. But since the publication of my book I have been in correspondence with Dr. F. Spaeth. As a result I find it is necessary to publish certain notes on the Cassidinae.

Dr. Spaeth informs me that *Hoplionota modesta*, Wagener, is found only in the Philippine Islands. The author wrongly re-

ported it from "India Orientalis." It is synonymous with *H. chapuisi*, Spaeth and *nitida*, Weise, but has priority over both.

Epistictia viridimaculata var. *trivandrumensis*, Maulik, is the same as *Epistictia reicheana*, Guer. When I proposed the variety I had not discovered the type of *reicheana* in the British Museum.

According to Spaeth *Aspidomorpha spaethei* Maulik=*A. inuncta*, Boh.

Aspidomorpha fusconotata, Boh., is found only in the Philippine Islands.

Laccoptera quadrimaculata var. *plagiographta*, Maulik=*L. fruhstorferi*, Spaeth.

Spaeth's *Chirida mystica* (December, 1919) falls as a synonym of my *Ch. novemkalankita* (July, 1919).

According to Spaeth *Cassida pauxilla*, Boh.=*C. conspurcata*, Boh.

VI. UN LINGUATULIDE NOUVEAU PARASITE D'UN BATRACIEN.

Par L. Gedoelst.

Parmi des matériaux parasitologiques reçus de l'Indian Museum de Calcutta et comprenant essentiellement des larves de dipteres, nous avons trouvé un objet d'un particulier intérêt, dont nous donnons la description ci-après.

Longueur : 3·6 mm., largeur maximum : 0·83 mm.

Le corps est cylindroïde, à face ventrale aplatie, à face dorsale fortement bombée ; l'extrémité antérieure est atténuée aux dépens des faces dorsale et latérales, de telle sorte que la face ventrale s'étend sans déviation jusqu'a l'extrême limite antérieure du corps ; l'extrémité postérieure est atténuée progressivement et uniformément sur toutes ses faces et se termine par deux lobes coniques latéraux, à axes divergents. Le tégument est blanc, plus ou moins transparent.

La tête vue par la face ventrale présente un contour triangulaire à sommet légèrement tronqué. Près de celui-ci s'ouvre la bouche, médiane, orbiculaire. Au-devant de celle-ci et sur le bord antérieur de la tête, on voit deux petits appendices papilliformes latéraux, qui représentent les deux renflements antennaires ; en arrière de la bouche sont disposées deux paires de crochets ; ceux-ci occupent les angles d'une figure trapézoïdale à grande base postérieure ; ces crochets sont simples, hyalins, légèrement jaunâtres, et proéminents au niveau d'un mamelon leur servant de gaîne et accosté à droite et à gauche d'un mamelon plus petit hémisphérique. Les crochets antérieurs sont plus petits que les postérieurs ; ils sont écartés l'un de l'autre de 450μ, les postérieurs de 720μ, ceux-ci étant situés à 140μ, en arrière des premiers. A la face dorsale de la tête on observe en avant du niveau occupé par la paire antérieure de crochets une paire d'appendices papilliformes et plus en arrière à la hauteur de la paire postérieure de crochets la cuticule se soulève à droite et à gauche en un renflement vésiculaire hémisphérique.

Le corps est formé de 25 anneaux comptés en arrière de la paire postérieure de crochets, le 25^{e} anneau étant constitué par les deux lobes divergents de l'extrémité bifide du corps, entre lesquels s'ouvre l'anus. Le relief des différents anneaux est en général peu accusé. Le pore génital se trouve situé au sommet d'un mamelon médian, court et épais, vers les 3^{e}-4^{e} anneaux du corps. Le deuxième anneau porte latéralement de chaque côté une petite papille ventrale.

Par ces caractères, cet organisme se range dans la famille des

Linguatulides et plus particulièrement dans le genre *Raillietiella* Sambon, 1910, dont il représente une espèce nouvelle, caractérisée surtout par ses petites dimensions et pour laquelle nous proposons le nom de *Raillietiella indica.* Mais ce qui fait tout l'intérêt de cette observation, c'est que ce parasite a été rencontré dans le poumon d'un *Bufo melanostictus* et constitue par conséquent le premier exemple d'un Linguatulide parasite d'un Batracien.

Le genre *Raillietiella* renferme actuellement les espèces suivantes:—

1. *Raillietiella furcocerca* (Diesing, 1835).

   Syn. : *Pentastoma furcocercum* Diesing, 1835.
   Pentastomum bifurcatum Diesing, 1850.
   Porocephalus bifurcatus Shipley, 1893.
   Porocephalus boulengeri Vaney et Sambon, 1910.
   Raillietiella boulengeri Sambon, 1910.
   Hôtes : *Amphisbaena alba* Gray, 1844.
   Drymobius bifossatus Radde, 1820.
   Zamenis constirctor Linné, 1766.
   Boa constrictor Linné, 1758.
   Boa imperator Daudin, 1803.
   Coluber melanoleucus Daudin, 1803.

2. *Raillietiella bifurcata* var. *orientalis* (Hett, 1915).

   Syn. : *Porocephalus bifurcatus* var. *orientalis* Hett, 1915.
   Hôtes : *Zamenis mucosus* Linné, 1766.
   Naia tripudians Merrem, 1820.

3. *Raillietiella bifurcata* var. *mediterranea* (Hett, 1915).

   Syn. : *Porocephalus bifurcatus* var. *mediterraneus* ett, 1915.
   Hôte : *Zamenis gemonensis* Laurenti, 1768.

4. *Raillietiella geckonis* (Diesing, 1850).

   Syn. : *Pentastomum geckonis* Diesing, 1850.
   Raillietiella geckonis Sambon, 1910.
   Hôte : Un gecko de Siam (probablement *Gecko verticillatus* Laurenti, 1768).

5. *Raillietiella indica* (Gedoelst, 1921).

   Hôte : *Bufo melanostictus* Schneider, 1799.

VII. NOTES ON THE OCCASIONAL ABSENCE OF THE PAIRED FINS IN FRESH WATER FISHES, WITH SOME OBSERVATIONS ON THE TWO APODAL GENERA *CHANNA*, GRONOW AND *APUA*, BLYTH.

By SUNDER LAL HORA. *M.Sc.*,
Research Assistant, Zoological Survey of India.

Willey[1] has recently referred to the absence of the ventral fins in a male specimen of *Amia calva* and urges the necessity of recording such observations as they are likely to throw some light on "natural mutations amongst fishes." In the course of my studies on the freshwater fishes of India, I have come across a few "mutations" of this nature and I take this opportunity of bringing them to notice.

(i) While examining a large collection of fish made in Manipur by the Manipur Survey party and myself, I found a specimen of *Barilius barila* (Ham. Buch.), in which both the ventral fins were totally absent. The abnormal specimen was captured in Khurda stream near Thanga, with a large number of normal specimens. It does not seem to have suffered any disadvantage on account of the absence of the ventrals. There is no external mark or scar to show that the condition is the result of an accident or injury. The proper place of the origin of the ventrals is completely covered with scales. Comparison of the arrangement of the scales in a normal and the abnormal specimen is shown in figure 1 (*a*).

Dissection of the body wall in the region of the pelvic fins under a high power of a binocular microscope, by stripping the different layers one by one, revealed no irregularity of arrangement and no trace of the pelvic girdle was found.

The total length of the abnormal specimen including the length of the caudal fin is 94 mm., while the average length of the species is about 125 mm.

(ii) In the Manipur collection I found another interesting specimen of a new species which I call *Barilius dogarsinghi*, in which the ventral fin of the left side was absent. The place of origin of the ventral fin is here also covered with scales. In a normal specimen there are four scales between the bases of the ventrals. They are longer than the rest and are more pointed posteriorly; they are arranged in such a way as to form a sheath on the inner side of the bases of the ventrals. In the abnormal

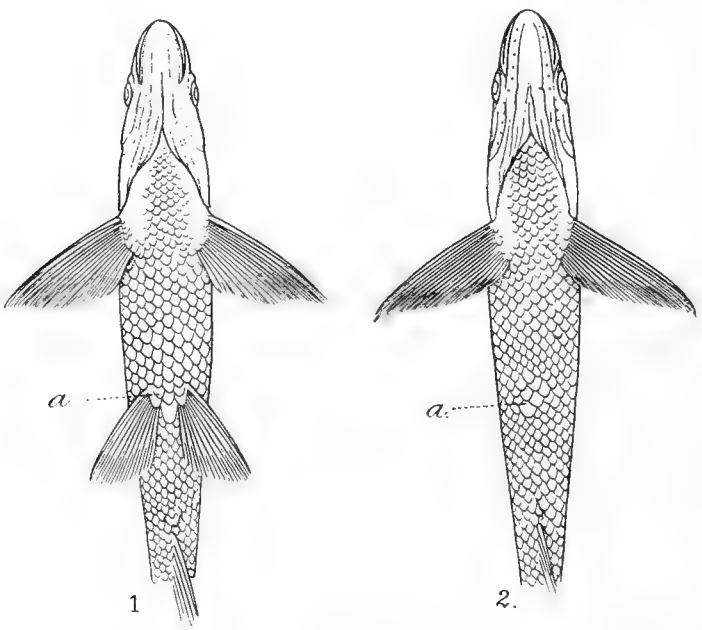
[1] Willey, *Proc. Zool. Soc. London*, pp. 89—90 (1920).

specimen there are no special scales in the region of the ventrals and the arrangement of these is not interrupted on the left side.

It is rather interesting to note that on dissection of this region the fin muscles and the girdle of the right side only were found to be present, while on the abnormal side no trace of either the muscles or the girdle was observed.

The abnormal specimen is 62 mm. in length and was collected in the Etok stream near Chanderkhong with eleven other normal specimens of the same species. The average length of the species is 85 mm.

(iii) In a specimen of another new species, *Nemachilus kangjupkhulensis*, the ventral fin of the right side is lacking. Even the fin on the other side is not normal. It is distorted in such a way that there appear to be two fins, one immediately behind the other. In the anterior portion of the abnormal fin there are three rays while in the posterior only four. In a normal specimen there are in all six to seven rays in the ventral fin. There is no indication that the absence of the ventral fin is due to any accident or injury. The abnormal specimen was collected in a small hill stream near Bishenpur, Manipur. It is about 43 mm. in length which is the average length of the species.



Text-fig. 1.—Normal and abnormal specimens of *Barilius barila* (Ham. Buch.)

1. Normal specimen × 2. 2. Abnormal specimen × 2.
a=Lepidosis in the region of the ventrals.

(iv) The most interesting specimen is that of *Rita rita* (Ham. Buch.), in which the pectoral fin of the right side is absent. The

specimen was collected by Mr. Hamid Khan in the Ravi River near Lahore. He noticed this abnormality and presented the specimen to the Government College Museum, Lahore. I am indebted to Prof. George Matthai for lending me the specimen from the above Museum and for allowing me to dissect it for study of the skeleton and the musculature of the abnormal region.

The pectoral fin in the genus *Rita* is a characteristic structure, as it is provided with a very strong spine. The spine is almost as long as the length of the pectoral girdle. The fish does not seem to have suffered as regards its size; its length including the length of the caudal fin is 32·6 cm., which is the average length of the species at Lahore.

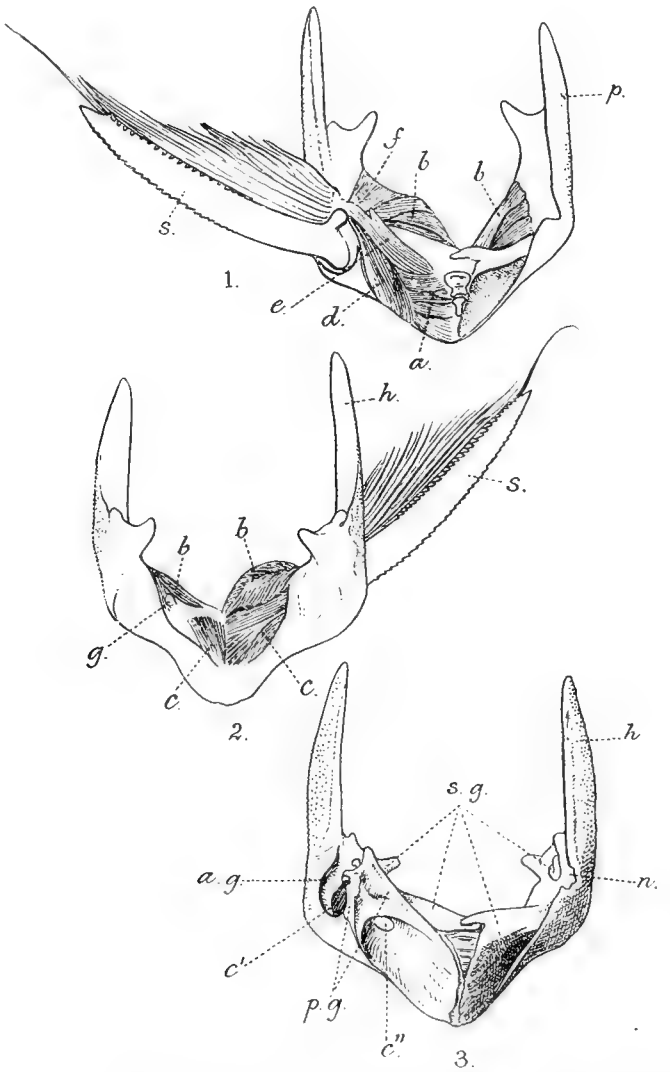
Correlated with the absence of the fin, the various muscles, associated with it are either absent or have undergone considerable degeneration. The abductor and adductor muscles (*e*, *f*) are totally absent. Of the muscles (*a*, *b*, *c*, *d*), which control the movements of the spine, *a* and *d* are not represented, while the other two, *b* and *c*, are greatly reduced. An accessory nodule of bone was found in the course of the greatly reduced muscle of the abnormal side. I am unable to understand its significance as the structure is not represented in the muscle of the opposite side or in other normal specimens.

The shoulder girdle of the abnormal side is considerably shorter in width than that of the opposite side. The primary girdle (*p.g.*), consisting mainly of the scapular and coracoid bones, is either altogether absent on the abnormal side or has so fused with the secondary investing bones of the girdle as to be quite indistinguishable from them. Consequently the canals (*c'*, *c''*) for the passage of the muscles of the spine are wanting, and this to a certain extent may account for the absence or degeneration of the muscles. The deep groove (*a.g.*), for the articulation of the condyle at the base of the spine, formed by the cubito-humeral process (*h*) and the clavicular element (*s.g.*) is represented on the abnormal side only by a notch (*n*) in the cubito-humeral process.

The degeneration of the muscles of the right side and the abnormalities in the skeleton of this region indicate that the absence of the fin is not due to any recent accident or injury. It seems quite probable that all the abnormalities noticed above are the direct or indirect result of the absence of the primary shoulder-girdle of the abnormal side; this will also account for the absence of the right fin. The musculature was probably affected secondarily, while the reduction in the secondary girdle is chiefly due to the disuse of the associated structures.

In almost all such abnormalities, it has been pointed out that the growth of the fish is not effected by them. It is only after careful examination that these abnomal forms can be separated from normal specimens netted with them.

Abnormalities of this nature have been regarded as congenital variations. Willey (*op. cit.*) regards them as mutations and comes to the conclusion "that the presence or absence of such deep-



TEXT-FIG. 2.—Musculature and skeleton of the pectoral girdle in an abnormal specimen of *Rita rita* (Ham. Buch.).

1. Muscles of the pectoral fin seen from above.
2. Muscles of the pectoral fin seen from below.
3. Skeleton of the pectoral arch seen from below.

a = muscle attached above the base of the condyle of the spine. This pulls the spine outwards thus expanding the fin ; *b* = muscle that pulls the spine inwards, thus folding the fin ; *c* = pulls the spine outwards ; *d* = folds the fin ; *e* = abductor muscle ; *f* = adductor muscle ; *g* = nodule of bone ; *h* = cubito-humeral process ; *a.g.* = articular groove ; *p.g.* = primary shoulder girdle ; *s.g.* = secondary shoulder girdle ; *n* = notch in the cubito-humeral process ; *s* = spine ; *c'*, *c''* = canals for the passage of muscles.

seated characters is linked up with their use or disuse, and that they do not necessarily dwindle away to vanishing point, but may simply drop out of the factorial system." Eigenmann and Cox,[1] who have recorded the absence of the ventrals in *Ameiurus natalis*, consider this character as a prepotent variation and suggest that "it is possible that some of the genera of fishes without ventrals have arisen from such prepotent variants, ..." Brindley,[2] who noticed the absence of the ventrals in a specimen of the White Bream (*Abramis blicca*, Bloch.) observed "that the defect is congenital and not the result of accidental injury. ...." Too much importance seems to have been attached to the variations in the germ-plasm especially when dealing with such cases of abnormalities. Dr. N. Annandale suggests, and I agree with him, that such abnormalities may be the result of some injury to the anlagen of the ventral or the pectoral fins in the developing embryo. There is, however, very little material available at present to come to any satisfactory conclusion.

I will now briefly deal with the two Indian genera of freshwater fishes that are distinguished from their nearest relatives by the absence of the ventral fins. These are *Channa*, Gronov. and *Apua*, Blyth. The genus *Channa*, which was hitherto known from Ceylon, the Philippines, China and Japan, has recently been recorded from Burma by Chaudhuri.[3] According to both Günther[4] and Day[5] this genus is distinguished from *Ophiocephalus*, Bloch., by the absence of the ventral fins and the pyloric or coecal appendages. In the original description of the genus by Gronovius[6] the only significant phrase is "*Ventrales nullæ.*" I have examined two species of *Channa*, one described by Chaudhuri (*op. cit.*) and the other contained in Dr. N. Annandale's Chinese collection. In both these species pyloric appendages similar to those of *Ophiocephalus* are present. The only character, therefore, that distinguishes *Channa* from *Ophiocephalus* is the absence of the ventral fins. The occasional absence of the ventrals has been regarded in other genera as an abnormality or a case of genital variation; but in *Channa* this character seems to have become permanent, for large series of specimens with the ventrals absent have been collected from the same locality. Moreover, no species of *Channa* has been described having the same specific characters as any known species of *Ophiocephalus*. Some people attribute the absence of the ventrals to the habits of these fishes, but how far this is true I have no evidence to judge at present.

It is otherwise in the case of the second genus, *Apua*, which was described from two specimens and has not been recorded since. Vinciguerra[7] doubted the existence of *Apua* and referred his spe-

[1] Eigenmann and Cox, *Amer. Naturalist*, XXXV, p. 33 (1901).
[2] Brindley, *Proc. Zool. Soc. London*, pp. 108—109, pl. x (1891).
[3] Chaudhuri, *Rec. Ind. Mus.* XVI, p. 284 (1919).
[4] Günther, *Cat. Brit. Mus. Fishes* III, pp. 468 and 483.
[5] Day, *Fishes of India*, II, p. 368.
[6] *Catalogue of Fish in the British Museum*, p. 99 (1854).
[7] Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, XXIX, pp. 348-49 (1889).

cimens to *Acanthophthalmus* from which Blyth's genus is distinguished chiefly by the absence of the ventral fins. I have carefully examined the two unique type-specimens preserved in the Indian Museum and a large series of fresh specimens of *Acanthophthalmus pangia* from Manipur. I do not find any trace of the ventrals or of accidental injury in the former. Moreover, I cannot distinguish Blyth's specimen from *Acanthophthalmus pangia* except by the absence of the ventrals. I am, therefore, led to believe that the specimens of *Apua* were abnormal and that the genus *Apua* cannot stand distinct from *Acanthophthalmus*.

I conclude, therefore, that the cases of *Apua* and *Channa* are not to be considered parallel. *Channa* has been found by numerous collectors at many different places over a very wide area and the ventrals are invariably absent. *Apua*, on the other hand, has only once been collected and only two individuals were then found.

I have carefully dissected a specimen of *Channa burmanica*, Chaudhuri, and have not been able to find any trace of the pelvic girdle.

VIII. REPORT ON A COLLECTION OF BRYOZOA FROM THE BAY OF BENGAL AND OTHER EASTERN SEAS.

By Alice Robertson, *Ph.D.*

The collection of bryozoa here reported upon was sent me by Dr. Annandale, Superintendent of the Museum at Calcutta, India. It consists of bryozoa obtained, for the most part, at various points on the coast of India and from various depths in the Bay of Bengal and vicinity. Both shore and deep water species are included, the bathymetric range varying from a few to several hundred fathoms.

The specific identification is accompanied with one or two synonyms only, referring both to a description and a plate, the endeavour being simply to make the identification intended unmistakable. In case the plate referred to is not easily accessible, or in those instances in which new species are described, drawings are given together with a description. No attempt has been made to give a complete synonymy, the authority adopted being that of Miss Jelly (1889). Any departure from this has been chiefly on the authority of Waters, especially as given in his recent papers on the Red Sea (1909) and the Zanzibar (1913) faunas.

This collection contains representatives of forty-five genera and ninety-five species. Of these nine species and one variety are thought to be new to science. Two genera, *Kinetoskias* and *Farciminaria*, are of special interest, since not only are they from abyssal depths, but also while possessing undoubted characteristics of these two genera, the two species by which they are represented possess other characters which link them to other but probably related genera in a manner not hitherto shown. Considerable interest attaches to certain membraniporas found in brackish waters. Three such are considered new to science. Their membraniporidan character was early recognized but certain other characters were extremely puzzling, and it was not until the work of Stoliczka (1869) on *M. bengalensis* was discovered that their true nature was revealed. Judging from the work done by Dr. Annandale on brackish water forms together with these river species of *Membranipora*, India abounds in brackish water variational forms of much interest.

Considerable difficulty has been encountered in this investigation since the writer has been unable in most cases to secure actual specimens for comparison. My thanks are specially due to Professor Trevor Kincaid in so cordially lending the facilities of

the Department of Zoology and of the Library of the University of Washington for the furtherance of this work.

List of Species treated.

1. *Actea truncata*, Landsborough
2. *Synnotum aviculare*, Pieper.
3. *Catenaria lafontii*, Aud.
4. *Scrupocellaria cervicornis*, Busk.
5. ,, *jolloisii*, Aud.
6. ,, *pilosa*, Aud.
7. ,, *macandrei*, Busk.
8. *Canda retiformis*, Pourtales.
9. *Caberea lata*, Busk.
10. *Diploecium simplex*, Kirk.
11. *Bugula neritina*, Linn.
12. ,, ,, var. *minima*, Waters.
13. *Beania ostia*, sp. nov.
14. ,, *conferta*, MacG.
15. *Kinetoskias arabianensis*, sp nov.
16. *Farciminaria andamanensis*, sp. nov.
17. *Cellaria salicornoides*, Lamx.
18. *Farcimia oculata*, Busk.
19. *Flustra cribriformis*, Busk.
20. ,, *rizophora*, Ortmann.
21. *Membranipora cervicornis*, Busk.
22. ,, *curvirostris*, Hincks.
23. ,, *incrustans*, Waters.
24. ,, *lacroixii*, Aud.
25. ,, *perfragilis*, MacG.
26. ,, *simplex*, Busk.
27. ,, *tehuelcha*, D'Orb.
28. ,, ,, var. *intertuberculata*, Waters.
29. ,, *trifolium* var. *minor*, Hincks.
30. ,, *spinostoma*, sp. nov.
31. ,, *amoyensis*, sp. nov.
32. ,, *devinensis*, sp. nov.
33. ,, *hugliensis*, sp. nov.
34. *Megapora ringens*, Busk.
35. *Steganopora magnilabris*, Busk.
36. *Thalamoporella rozieri*, Aud.
37. *Smittipora abyssicola*, Smitt.
38. *Cribrilina radiata*, Moll.
39. ,, *punctata*, Hassall.
40. *Microporella ciliata*, Pallas.
41. ,, *distoma*, Busk.
42. ,, *impressa*, Aud.
43. ,, *malusii*, Aud.
44. ,, *yarraensis*, Waters.
45. *Porina tubulosa*, Norman.
46. *Tubucellaria cereoides*, Ell. and Sol.
47. *Schizoporella auriculata*, Hassall.
48. ,, *biaperta*, Michelin.
49. ,, *brunnescens*, Ortmann.
50. ,, *cecilii*, Aud.
51. ,, *linearis*, Hassall.
52. ,, ,, form *quincuncialis*, Hincks.
53. ,, *nivea*, Busk.
54. ,, *pertusa*, Esper.
55. ,, *dutertrei*, Aud.
56. ,, ,, var. *foliacea*, nov.
57. *Lepralia adpressa*, Busk.
58. ,, *depressa*, Busk.
59. ,, *feegeensis*, Busk.
60. ,, *turrita*, Smitt.
61. *Escharoides occlusa*, Busk.
62. *Petralia laccadivensis*, sp. nov.
63. ,, *vultur*, Hincks.
64. ,, ,, var. *armata*, Waters.
65. *Smittia landsborovii*, Johnston.
66. ,, *marmorea*, Hincks.
67. ,, *nitida*, Verrill.
68. ,, *trispinosa*, Johnston
69. ,, ,, var. *producta*, Thornely.
70. ,, *latiavicularia*, Kirk.
71. *Retepora delicatula*, Busk.
72. ,, *porcellana*, MacG.

73. *Retepora punctiligera*, Ortmann.
74. *Reteporella minor*, Ortmann.
75. *Haswellia australiensis*, Haswell.
76. *Adeonella japonica*, Ortmann.
77. ,, *platalea*, Busk.
78. ,, *marginata*, sp. nov.
79. *Lagenipora costazii*, Aud.
80. ,, *tuberculata*, MacG.
81. *Holoporella aperta*, Hincks.
82. ,, *tridenticulata*, Busk.
83. ,, *mammillata*, Busk.
84. *Cupularia canariensis*, Busk.
85. *Crisia* sp?
86. *Filisparsa tubulosa*, Busk.
87. *Idmonea atlantica*, E. Forbes.
88. ,, *gracillima*, Busk.
89. *Entalophora raripora*, d'Orb.
90. *Lichenopora radiata*, Aud.
91. *Domopora truncata*, Jameson.
92. *Alcyonidium mytili*, Dalyell.
93. *Amathia semiconvoluta*, Waters.
94. *Zoobotryon pellucidus*, Ehrenberg.
95. *Pedicellina cernua*, Pallas.

ABBREVIATIONS USED IN TEXT-FIGURES.

av. avicularium.
av.ar. avicularian area.
av.zoe. avicularian zoœcium.
b.j. break joint.
ba.sp. basal spine.
chi.r. chitinous rim.
de.mus. degenerating muscle.
de.poly. degenerating polypide.
emb. embryo.
fer.zoe. fertile zoœcium.
l. lobe.
lat.sp. lateral spine.
mus. muscle.
nu.zoe. nutritive zoœcium.
oe. oœcium.
oe.zoe. oœcial zoœcium.
op. operculum.
op.r. opercular rim.
op.sp. opercular spine.
p. pore.
ped.av. pedunculated avicularium.
pl. plate.
pr. process.
pri.mo. primary mouth.
re.ele. reproductive elements.
ses.av. sessile avicularium.
sh. sheath.
sp.av. spatulate avicularium.
st. stomach.
t.ba. tubular base.
um. umbo.
zoe. zoœcium.

CHEILOSTOMATA.

1. Aetea truncata, Landsborough.

Aetea truncata, Robertson, 1905, vol. 2, no. 5, p. 246, pl. iv, figs. 5, 6.

A mere fragment growing on a piece of shell together with other Bryozoa. Obtained on the Pearl Banks, Ceylon, depth unknown. This species seems to be a northern form which has strayed south. It is present as a shore form on the coast of Alaska, has been obtained on a holdfast at La Jolla, California, at a depth of two fathoms, and is reported from Zanzibar at eight fathoms.

2. Synnotum aviculare, Pieper.

Synnotum aviculare, Hincks, 1886, ser. 5, vol. 17, p. 257.
Synnotum aviculare, Robertson, 1905, vol. 2, no. 5, p. 286, pl. xiv, figs. 84, 85.

Mr. Waters (1913) criticises my identification of *S. aviculare* obtained from the coast of California, considering that the species there obtained is *S. contorta.* After examining the specimen from Madras Harbour I am the more inclined to the opinion that the California species is identical with the species in this collection and that both are *S. aviculare.* A piece of a colony growing with *B. neritina* obtained from Madras Harbour ; also found at a depth of 6 to 8 fathoms, growing on cinder at the entrance to Palk Straits.

3. Catenaria lafontii, Audouin and Savigny.

Catenaria lafontii, Harmer, 1902, vol. xlvi, p. 305, pl. 17, fig. 49.

Obtained at three stations in Madras Harbour, dredged at from 6 to 8 fathoms ; also at Mergui, Burma.

4. Scrupocellaria cervicornis, Busk.

Scrupocellaria cervicornis, Busk, 1852, pt. i, p. 24, pl. lxii.

Common in Madras Harbour at depths of from 4 to 6 fathoms ; obtained also at the entrance to Palk Straits and at Mangalore, west coast of India.

5. Scrupocellaria jolloisii, Audouin and Savigny.

Scrupocellaria jolloisii, Waters, 1909, p. 132, pl. 10, figs. 5-10.

A common species in this vicinity obtained at several localities : Mangalore, Gaspar Straits, Malay Archipelago and Mergui, Burma. Also dredged at depths of from 30 to 24 fathoms off the Ganjam coast and at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) at depths of from 49 to 40 fathoms.

6. Scrupocellaria pilosa, Audouin and Savigny.

Scrupocellaria pilosa, Waters, 1913, p. 478, pl. lxviii, figs. 3, 4.

Found growing on cinder at depths of from 6 to 8 fathoms, at the entrance of Palk Straits.

7. Scrupocellaria macandrei, Busk.

Scrupocellaria macandrei, Busk, 1852, pt. i, p. 24, pl. xxiv, figs. 1-3.

Dredged at 31 fathoms at Mangalore, west coast of India.

8. Canda retiformis, Pourtales.

Canda retiformis, Waters, 1913, p. 479, pl. lxix, figs. 1, 2, 6.

Obtained at the Andamans growing on coral ; also at station 287 (Arabian Sea, 21°8′30″ N. 65°47′ E.) and dredged at 34 fathoms in 81°16′ E., 6°01′ N.

9. Caberea lata, Busk.

Caberea lata, Busk, 1852, pt. i, p. 39, pl. xlix.

Obtained off Ganjam, east coast of Madras Presidency, at 24 to 30 fathoms.

10. Diplœcium simplex, Kirkpatrick.

Diplœcium simplex Kirkpatrick, 1888, ser. 6, vol. 1, p. 73, pl. vii, fig. 1.

Zoarium consisting of many branches composed of relatively short internodes, the whole forming bushy tufts 25 or 30 mm. in height. *Internodes* separated by chitinous joints which form in place of the two distal zoœcia of the internode, and consisting commonly of eight zoœcia although varying in number from four to twelve. *Branching* dichotomous. *Zoœcia* arranged in pairs, back to back, each pair at right angles to the preceding pair (Fig. 1); tubular, somewhat wider in the middle. Zoœcial wall delicately calcareous, and regularly porous. *Orifices* rounded above with a sinus on the lower margin. Oœcia porous, somewhat flattened, closed by the operculum; lower margin curved so that the orifice of the fertile zoœcium is larger than that of an ordinary zoœcium. In older parts of the colony the rim of the oœcia is somewhat thickened, due probably to increased calcification.

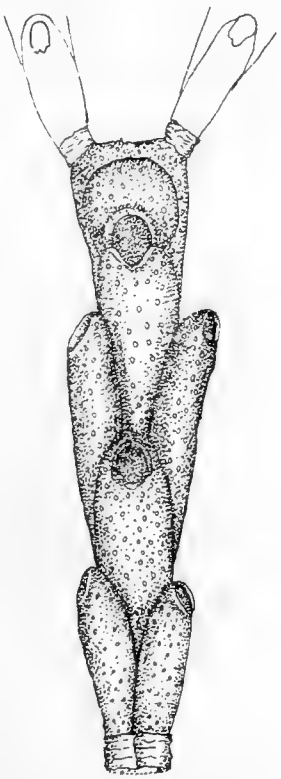


FIG. 1—*Diplœcium simplex* Kirk. × 40.

The species here identified differs slightly from that described by Kirkpatrick, notably in the greater size of internodes and in the shape of the oœcio-zoœcial orifice. The latter is thought to be an important difference, perhaps of specific value. For the present, however, these differences will be considered mere variations of the original species. This species is a puzzling one and it is doubtful, as Kirkpatrick remarks, just where it belongs in the present classification of the bryozoa.

Obtained at station 47, off mouth of Godaveri R., 5–6 fathoms. Probably dredged or taken in tangles, judging from the condition of the material. Miss Thornely reports this species from the Andamans at 17 fathoms.

11. Bugula neritina, Linnaeus.

Bugula neritina, Waters, 1909, p. 135, pl. xi, figs. 1-3.

Abundant in Madras Harbour, often growing in large masses with hydroids and other bryozoa; in one instance entangled in *Zoobotryon pellucidus*. Dredged at depths varying from 4 to 6 fathoms.

12. **Bugula neritina**, var. **minima**, Waters.

B. neritina, var. *minima*, Waters, 1909, vol. xxxi, p. 136, pl. ii. figs. 4, 7.

Small piece of a colony dredged at 31 fathoms, 21 miles S. W. by W. of Mangalore, west coast of India.

13. **Beania ostia**, sp. nov.

Zoarium forming a flat lace-like mass growing on old pieces of bone. *Zoœcia* boat-shaped, each connected with its neighbour by four tubes of approximately equal length (Fig. 2). *Aperture* occupying the whole or almost the whole of the front. Five short *spines* at the distal extremity. In a few instances there are but four spines, the margin between the second and fourth being raised, much curved and bounded by a strong chitinous rim.

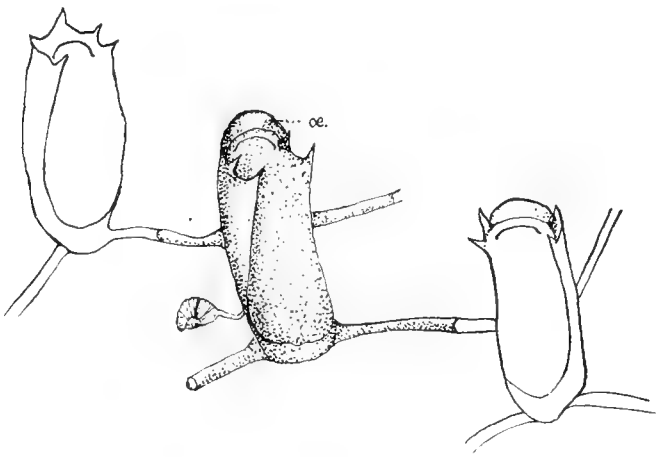


Fig. 2.—*Beania ostia*, sp. nov × 50.

This is thought to represent the *oœcium* (*œ.*). In one instance only has an *avicularium* been found, although many zoœcia have been examined. Unfortunately the material became dry before it could be studied, and hence very brittle. On a few zoœcia there are indications of the remains of an avicularium but nothing that can be positively so regarded. *Avicularium* small, pedunculated, situated at one side near the base of the aperture.

Obtained at Gopalpore, east coast of India, dredged at depths of from 25 to 28 fathoms.

14. **Beania conferta**, MacGillivray.

Beania conferta, MacGillivray, 1886, vol. xxii, p. 130, pl. 1, fig. 5.

A minute quantity growing with *F. oculata* on a worm tube, obtained at Gaspar Straits, Malay Archipelago.

15. Kinetoskias arabianensis, sp. nov.

Zoarium incomplete, consisting of a single stem with a few branches at the distal end and breaking into a number of rootlets at the attached end. The stem is composed of a number of radical tubes, and of zoœcia which are smaller and stiffer than the zoœcia of the distal branches, the two forming a stalk or stem which is probably flexible in the natural state but sufficiently rigid to hold the crown of branches two or more inches above the ocean-floor. That the substratum in which this specimen grew is similar to that usually described for *Kinetoskias* is shown by the globigerina and other shells, and grains of sand adhering to the finest rootlets. The branches at the distal end consist of zoœcia in two series, the zoœcia of each series forming an acute angle with the zoœcia of the other.

The adult or nutritive zoœcia (Fig. 3, A) are very long and may be considered to consist of two parts or regions, the zoœcia proper (*zoe.*) and the tubular base (*t.ba.*) more or less independent of the former, and into which the polypide does not extend. Indeed, the connection between it and the main body of the zoœcium is easily and frequently broken, in which case the tubular portion remains attached to the zoœcium from which it sprang, while the main portion is lost. Outlining each zoœcium and thus strengthening the rim is a chitinous border. At the point of union of the zoœcium proper and the basal prolongation, the chitinous rim is frequently bent inward forming a weakened place or break joint (*b.j.*). At the distal end of the zoœcium the chitinous margin grows thinner and there forms a blunt point. The wall of the zoœcium is delicate and transparent, the *orifice* is formed by the opening of a broadly semicircular lip bounded by a heavy chitinous bar. Both sessile and pedunculated *avicularia* occur. At the dorso-lateral angle of each zoœcium there is a sessile avicularium (*ses.av.*) with a mandible curved at the extremity and fitting into a chitinous groove. This avicularium is seated on a distinct area on the dorso-lateral wall to which the strong mandibular muscle is attached and which is outlined by a delicate rim (*C*, *av.ar.*). These avicularia frequently break off, in which case the area is exposed. On a few zoœcia only were frontal pedunculated avicularia found, attached to the lower inner margin (B, *ped.av.*). These have an extremely short peduncle, but the avicularia are relatively large. Through the transparent wall of the zoœcium the polypide is clearly visible especially in stained preparations. Within the zoœcium is found also a large and powerful muscular organ (A,B, *mus.*). This is composed of two groups of muscle fibres lying in the lower part of the zoœcium just above the tubular prolongation and spreading on two sides of the median line like two fans. Viewed from the front, the stomach of the contracted polypide is visible between the two groups of muscle fibres (A, *st.*).

In this colony there is but one fertile zoœcium. It arises as

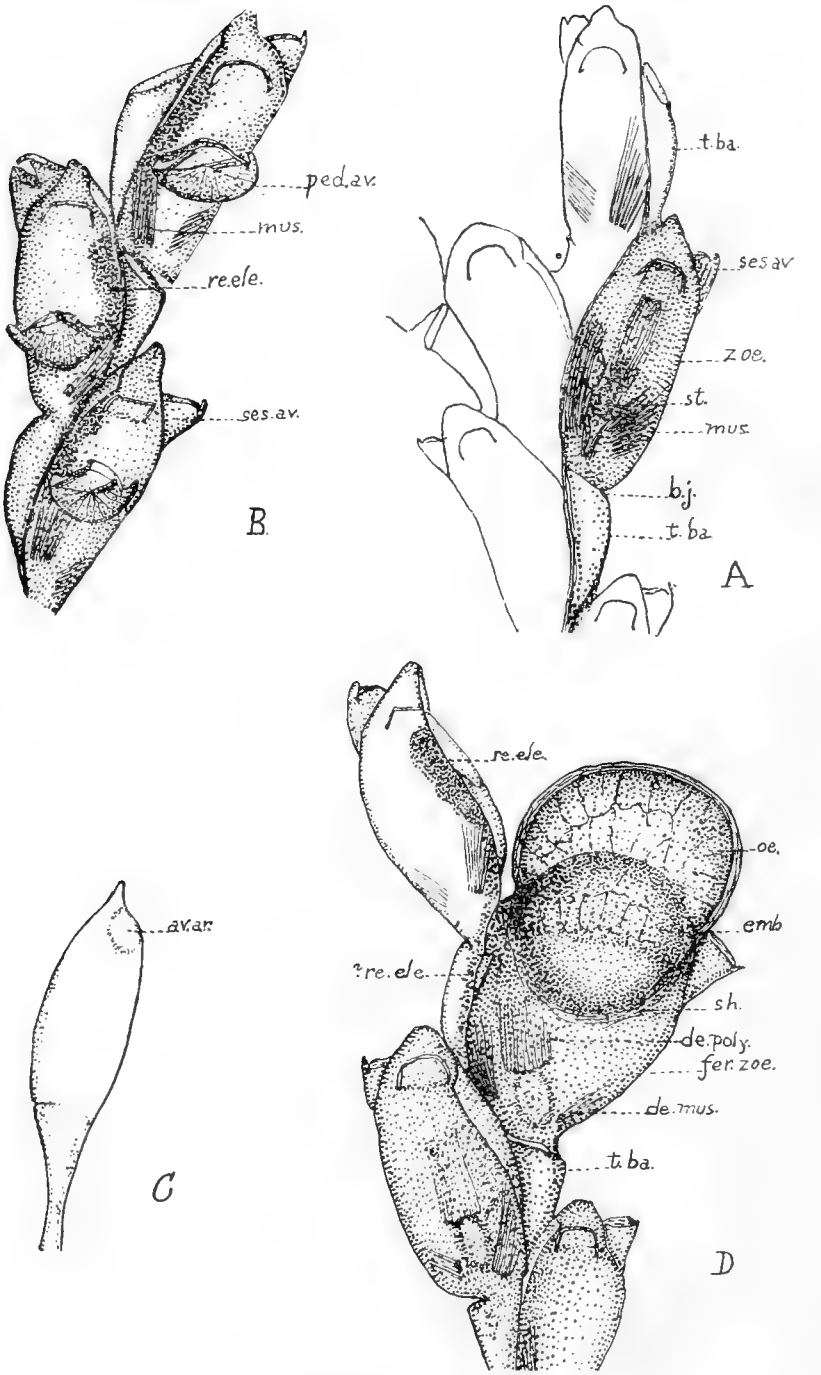


FIG. 3.—*Kinetoskias arabianensis*, sp. nov. × 40.

(*A*) Outlines of a few nutritive zoœcia showing detail in one.

(*B*) Three zoœcia possessing both pedunculated (*ped.av.*) and sessile avicularia (*ses.av.*).

(*C*) Dorsal surface of a zoœcium to show area from which a sessile avicularium has broken away (*av.ar.*).

(*D*) Three nutritive and one fertile zoœcia (*fer.zoe.*) to show especially the relative position and size of the latter, together with certain details: embryo (*emb.*), oœcium (œ.), sheath of embryo (*sh.*), degenerating polypide (*de. poly.*) and muscles (*de. mus.*).

do the nutritive zoœcia, and indeed is a transformed nutritive zoœcium. It also consists of two parts, a much enlarged zoœcium proper and a basal prolongation (Fig. 3, D). The zoœcium proper, again, consists of two parts. These may be distinguished by a difference in the texture of the wall, the lower half being membranous, the upper half being thickened and strengthened by delicate calcareous plates (*fer.zoe.*). The calcareous wall of the upper half is bulging and rounded and obviously forms a brood sac or *oœcium* (*oe.*). The dorsal and ventral walls of this zoœcium unite distally and are bounded by broadly rounded chitinous bars, one forming the distal edge of the dorsal wall, the other forming the distal edge of the ventral wall, the whole closing the mouth of the oœcium through which the developed embryo (*emb.*) or larva eventually escapes. That the chitinous rim of the ventral wall is homologous with the operculum of the nutritive zoœcia is obvious when the muscular attachment of each is studied. The chitinous opercula possess a rather broad expansion at each end to which the opercular muscles are fastened. The chitinous rim of the oœcium possesses a similar expansion at each end to which muscle fibres are attached, and whose action presumably serves to open the oœcium. Conclusive proof that the fertile zoœcium is a transformed nutritive zoœcium is afforded by the presence within the fertile zoœcium of the degenerating remains of a polypide (*de. poly.*) and of parietal muscles (*de. mus.*). Lying above these is the large opaque body of the embryo suspended in a membranous sheath (*sh.*) and only partially enclosed by the calcareous wall of the ovicell. Traces of reproductive elements were found in a few zoœcia (B, *re. ele.*), and in each case these resemble testis rather than ovary. In the zoœcium adjoining the oœcium, what is regarded as testis is also found and it is perhaps significant that similar tissue extends into the basal prolongation of this zoœcium (? *re. ele.*). In no case has undoubted ovary been apparent.

Obtained at station 193, Arabian Sea, 72°28′45″ E. 15°11′ N., dredged at 931 fathoms.

This interesting specimen was obtained at a depth of 931 fathoms or from a depth of over a mile and is therefore to be regarded as an abyssal form. Considerable difficulty has been encountered in the attempt to identify it because, while it possesses features undoubtedly allying it with *Kinetoskias*, it possesses others which differ markedly from any known species of that interesting genus and which relate it to another family, viz. the Cellulariidæ.

It is allied to *Kinetoskias* by its unique muscular organ coupled with the possession of articulated avicularia, and by its abyssal habitat. It is allied to the Cellularians by the possession of sessile avicularia and by the structure of its peduncle, while the unique structure of the oœcium is unlike that of any Cheilostomatous ovicell known to the writer save one, that of *Cellularia cirrata*, Busk (1884), to which the species under consideration is related if not identical.

According to the discussion of the genus *Kinetoskias* presented by Busk (1881), this genus was originally established to embrace two peculiar abyssal species of bryozoa first described by Danielssen in 1867, later more fully by Koren and Danielssen. Among the Challenger bryozoa, Busk (1884) describes two new species of this genus obtained in the North Atlantic, the one from a depth of 1526 fathoms, the other from 265 fathoms. The distinguishing mark of these four species is the strong "parietal muscle arising near the base of the zoœcium and passing obliquely backwards and upwards expanding in a fan-shaped manner to be inserted into its hinder wall to the height of about one-third or one-fourth of the zoœcium." To quote further, the author adds, "the action of this muscle must be to draw the entire zoœcium downwards and forwards, or in other words, to bend it on itself, and thus by the concurrent action in many zoœcia to curl the branches forwards; an action that has in fact been noticed by Koren and Danielssen in the living condition."

It is clearly shown in the various figures that this Arabian species possesses the Kinetoskian muscle developed to a greater degree than it is in any of the species heretofore described. It is seen to arise at two points near the base of the zoœcium proper and to spread out in two directions forming a double muscle, that portion lying toward the inner side of the zoœcium being somewhat more strongly developed than that lying toward the outer side. The four species hitherto described agree in the possession of pedunculated avicularia, one for each zoœcium. One of the puzzling things about the *K. arabianensis* was the apparent lack of these structures. After a close and painstaking search three zoœcia were found, each of which possessed one. Whether the rest of the material is mutilated in this respect it is impossible to say. The union between these avicularia and the margin of the zoœcia is extremely delicate and may have been broken, leaving no trace. Certain it is that no traces of their former presence are visible. It is further noted that in this species the pedunculated avicularia are attached to the inside border, whereas in other species reported they are attached to the outside border.

In the discussion mentioned above Busk makes a point of the structure of the peduncle, considering it to be a specialized, highly differentiated structure, formed by a coalescence of radicle fibres. In the species he describes, the peduncle consists of transparent, homogeneous tissue, homologous, according to that investigator, with an internode of a root fibre. In the Arabian species the peduncle is a more primitive structure, consisting as does that of some Bugulas, its near relatives, of an intermixture of root fibres and zoœcia, the former twisting about the somewhat rigid zoœcia for a considerable distance before the stem thus formed divides into several branches. One root fibre at least continues upward on the dorsal side of each branch, while at the base the main stem again divides into a few coarse fibres, these into smaller and

smaller branches, the finest rootlets clasping minute objects in the substratum.

In so far the characters of the *K. arabianensis*, while differing somewhat from other members of this genus, do not remove it from the family Bicellariidæ to which Kinetoskias and the Bugulas belong. The two characters remaining to be discussed, viz. sessile avicularia and the peculiar structure of the oœcium are both unknown in that family. The former is a distinguishing mark of the family Cellulariidæ, and except in a slight difference in position the sessile avicularia on the Arabian species are similar to the lateral avicularia found on such Cellularians as *Menipea* or *Scrupocellaria*.

The unique oœcium of this species reveals a wholly unexpected dimorphism previously unknown in either of the two families mentioned above and only rarely occurring in the Cheilostomes. The only other Cheilostomatous bryozoan which shows a similar condition is *Adeonella* and its congeners where a trimorphism exists, resulting in nutritive zoœcia, reproductive or oœcial zoœcia, and zoœcia transformed into avicularia. In *Crisia*, a Cyclostome, there is found a dimorphic condition quite similar to that which obtains in *K. arabianensis*, in which a zoœcium grows to an unusual size and takes on the reproductive instead of the nutritive function. Unlike the oœcium of *Crisia* which never assumes the nutritive functions, the species found in the Arabian Sea first performs the nutritive function, indicated by the presence of a polypide, and only secondarily assumes the oœcial function.

The oœcial condition most nearly resembling that shown by *K. arabianensis* is found in *Cellularia cirrata*, Busk (1884). "The oœcium," as Busk remarks, "is formed by an entire metamorphosed zoœcium, with a wide opening closed by a broad valve having a semilunar chitinous border." At first glance, the occurrence of oœcia so unusal in structure and yet so similar externally would lead one to suspect close relationship between *C. cirrata* and the present species. And indeed for a time the two were thought to be identical. This opinion was strengthened by the facts that both are abyssal and both come from regions geographically similar. Busk, however, makes no mention of internal structure, but remarks that the material was in poor condition and much curled. He evidently found no articulated avicularia and no parietal muscles, and the characters which his specimen disclosed justified him in placing it in the Cellulariidæ. However he expresses a doubt that he is correct and remarks that perhaps a new genus should be established to receive his species. The occurrence of this peculiar oœcium in these two species leads one to wonder if *C. cirrata* and the species from the Arabian Sea are identical, especially when one reflects that the curled condition upon which Busk remarks might be caused by the contraction of parietal muscles and at the same time might make the detection of these muscles impossible.

The facts in regard to the reproductive elements and the reproductive processes which have been ascertained through a study of this material reveal a curious parallel between it and *Crisia* and other Cyclostomes. In both, testis is abundant while ovary is apparently correspondingly scarce. Is it perhaps true, as has been shown for *Crisia*, that but few ova are produced, or that ova arrive at maturity in but one zoœcium, or in but few zoœcia? Again, since, the ovicells and embryos are of such size and character it seems probable that zoœcia destined to become ovicells are early set apart for that purpose, and likewise possible, as in the Cyclostomes, that the ova are produced in the growing tissues and become secondarily united with a zoœcium. Judging from the size of the embryos together with their small number, the supposition that embryonic fission may occur here is not improbable, and increases the interest in this species as an object of study.

16. Farciminaria andamanensis, sp. nov.

Part of a colony consisting of a long stem and numerous branches (fig. 4, A). Stem incomplete, made up of four rows of aborted zoœcia arranged around an imaginary axis, four sided, the corners strengthened by chitinous bars or modified root fibres, from the inner edges of which strong teeth project into the interior of the zoœcia; the four zoœcia in each group at the same level so that the stem has a segmented appearance. At the distal end the stem divides into two branches connected for a short distance by a filmy membrane. The segmented appearance continues for four or six segments above the first branches when the second branching occurs, and the zoœcia from this point contain polypides. The branches, at first biserial, soon become tri- or quadriserial, the zoœcia assuming an alternate arrangement (fig. 4, B).

Branches lose their segmentation, and the zoœcia face outwardly and laterally. *Zoœcia* elongated, area occupying the whole of the front. *Orifice* at the summit closed with a protruding lip. No spines and no avicularia. No oœcia have been observed. In older parts of the colony rounded or oval bodies occur which may be embryos. These are always found, when they occur, in the upper part of the zoœcium, sometimes in company with a degenerating polypide, again with a regenerating one. These are not brown bodies.

Considerable hesitation is experienced in placing this specimen in this genus since the zoœcia are not all arranged around an imaginary axis, as is usually described for *Farciminaria*, but simply folded, as it were, one or two middle rows projecting forward and the two lateral rows turned somewhat, so that the zoœcia when viewed from the front are seen in profile. So many characters, however, both of the zoœcia and of the zoarium as a whole, are Farciminarian that it seems to belong here rather than with any allied genus.

In the absence of spines, avicularia, and oœcia this species resembles *Farciminaria hexagona*, Busk (1884). That species, however, has six series of zoœcia facing around the branch, the two inner rows consisting of sterile zoœcia only. There is also considerable resemblance between it and *Farciminaria simplex*, MacGillivray (1886). The Australian species has a prominent oœcium, and both description and plate are so meagre that identification by their means alone seemed impossible.

Material obtained at the Andamans (1899).

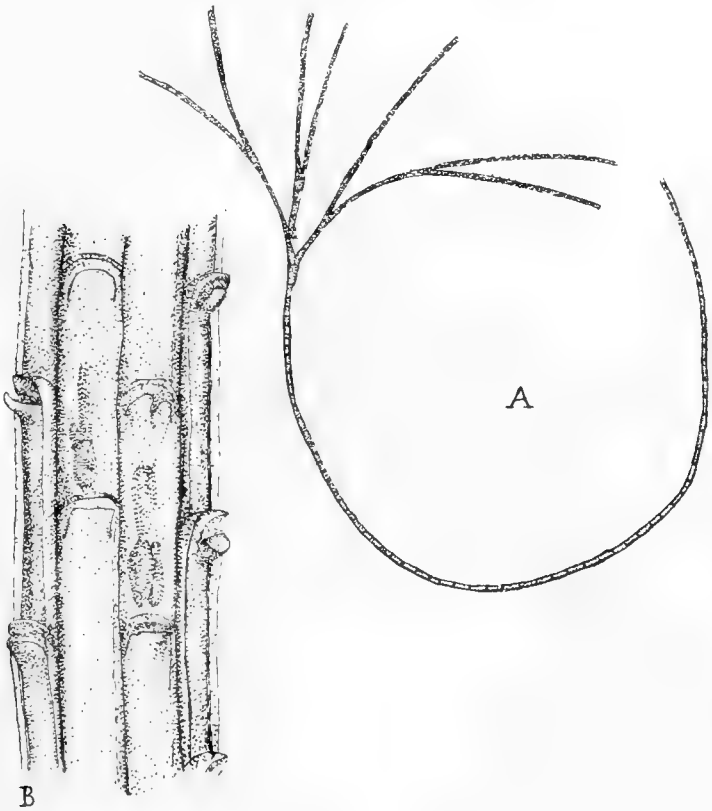


FIG. 4.—*Farciminaria andamanensis*, sp. nov.
A. Habit sketch. × 2.
B. A few zoœcia. × 50.

17. Cellaria salicornioides. Lamouroux.

Cellaria johnsoni, Hincks, 1880, p. 112, pl. xiii, figs. 9-12.

Obtained at one locality only, Santapilly, Madras (east coast).

18. Farcimia oculata, Busk.

Nellia oculata, Busk, 1852, pt. i, p. 64, fig. 6.

Extremely abundant, obtained at at least nine stations: Mergui; Palk Straits; Mangalore; Gaspar Straits; Ganjam coast; Ancutta Reef, Laccadives; Gopalpore.

19. Flustra cribriformis, Busk.

Carbasea cribriformis, Busk, 1884, vol. x, p. 50, pl. xxx.

Zoarium dry and in fragments, but fenestrated condition very apparent. Zoœcial characters agree with description as given by Busk. This material contained many embryos in various stages of growth. When full grown, the embryos hang suspended in a bag or membrane, the distal end shoved into the shallow oœcium while the larger portion extends into the zoœcium, about filling the upper half.

Obtained at Singapore.

20. Flustra rhizophora, Ortmann.

Carbasea rhizophora, Ortmann, 1890, p. 27, taf. i, fig. 24.

Dredged at 31 fathoms, 21 miles S.W. by W. of Mangalore, east coast of India.

21. Membranipora cervicornis, Busk.

Membranipora cervicornis, Busk, 1854, pt. ii, p. 60, pl. C, fig. 3.

Obtained at two stations at the entrance to Palk Straits, 3 miles N.N.W. of Pt. Pedro, dredged in sand at from 6 to 8 fathoms.

22. Membranipora curvirostris, Hincks.

Membranipora curvirostris, Hincks, 1880, p. 153, pl. xx, figs. 5, 6.

Dredged off the Ganjam coast at from 24 to 30 fathoms.

23. Membranipora incrustans, Waters.

Membranipora incrustans, Waters, 1898, p. 686, pl. 47, fig. 13.

Obtained at entrance to Palk Straits and on Ancutta Reef, Laccadives.

24. Membranipora lacroixii, Audouin.

Membranipora lacroixii, Busk, 1854, pt. ii, p. 60, pl. 69, fig. 1.

Found growing on shells and pieces of bamboo at Puri beach, Orissa coast. Also growing on crab.

25. Membranipora perfragilis, MacGillivray.

Membranipora perfragilis, Hincks, 1884, ser. 5, vol. xiv, p. 278, pl. viii, fig. 4.

Abundant in this collection, being found at nine or ten stations: Madras; Mergui, on the Brig "Cassandra;" off Akyab, Arrakan coast at 17 fathoms; Puri beach and Black Pagoda, Orissa coast; Virkalay, Travancore coast; at Andamans Is.,; off Carwar and Molki; and Gopalpore. Also at stations 468 (Andaman Is., Port Blair Harbour); st. 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) at 49 to 40 fathoms, and st. 532 (Mergui Archipelago, 12°15′20″ N., 97°10′10″ E.), 62 fathoms.

26. Membranipora simplex, Busk.

Nellia simplex, Busk, 1852, pt. i, p. 19, pl. lxv, fig. i; pl. lxv (bis), fig. 3.

Obtained at Santapilly and at Madras.

27. Membranipora tehuelcha, D'Orbigny.

Membranipora tehuelcha, Robertson, 1908, p. 265, pl. 15, figs. 16, 17; pl. 16, fig. 18.

More or less abundant at Puri beach, Orissa coast on bits of wood, also at station 380 (off Akyab, Burma, 19°8′ N., 92°59′ E.), said to be dredged at 530 fathoms, but since the specimens were growing on sea weed this is thought to be doubtful. [The weed on which it grew commonly floats on the surface. *N. A.*]

28. Membranipora tehuelcha var. intertuberculata, Waters.

M. tehuelcha var. *intertuberculata*, Waters, 1898, p. 676, pl. 48, figs. 1, 2

Obtained from two localities, Puri beach, Orissa coast and from tide pools at Kyouk-Phyu, Burma. In the adult stage this variety assumes a most fantastic appearance due to the elevated, folded, spinous walls. The tubercles are often more numerous and fantastic than represented by Waters, mere seasonal or environmental variations, probably, of this cosmopolitan species.

29. Membranipora trifolium var. minor, Hincks.

Membranipora trifolium var. *minor*, Hincks, 1885, ser. 5, vol. 15, p. 255, pl. viii, fig. 7.

Obtained at Mangalore at 31 fathoms, and at the Andamans; also off Ceylon at 703 fathoms, growing on shell.

30. Membranipora spinostoma, sp. nov.

Zoarium loosely incrusting a stem. *Zoœcia* irregularly quadrangular with a broad calcareous border crenulated on the inner margin (fig. 5, A). *Aperture* membranous, occupying the whole of the front. *Operculum* large, with a heavy chitinous rim, opening close to the calcareous border. The spinal adornment of operculum and area constitutes the unique feature of this species. Spines occur in three locations: (1) on the margin of the area; (2) on the operculum; (3) below and at each extremity of the operculum. *Spines* on the margin of the area, delicate, finely pointed, varying in number from 12 to 15 placed regularly, to a few at irregular intervals. *Spines* on the operculum (fig. 5, A, C) heavy, chitinous, arranged in two rows, alternate, at least six, usually eight in number, one springing from near the base of the operculum, the other about half way from the base, stiff, longer than the width of the operculum, directed upward or toward and beyond the distal border (C, *op.sp.*). Two *lateral spines* at the extremities of the opercular bar invariably present. These grow in sockets and are movable in two directions, upward and downward.

(A, B, C, *lat.sp.*). In their slenderness, length and mobility they resemble vibracula. In the space between these lateral spines or vibracula, other spines, from one to four in number, are sometimes found springing from the top of the area and extending stiffly downward. These are more or less inconstant being apparently easily broken.

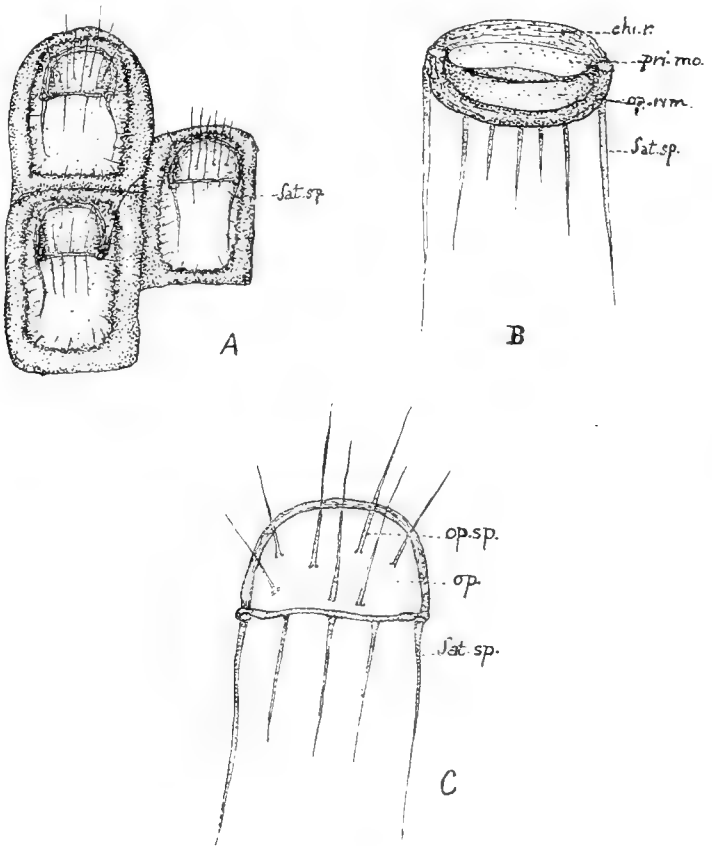


FIG. 5.—*Membranipora spinostoma*, sp. nov.
A. Three zoœcia, ×25.
B. Operculum thrown widely open showing the inner surface, primary mouth (*pri.mo.*) and chitinous rim above it. × 100.
C. A magnified view of operculum and opercular spines. × 100.

Obtained at station 352, Persian Gulf, 29°20′ N., 48°47′ E., at a depth of 13 fathoms.

The material upon which these observations are made is dry, hence brittle and difficult to study. The upstanding spines on the operculum serve to catch and hold debris, thus increasing this difficulty. In Figure 5, B, showing the operculum thrown back and revealing the inner surface, the primary mouth (*pri.mo.*)

seems to consist of a slit or opening under the operculum. Above and close to the calcareous margin is a rather broad, delicate, semi-chitinous rim (*chi. r.*) against which the spiny operculum closes. The space formed by the opening of the operculum constitutes a secondary mouth. Moreover the heavy operculum frequently tears away from the delicate membrane of the area, leaving an opening between operculum and area having the appearance of a mouth. This was confusing until, after soaking small pieces in oil for a few hours, then teasing on a slide, instances were found in which the operculum was thrown back and opened as in fig. 5, B. It is important that this species be examined further, either fresh or preserved in alcohol.

Brackish Water Membranipora.

The three species of *Membranipora* which follow belong to brackish-water forms similar to *Membranipora bengalensis* described by Stoliczka (1869). That investigator found this species in a tank of water only one-fifth as saline as sea-water. Later he found it distributed throughout that region of India known as the Sunderbans, incrusting old pieces of wood, or trunks of trees at the mouths of rivers and on the shores of salt lakes, but never in fresh water. In his description of this species, Stoliczka remarks that he has observed similar forms incrusting shells and fragments of wood in various places along the coast of Bengal Bay, but had not succeeded in obtaining specimens which were in a good state of preservation.

In this collection there are three species of Membranipora which have proved most puzzling until the description and plates of *M. bengalensis* were obtained. These three species resemble each other and *M. bengalensis* in several features: (1) in the loose connection existing between the zoaria and the substratum, and often between the zoœcia themselves; (2) in the possession of delicate chitinous rather than calcareous lateral walls, together with an extremely delicate calcareous wall over portions of the front of the zoœcia; (3) in the development, as a rule, of conspicuous spines which are highly characteristic and distinct for each species. Like *M. bengalensis* also, all grow on wood more or less sodden or on shells of brackish-water mollusks.

31. **Membranipora amoyensis,** sp. nov.

Zoarium loosely incrusting a shell and in places forming bilaminar folds. *Zoœcia* large, quadrangular, alternate, separated by thickened lines (fig. 6). *Aperture* occupying more than half the front. *Operculum* semicircular, large, situated close to the top. Aperture surrounded by a calcareous margin from which project numerous small calcareous *spines*, 17 or 18, or perhaps 10 to 12, depending on the size of the zoœcium. On young zoœcia a single stout spine on each side at the upper angles. On older

zoœcia this spine becomes trifid, one branch usually extending outward, one upward and one downward. No *oœcia* have been found.

This species was obtained from Amoy, China. No other data given. The material incrusts a shell which is judged to be from water only slightly saline since, while calcareous, it is extremely soft and chalk-like and not of the ordinary marine type.

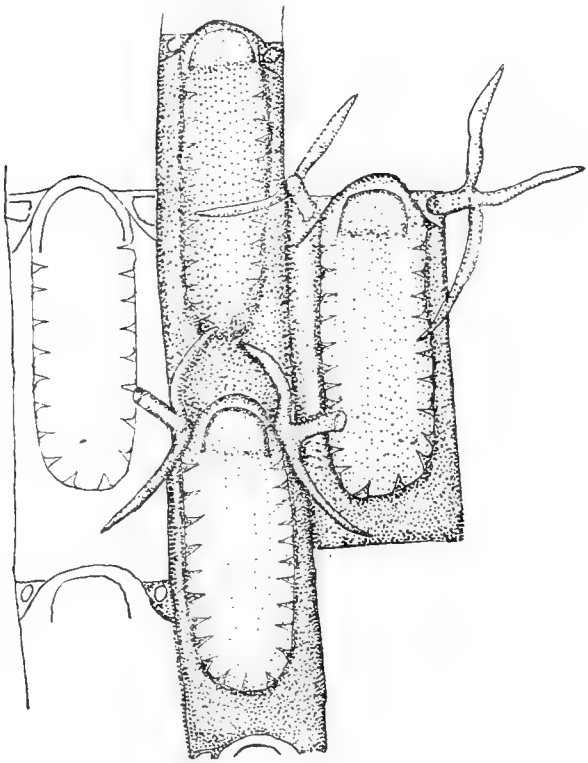


Fig. 6.—*Membranipora amoyensis*, sp. nov. ×90.

32. Membranipora devinensis, sp. nov.

Zoarium incrusting bark of sodden wood, loosely attached. *Zoœcia* elongated, sometimes of extreme length and connected together loosely (fig. 7). *Aperture* occupying almost all of the front, the margin beset with a large number of spines which meet across the front. *Operculum* semicircular, large at the top of the aperture. The portion of the zoœcium below the aperture covered with a delicate calcareous wall marked by two large pores. Sometimes two zoœcia form in the place of one, when each zoœcium possesses but one pore. In no case has a spine been found projecting from these pores. *Oœcium* small, projecting over the zoœcium above, almost to its pores.

Obtained on the Orissa coast at the mouth of the Devi river, Bay of Bengal, dredged at depths varying from 23 to 25 fathoms.

33. Membranipora hugliensis, sp. nov.

Zoarium growing in a single layer on chips of wood to which hydroid stems adhere and encircling these stems, where it forms small bilaminate expansions. *Zoœcia* elongated, aperture occupying three-fourths of the front or more, surrounded by a delicate calcareous border crenulated on the inner margin (fig. 8). The lower part of the front of the zoœcia covered with a calcareous layer. The distal portion of each zoœcium projecting over the zoœcium above almost to the crenulated margin of the aperture. Where the zoœcia are crowded, the aperture much reduced and may become almost circular. That part of the zoarium growing flat and single layered is without spines, while that part which climbs on the hydroid stems and sends out bilaminate folds, possesses many conspicuous basal spines. Usually each zoœcium in the spinous region possesses two or more spines situated on the calcareous layer of the front wall just below the aperture. In some cases where the zoœcia are narrowed below, but one process may occur, usually then in the middle of the lower front wall. In still other instances no spines occur on the double layered portion. These *spines* (*sp.*) are tall, hollow, tapering processes formed of a transparent membrane, and lined with a delicate epithelium

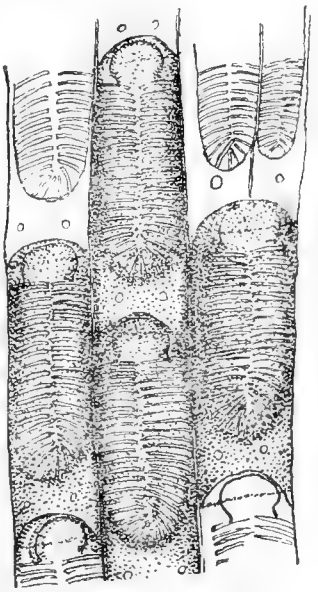


FIG. 7.—*Membranipora devinensis*, sp. nov. × 50.

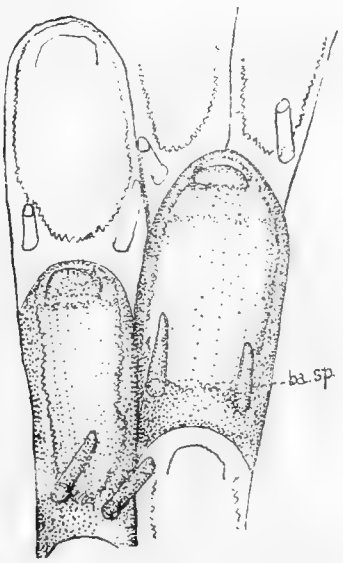


FIG. 8.—*Membranipora hugliensis*, sp. nov. × 90.

continuous with that of the parietal lining of the zoœcium. They are not articulated but bend easily, the membranous layer simply wrinkling on one side. No oœcia were found.

Obtained in considerable abundance at the mouth of the Hugli river, Bay of Bengal.

34. Membranipora ringens, Busk.

Megapora ringens, Hincks, 1880, p. 172, pl. xxii, fig. 1.

Obtained at entrance to Palk Straits, 3 miles N.N.W. of Point Pedro, dredged at 6 to 8 fathoms. Incrusting a coral mass with sponge and other bryozoa.

35. Steganoporella magnilabris, Busk.

Steganoporella magnilabris, Busk, 1884, pt. xxx, p. 75, pl. xxiii, fig. 2.

Obtained at four rather widely separated localities showing that the species is abundant in the Bay of Bengal. Found at the Andamans growing over masses of coral; on Ancutta Reef, Laccadives; off Ceylon at 703 fathoms, and at station 384 (off C. Negrais, Burma, 16°0′ N., 93°37′ E.), dredged at 40 fathoms, growing over roots and debris.

36. Thalamoporella rozieri, Audouin.

Thalamoporella rozieri, Robertson, 1908, vol. 4, no. 5, p. 277, pl. 17, figs. 27, 28, 29.

Obtained at one locality only, Pedro Shoal, Palk Straits.

37. Smittipora abyssicola, Smitt.

Vincularia abyssicola, Smitt, pt. ii, p. 6, pl. i, figs. 60, 61.

Obtained at the entrance to Palk Straits, dredged at 6 to 8 fathoms, also at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.), dredged at 40 to 49 fathoms.

38. Cribrilina radiata, Moll.

Cribrilina radiata, Hincks, 1880, p. 185, pl. xxv, figs. 1-9.

Abundant in this collection. Obtained at Palk Straits, dredged at 6 to 8 fathoms; Andamans; Laccadives; Puri, Orissa coast; off Ceylon at 703 fathoms; off Gopalpore at 25 to 28 fathoms; at station 522 (Mergui Archipelago, 12°35′ 15″ N., 98° 16′ E.); at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.).

39. Cribrilina punctata, Hassall.

Cribrilina punctata, Hincks, 1880, p. 190, pl. 26, fig. 3.

Obtained at two points: off Gopalpore at 25 to 28 fathoms and in the Bay of Bengal at 15 to 30 fathoms.

40. Microporella ciliata, Pallas.

Microporella ciliata, Hincks, 1880, p. 206, pl. xxviii, figs. 1-8.

Abundant in this collection: obtained at Gopalpore at 24 fathoms; Palk Straits at 6-8 fathoms; Andamans, Bay of Bengal at 15 to 30 fathoms; at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) dredged at 40 to 49 fathoms.

41. Microporella distoma, Busk.

Adeonella distoma, Busk, 1884, pt. xxx, p. 187, wood cuts, 56, 57.

Rather widely distributed. Obtained at the Andamans, North Sentinal I.; station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) dredged at 40 to 49 fathoms, at Cape Bluff dredged at 375 fathoms.

42. Microporella impressa, Audouin.

Microporella impressa, Hincks, 1880, p. 214, pl. xxvi, figs. 9-11.

Obtained off Ceylon, growing on a dead shell dredged at 703 fathoms.

43. Microporella malusii, Audouin.

Microporella malusii, Hincks, 1880, p. 211, pl. xxviii, fig. 11.

Dredged at 6-8 fathoms at the entrance to Palk Straits.

44. Microporella yarraensis, Waters.

Eschara lichenoides, Busk, 1854, pt. ii, p. 90, pl. cvi, figs. 1, 2, 3.

Obtained 21 miles S.W. by W. of Mangalore, west coast of India, dredged at 31 fathoms, growing on a shell.

45. Porina tubulosa, Norman.

Porina tubulosa, Hincks, 1880, p. 230, pl. xxxii, figs. 6-9.

Obtained at the Andamans and dredged at the entrance to Palk Straits at 6-8 fathoms.

46. Tubucellaria cereoides, Ellis and Solander.

Tubucellaria cereoides, Waters, 1907, p. 130, pl. xv, fig. 8.

A small piece of a colony about an inch in height obtained by the "Investigator" at the Andamans at 20 fathoms.

47. Schizoporella auriculata, Hassall.

Schizoporella auriculata, Hincks, 1880, p. 260, pl. xxix, fig. 4.

Dredged in the Bay of Bengal (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) at 15 to 30 fathoms, also at station 237 (Andaman Sea, 13°17′ N., 93°7′ E.) at 90 fathoms, at station 387 at 40 to 49 fathoms and off Ceylon at 703 fathoms. Obtained also at the Andamans.

These specimens conform to the description and plates given by Hincks except in a variation in position and size of avicularia.

Most of the zoœcia possess the avicularium just below the sinus. This is lacking in other instances but replaced apparently by another avicularium, somewhat larger usually, but placed somewhere else on the front wall, most generally on the lower part with mandible directed transversely. Occasionally both kinds of avicularia are found on the same zoœcium.

48. Schizoporella biaperta, Michelin.

Schizoporella biaperta, Hincks, 1880, p. 255, pl. xl, figs. 7-9.

Obtained at two stations at the Andamans.

Slight variations occur in these specimens differing from those described by Hincks. The oœcia possess two transparent areas on the front instead of an area with radiating lines. The mammillated avicularia possess a spatulated mandible, not a triangular one, as does the British species.

49. Schizoporella brunnescens, Ortmann.

Schizoporella brunnescens, Ortmann, 1890, p. 50, pl. 4, fig. 2.

Obtained on the Ceylon Pearl Banks, and Marble Rock, Mergui. Also at 11°33½′ N. and 98°20½′ E.

50. Schizoporella cecilii, Audouin.

Schizoporella cecilii, Hincks, 1880, p. 269, pl. xliii, fig. 6.

Obtained at the Andamans.

51. Schizoporella linearis, Hassall.

Schizoporella linearis, Hincks, 1880, p. 247, pl. xxxviii, fig. 5.

Dredged at 31 fathoms 21 miles S.W. by W. off Mangalore; at 29 fathoms, off Carwar and Molki; off Ceylon; 26 miles W. S.W. of Honawar, at 28 fathoms, west coast of India.

52. Schizoporella linearis, Hassall, form quincuncialis, Hincks.

Schizoporella linearis, form *quincuncialis*, Hincks, 1881, ser. 5, vol. 7, p. 158, pl. ix, fig. 3.

A small colony growing on the inside of sea-urchin's test, obtained at "Investigator" stations 532 (Mergui Archipelago, 12°15′ 20″ N., 97°10′10″ E.) and 534 (Mergui Archipelago, 12°59′ N., 96°48′30″ E.).

53. Schizoporella nivea, Busk.

Schizoporella nivea, Busk, 1884, pt. xxx, vol. x, p. 163, pl. xvii, fig. 1.

Dredged at 6-8 fathoms at entrance to Palk Straits, 3 miles N.N.W. of Pt. Pedro. Obtained also at Santapilly.

54. Schizoporella pertusa, Esper.

Lepralia pertusa, Hincks, 1880, p. 305, pl. xliii, figs. 4, 5.

Obtained at Santapilly, and dredged off Ganjam coast at 24-30 fathoms.

55. Schizoporella dutertrei, Audouin.

Mastigophora dutertrei, Hincks, 1880, p. 279, pl. xxxvii, fig. 2.

Dredged off Gopalpore at 25 to 28 fathoms growing on *Ostrea imbricata*. Obtained also at "Investigator" station 384 (off C. Negrais, Burma, 16°0′ N., 93°37′ E.).

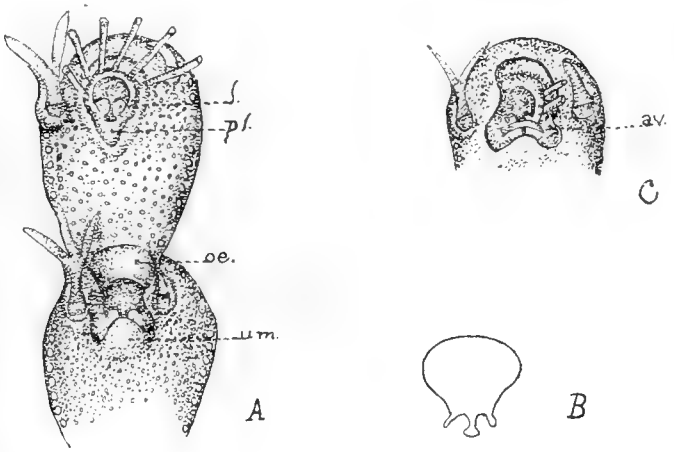


FIG 9.—*Schizoporella dutertrei*, var. *foliacea*, nov.

A. Two zoœcia showing detail, × 40.
B. Operculum much magnified, × 90.
C. Distal portion of older zoœcium showing an avicularium (*av.* on umbo below orifice, × 40.

56. Schizoporella dutertrei var. foliacea, nov

Zoarium loosely attached to coral conglomerate. *Zoœcia* flat, surface finely porous. *Orifice* surrounded by a thickened calcareous border from which six or eight spines extend (fig. 9, A). Upper margin of orifice arched, lower margin with a deep narrow sinus which widens suddenly at the lowest part. *Operculum*, assuming the shape of the orifice, resembles a flat rounded plate with a handle (fig. 9, B). The zoœcial wall projecting on each side of the narrow neck or handle in two conspicuous calcareous lobes (fig. 9A, *b.*), the thickened border of the orifice uniting below into a flat triangular platform (*pl.*). In older zoœcia an umbo forms below the orifice (*um.*) hiding the stem-like portion of the operculum. Occasionally this umbo supports an avicularium (fig. 9 C, *av.*) with mandible directed horizontally. On each side of the orifice a sessile avicularium with mandible directed

upward. In at least one of these the mandible is prolonged into a branching process sometimes bifid, sometimes trifid, each branch assuming the form of a rather broad thin blade, reminding one of the wings of maple seed or of the membranous wings of an insect. The avicularium on the other side small, with a triangular mandible directed upward. *Oœcium* shallow, widely open, two or three spines on each side projecting in front of it (fig. 9, A, *œ.*).

Dredged at 25 to 28 fathoms off Gopalpore, Ganjam district, east coast of India.

57. Lepralia adpressa, Busk.

Lepralia adpressa, Busk, 1854, pt. ii, p. 82, pl. cii, figs. 3, 4.

Obtained at "Investigator" station 532, at 62 fathoms, Mergui Archipelago (12°15′ 20″ N., 97°10′ 10″ E.).

58. Lepralia depressa, Busk.

Lepralia depressa, Busk, 1854, pt. ii, p. 75, pl. xl, figs. 3, 4.

Many avicularia possess mandibles long and tapering, almost vibraculoid in character, others possess stout mandibles which terminate in a three parted process resembling the claws of a gallinaceous bird. Commonly the avicularia are similar to those represented by Busk.

Growing on a mass of conglomerate, dredged at 15 to 30 fathoms in the Bay of Bengal, and at 70 fathoms off Ceylon.

59. Lepralia feegeensis, Busk.

Lepralia feegeensis, Busk, 1884, pt. xxx, vol. x, p. 144, pl. xxii, fig. 10.

Loosely incrusting coral conglomerate obtained from coral reefs of Kilakarai, Ramnad district, G. of Manaar.

60. Lepralia turrita, Smitt.

Lepralia turrita, Smitt, 1873, pt. ii, p. 65, pl. xl, figs. 226, 228.

Dredged at 24 fathoms on the Ganjam coast, also at 6 to 8 fathoms at the entrance to Palk Straits. Obtained off Gopalpore, and at Galle, Ceylon.

61. Escharoides occlusa, Busk.

Lepralia occlusa, Waters, 1909, vol. xxxi, p. 152, pl. 14, figs. 1, 2.

A fine specimen obtained in Gaspar Straits, Malay Archipelago. Small, broken and somewhat imperfect specimens obtained at the Andamans and dredged at 112 fathoms off Port Blair, Andamans.

62. Petralia laccadivensis, sp. nov.

Material consisting of several small colonies incrusting sponge or small shells. Adult *zoœcia* with front wall rounded, porous,

heavily calcified, ornamented with numerous outstanding processes (Fig. 10). Orifice rounded above, possessing in young zoœcia three distinct denticles on the lower margin, the middle one forming a relatively broad mucro. Below the orifice a plain non-porous platform (*pl.*) which in older zoœcia tends to grow thicker and to extend up each side of the orifice to form the supports of small elevated, sessile, lateral avicularia (*av.*). Frequently one of these lateral avicularia is replaced by an elongated one of considerable size with spatulate mandible directed downward. (*sp.av.*). From the platform below the orifice there springs a tall process which may become bi- tri- or even quadrifid, almost completely obliterating the orifice (*pr.*). The tips of the branches of these frontal processes may acquire small rounded avicularia. Other processes of considerable height, usually tipped with an avicularium, may decorate any part of the front wall. *Oœcia* rounded, wall granular or pierced with minute pores.

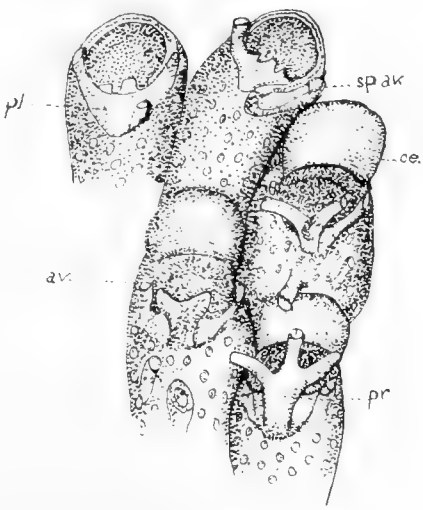


FIG. 10—*Petralia laccadivensis*, sp. nov. × 40.

A species easily recognized by the unusual number of fantastic processes scattered over the surface of the zoarium. Obtained at Ancutta Reef, Laccadives, at Santapilly, Madras, and dredged at 24 to 30 fathoms off the Ganjam coast.

63. **Petralia vultur**, Hincks.

Mucronella vultur, Hincks, 1882, (5), vol. x, p. 167, pl. viii, fig. 2.

Identification tentative since no comparison with identified specimens has been possible and since certain variations occur here not noted by Hincks. These consist chiefly of numbers of large avicularia found mainly in older parts of the colonies, with mandibles of much variety of form. The mandibles of these avicularia are sometimes long and narrow, sometimes duck-bill shaped, and others again are forked at the extremity. Material fairly abundant. Obtained off Gopalpore, Ganjam district, Madras Presidency, at depths varying from 24 to 30 fathoms; near Mangalore at 31 fathoms; also at Black Pagoda, Orissa coast, at 15 fathoms.

Other material found at Santapilly and at station 296 (Per-

sian Gulf, 26°4′ N., 56°2′ E.) in 47 fathoms, agrees with the description of *P. vultur* in most respects, but differs in showing a variable number of upstanding processes around the orifice, often a median triangular one and several smaller lateral ones, all of which may or may not support small avicularia. These it is thought are only of variational value.

64. Petralia vultur, var. armata, Waters.

Petralia vultur, var. *armata*, Waters, 1913, p. 518, pl. lxx, fig. 18.

Material loosely incrusting small oyster-shells dredged at 160 fathoms, Java Sea, Malay Archipelago (Eastern Telegraph Co.).

65. Smittia landsborovii, Johnston.

Smittia landsborovii, Hincks, 1880, p. 341, pl. xlviii, figs. 6-9.

Obtained near Puri, Orissa coast, and at Black Pagoda, Orissa coast, dredged at 15 fathoms.

66. Smittia marmorea, Hincks.

Smittia marmorea, Hincks, 1880, p. 350, pl. xxxvi, figs. 3-5.

Obtained at the Andamans and dredged at 40 to 49 fathoms at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.).

67. Smittia nitida, Verrill.

Smittia nitida, Hincks, 1881, ser. 5, vol. 7, p. 159, pl. x, fig. 5.

Obtained off Gopalpore, Ganjam coast, dredged at 24 fathoms.

68. Smittia trispinosa, Johnston.

Smittia trispinosa, Hincks, 1880, p. 353, pl. xlix, figs. 1-8.

This species rather widely distributed: obtained at the Andamans; the entrance to Palk Straits at 6 to 8 fathoms; Black Pagoda, Orissa coast, at 15 fathoms; off Gopalpore at 25 to 28 fathoms at station 532 (Mergui Archipelago, 12°15′20″ N., 97°10′10″ E.) at 62 fathoms.

69. Smittia trispinosa var. producta, Thornely.

Smittia trispinosa var. *producta*, Waters, 1909, p. 173, pl. xvii, fig. 5.

Obtained at Santapilly and at station 528 (Mergui Archipelago, Elphinstone I., Port Maria).

70. Smittia latiavicularia, Kirkpatrick.

Smittia latiavicularia, Kirkpatrick, 1888, ser. 6, vol. 1, pl. x, fig. 3.

Obtained off the Ganjam coast, dredged at 24 to 30 fathoms.

71. Retepora delicatula, Busk.

Retepora delicatula, Busk, 1884, pt. xxx, vol. x, p. 124, pl. xxvi, fig. 3.

Obtained off the Ganjam coast, dredged at 24 to 30 fathoms, and at station 387 (off C. Negrais, Burma, 15°25′ N., 93°45′ E.) dredged at 40 to 49 fathoms.

72. Retepora porcellana, MacGillivray.

Retepora crassa, Busk, 1884, pt. xxx, vol. x, p. 115, pl. xxvi, fig. 10; pl. xxvii, fig. 3.

Obtained at 6°01′ N. 81°16′E. at 34 fathoms; also in the Bay of Bengal, dredged at 15 fathoms.

73. Retepora punctiligera, Ortmann.

Retepora punctiligera, Ortmann, 1890, p. 35, taf. ii, fig. 24.

Obtained off Gopalpore, Ganjam coast, dredged at 24 to 30 fathoms.

74. Reteporella minor, Ortmann.

Reteporella minor, Ortmann, 1890, p. 37, taf. ii, fig. 28.

Obtained at station 532 (Mergui Archipelago, 12°15′20″ N., 97°10′10″ E.) in 62 fathoms.

75. Haswellia australiensis, Haswell.

Haswellia australiensis, Busk, 1884, pt. xxx, vol. x, p. 172, pl. xxiv, fig. 8.

Obtained off Port Blair at 112 fathoms; also dredged at 8 fathoms in 136° E., 10′ S., and at 49 fathoms in 142° E., and 8′ S.

76. Adeonella japonica, Ortmann.

Adeonella japonica, Ortmann, 1890, p. 54, taf. iv, fig. 11.

Obtained at Santapilly and at station 464 (S. of Ceylon, 6°2′ 30″ N., 81°29′ E.) in 52-68 fathoms.

77. Adeonella platalea, Busk.

Adeonella platalea, Busk, 1884, pt. xxx, vol. x, p. 184, pl. xxi, figs. 4, 4*a* and text figure 50.

Fine specimen obtained at Mergui, Burma.

78. Adeonella marginata, sp. nov.

Zoarium consisting of numerous flat, strap-like branches, two or more inches in height. Mode of attachment not known, the material consisting of fragments only. To the naked eye each fragment or branch is seen to consist of a somewhat flattened middle portion with a border or margin of large zoœcia forming irregularly radiating lines. The two surfaces of each branch are

almost exact duplicates of each other. This may be seen readily if one inspects the margins, and especially a cross section of a branch. As is characteristic of this genus, the zoœcia are polymorphic consisting of three kinds of individuals: 1, the ordinary nutritive zoœcia (fig. 11, A and B, *nu. zoe.*), 2, the oœcial zoœcia (B, *oe. zoe.*), 3, the avicularian zoœcia (B *av. zœ.*). The middle portion of each branch is occupied by six or eight rows of nutritive zoœcia regularly alternate (A, *nu. zoe.*). Bordering these on each side are two or more rows of large reproductive zoœcia, and outside these a row of large avicularian zoœcia.

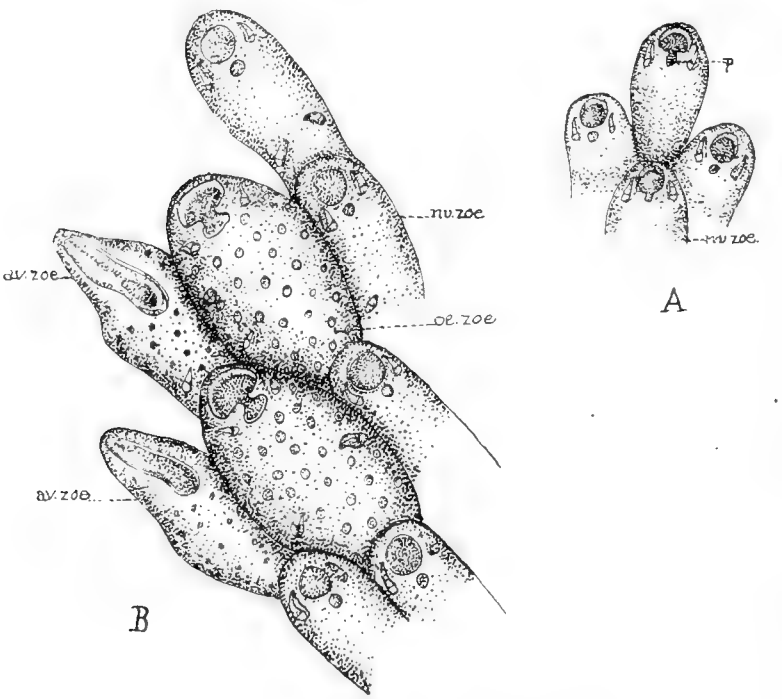


Fig. 11.—*Adeonella marginata*, sp. nov. × 40.
A. Four young zoœcia in middle portion of a branch.
B. To show the three kinds of zoœcia on the margin of the colony.

At the tips of the branches, the young nutritive zoœcia (fig. 11, A) are more than half immersed although the whole of the outline may be detected while the matrix is thin. Front wall hyaline, non-porous. *Orifice* round with a deep wide sinus, the upper edges of which soon close to form a large pore (*p.*). On each side of the pore an avicularium with triangular mandible directed upward. Lower down, somewhat to one side of the median line, another avicularium with mandible directed transversely (B). In older zoœcia avicularia increase in number and with increase in calcification may increase or decrease in size.

Even nutritive zoœcia tend to become larger as they approach the margin (B, *nu. zoe.*). A relatively small number of zoœcia attain a very large size (B *oe. zoe.*), whose wall becomes highly calcified and porous. These are the reproductive zoœcia characteristic of this genus. The outermost row of the margin consists of zoœcia which function only as avicularia (*av. zoe.*); mandible directed obliquely upward and outward.

Dredged at 65 fathoms near Mergui Archipelago, station 535 (13°4′30″ N., 96°44′ E.).

79. Lagenipora costazii, Audouin.

Cellepora costazii, Hincks, 1880, p. 411, pl. lv, figs. 11-14.

Found quite commonly, incrusting stems of seaweed: Mangalore, off Carwar and Mulki; at Cheval Paar; Colombo; dredged at 10-15 fathoms at Seven Pagodas, Madras, and at 34 fathoms by the "Investigator" at 6°01′ N., 81°16′ E.; also dredged off Gopalpore at 28-25 fathoms and Ganjam at 25 fathoms.

80. Lagenipora tuberculata, MacGillivray.

Lagenipora tuberculata, MacGillivray, 1882, p. 209, pl. 156, figs. 1, 2.

Identification tentative. Material obtained at two localities growing on coral conglomerate: Laccadives, and dredged at 34 fathoms by the "Investigator" in 6°01′ N. and 81°16′ E.

81. Holoporella aperta, Hincks.

Holoporella aperta, Waters, 1909, p. 161, pl. 18, figs. 20-23.

Dredged at 24-30 fathoms off the Ganjam coast.

82. Holoporella tridenticulata, Busk.

Cellepora tridenticulata, Busk, 1884, pt. xxx, vol. x, p. 195, pl. xxix, fig. 5.

Obtained at Cinque Island, Andamans, "Investigator"; also near Puri, Orissa coast.

83. ? Holoporella mammillata, Busk.

? Cellepora mammillata, Busk, 1854, pt. ii, pl. cxx, figs. 3, 4, 5.

In most points this species agrees with the description given by Busk, but this identification considered somewhat doubtful. Common, found at depths ranging from 15 fathoms to 703 fathoms at eight stations in the Bay of Bengal.

84. Cupularia canariensis, Busk.

Cupularia canariensis, Busk, 1859, vol. 7, p. 66, pl. 23, figs. 6-9.

Several colonies of various sizes obtained at the Andamans. The largest colony is about 11 mm. in diameter and 2 mm. high at the apex. The others vary from 8 to 5 mm. in diameter. The

material is dry, but it is thought to have contained living colonies when collected.

Cyclostomata.

85. Crisia sp.

Material consists of several fragments of *Crisia* which contain no ovicells, hence impossible to identify. Obtained off Ganjam coast at 24 to 30 fathoms, also from Gaspar Straits, and from station 152 (11½miles S. 83° W. of Colombo Lt., Ceylon) at 26½ fathoms.

86. Filisparsa tubulosa, Busk.

Filisparsa tubulosa, Waters, 1910, p. 235, pl. xxv, figs. 16, 17.

Obtained in Gaspar Straits growing with *F. oculata*.

87. Idmonea atlantica, E. Forbes.

Idmonea atlantica, Hincks, 1880, p. 451, pl. lxv, figs. 1-4.

Obtained in Gaspar Straits and at station 47 (off mouth of Godaveri R., Bay of Bengal) in 5-6 fathoms.

88. Idmonea gracillima, Busk.

Idmonea gracillima, Ortmann, 1890, p. 60, pl. iv, fig. 26.

Beautiful specimen obtained 4 miles south of Ganjam at 25 fathoms.

89. Entalophora raripora, d'Orbigny.

Pustulopora proboscidea, Busk, 1886, pt. 4, vol. xvii, p. 19, pl. lv, fig. 1.

Several colonies obtained at Santapilly, also at station 152 (11½ miles S. 83° W. of Colombo Lt.) at 26½ fathoms.

90. Lichenopora radiata, Audouin.

Lichenopora radiata, Hincks, 1880, p. 476, pl. lxviii, figs. 9, 10.

A single colony growing on the inside of a shell obtained by the "Investigator" at station 384 (off C. Negrais, Burma, 16°0′ N., 93°37′ E.) in 40 fathoms.

91. Domopora truncata, Jameson.

Domopora truncata, Hincks, 1880, p. 485, lxiii, figs. 5-9.

A single specimen growing on a mass of coral conglomerate obtained at entrance to Palk Straits, 3 miles N.N.W. of Point Pedro, in 6 to 8 fathoms.

Ctenostomata.

92. Alcyonidium mytili, Dalyell.

Alcyonidium mytili, Hincks, 1880, p. 498, pl. lxx, figs. 2, 3.

Obtained at Puri beach, Orissa coast, growing on twigs.

93. Amathia semiconvoluta, Lamouroux.

Amathia semiconvoluta, Waters, 1910, p. 243, pl. 24, fig. 6.
Amathia connexa, Busk, 1886, pt. I, vol. 17, p. 35, pl. 6, fig. 3.

Obtained at Karachi.

94. Zoobotryon pellucidus, Ehrenberg.

Zoobotryon pellucidus, Reichert, 1869.
Bowerbankia biserialis, Hincks, 1887, ser. 5, vol. xlx, p. 309, pl. 9, fig. 6.

Obtained in abundance in Madras Harbour where it was collected by Dr. Annandale at four stations. As Reichert remarks, this species seems to be distributed throughout the warm seas. The writer can bear witness to its presence in the warm waters of the north Pacific ocean, from which region it has not hitherto been reported. Specimens have been sent me from Hokkaido, Japan, and from Honolulu, Hawaiian Islands. In the summer of 1905 it occurred in abundance in San Diego Bay, California. There, in water 10 or 12 feet deep, it grew in luxuriant masses of a green tint, the whole resembling clumps of freshly cut hay.

ENTOPROCTA.

95. Pedicellina cernua, Pallas.

Pedicellina cernua var. *glabra*, Hincks, 1880, p. 565, pl. lxxxi, figs. 1-3.

Obtained at Puri beach, Orissa coast, growing on twigs.

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IX. THE INDIAN SPECIES OF THE GENUS *TRICULA*, BENSON.

By B. PRASHAD, *D.Sc., Offg. Superintendent, Zoological Survey of India.*

In a recent paper[1] I discussed at length the systematic position of the genus *Tricula*, Benson, and further notes on the same subject were added by Dr. Annandale and myself[2] in our revision of the Indian genera of the family Hydrobiidae. In this paper I propose giving a revised description of the shell of *T. montana*, Benson—the type-species of the genus, together with an account of a new species which was discovered by Dr. F. H. Gravely in the Nerbudda River in the Central Provinces. A reference to this second species was made by Dr. Annandale in his recent paper.[3]

The two species may be distinguished by the help of the following key:—

1. Shell conico-ovate, twice as long as broad; with very fine ribs; whorls not greatly swollen, body-whorl in dorsal view subtrigonal, only a little longer than broad; mouth nearly $\frac{3}{4}$ the height of the body-whorl, acutely pointed above and with the columellar callus of unequal width ... *T. montana.*
2. Shell elongate-ovate, not more than $1\frac{2}{3}$ as long as broad; smooth; whorls very tumid; body-whorl in dorsal view band-shaped, about twice as long as broad; mouth only a little more than $\frac{1}{2}$ the height of the body-whorl, narrowly rounded above and with a columellar callus of about the same width in its entire length ... ... *T. gravelyi.*

I am unable to add any notes on the var. *curta* of Nevill,[4] a variety of *T. montana* based by Nevill on two specimens from the Jhiri valley at an altitude of 3,000 feet in North Cachar, collected by Colonel H. H. Godwin-Austen, as I have not succeeded in tracing the specimens in the Indian Museum collection.

Tricula montana, Benson.

1843. *Tricula montana*. Benson, *Calcutta Journ. Nat. Hist.*, III. p. 467.
1862. *Tricula montana*, *id.*, *Ann. Mag. Nat. Hist.* (3)X, pp. 415, 416.
1876. *Tricula montana*, Hanley and Theobald, *Conch. Ind.*, pp. xvii and 62, pl. clv, fig. 5.
1885. *Tricula montana*, Nevill, *op. cit.*, p. 64.
1915. *Tricula montana*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 68.

Nothing is known about this interesting mollusc beyond the original descriptions of Benson and the poor figure of the ventral

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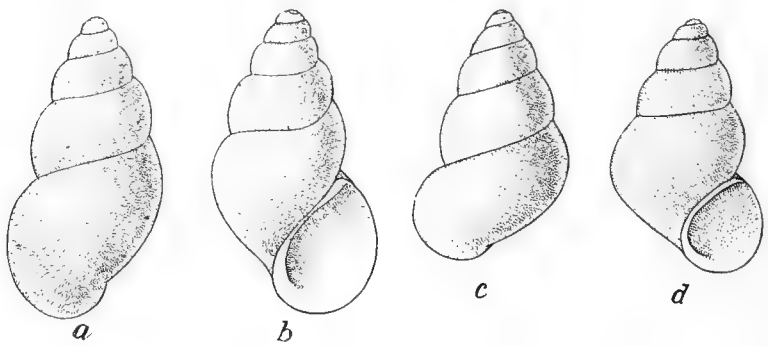
Prashad, *Rec. Ind. Mus.*, XVIII, pp. 221, 222 (1921).
[2] Annandale and Prashad, *Rec. Ind. Mus.*, XXII, p. 3 (1921).
[3] Annandale, *Ind. Journ. Med. Research*, VIII, p. 103 (1920).
[4] Nevill, *Hand List Moll. Ind. Mus.*, II, p. 64 (1885).

view of the shell published by Hanley and Theobald. Fortunately, however, some of Benson's co-types are preserved in the Indian Museum, and I have, therefore, thought it desirable to give a complete description and accurate figures of a full-grown shell. It may also be mentioned here that I failed to discover any more specimens of the species in the type-locality at Bhim Tal in August, 1920, whence Benson's specimens were obtained, nor did I find any in the tanks at Moradabad, where Benson introduced living specimens.

The shell of this species is conico-ovate, twice as long as broad; with an obtuse apex, sometimes decollate; consisting of $5\frac{1}{2}$–6 whorls and of a light olive colour. The whorls increase somewhat irregularly and are not very tumid. The suture is oblique, curved and somewhat canaliculate, the whorls themselves being a little flattened just next to it. The first whorl is



Text-fig. 1.—Shells of *Tricula*, x 12.

(*a*) Dorsal view of *T. montana*, Benson.
(*b*) Ventral view of the same.
(*c*) Dorsal view of *T. gravelyi*, Prashad.
(*d*) Ventral view of the same.

minute, the penultimate whorl is band-shaped and comparatively more swollen than the other whorls; the body-whorl, which is not very tumid, is $2\frac{1}{2}$ times as broad as the penultimate whorl, it is roughly trigonal or subtrigonal in both dorsal and ventral views. Its upper surface is somewhat flattened but not angulate, the inner margin is regularly arched and ends in a short projecting lobe corresponding to the inner angle of the mouth, the outer margin is sharply curved and is continued with the regularly curved ventral margin to form the lobe noted already. The mouth is large, oblique, ovoid, pointed above and has a part of the peristome curved over its angle. The peristome is continuous, but the columellar callus is narrow and of unequal width, the outer and lower margins of the mouth are only slightly re-curved. The shell is subumbilicate.

Distribution.—The original series of specimens was found attached to the stems and leaves of an aquatic plant in a stream

flowing through a marsh at the head of the Bhim Tal Lake in the United Provinces. Besides these there are a few specimens in the Indian Museum collection from Naini Tal.

Tricula gravelyi, sp. nov.

The shell of this species is elongate-ovate, not more than $1\frac{2}{3}$ as long as broad, with an obtuse apex consisting of $5\frac{1}{2}$-$6\frac{1}{2}$ whorls and of a pale yellowish colour. The whorls increase regularly and are evenly swollen. The suture is oblique, deeply impressed but not canaliculate. The first two whorls are minute, but the others increase regularly and evenly in size; the body-whorl is fairly tumid, narrow, about twice as broad as the penultimate whorl and band-shaped in dorsal view. The lobe corresponding to the anterior angle of the mouth seen in dorsal view and described for *T. montana* is present, but is not so deep, both the inner and outer margins are sharply curved. The mouth is oblique, rather smaller than in *T. montana*, ovate and narrowly rounded above. The peristome is continuous and the columellar lip is of the same thickness throughout, the outer margin is only narrowly recurved backwards. The shell is sub-umbilicate or even umbilicate.

I give below the measurements of three specimens of each species for comparison.

Measurements (in millimetres).

	T. gravelyi.			*T. montana.*		
Length of shell	3	2·4	2·5	3·6	3·8	3·5
Breadth of shell	1·6	1·4	1·5	1·8	1·8	1·7
Length of aperture	1·4	1·3	1·4	1·6	1.7	1·6
Breadth of aperture	1·1	1·1	1·1	1·2	1·3	1·15

Type series.—No. M 11895/2 in the registers of the Zoological Survey of India (Indian Museum).

Habitat.—Specimens of this interesting form were collected by Dr. F. H. Gravely in still creeks amongst small islands in the bed of the Nerbudda River at Hoshangabad in the Central Provinces of India in March 1919, attached to weeds.

X. A NEW SPECIES OF *TERMITAPHIS* (HEMIPTERA-HETEROPTERA) FROM INDIA.

By F. Silvestri (*Portici*).

Dr. N. Annandale, Director of the Zoological Survey of India, has kindly sent me for examination a collection of Termites and Termitophils carefully made by himself on Barkuda Island in the Chilka Lake, Orissa. Among this material I have found several specimens of the interesting termitophil genus *Termitaphis* Wasm.

As these specimens are the first collected in India and as among them are young females and adult males, which until now were unknown, I wish, with Dr. Annandale's kind permission, to describe them in the present paper.

HEMIPTERA-HETEROPTERA.

Fam. TERMITOCORIDAE.

The family Termitocoridae was founded by me[1] in 1911 on the genus *Termitaphis* Wasm.[2] first referred to the Aphididae. The type of the genus is *Termitaphis circumvallata* Wasm. from Columbia. In 1911 (*op. cit.*) I described *T. mexicana* from Mexico and *T. subafra* from Principe I. (West Africa); Mjöberg[3] added the description of another species (*T. australiensis*) from Australia.

The species now found in India by Dr. Annandale confirms the general distribution of *Termitaphis* in the tropics, in nests of Termites, especially of the genera *Leucotermes*, *Coptotermes*, *Schedorhinotermes*, *Hamitermes*.

The three species *T. circumvallata*, *T. mexicana* and *T. subafra* were described from a single stage, it was thus not possible to know the different characters of adult females, adult males, and young. The material collected by Dr. Annandale has enabled me to give complete descriptions of the various stages.

Termitaphis annandalei sp. n.

(Figs. I–III).

♀ Corpus (Fig. I, 1) testaceo-isabellinum parte ventrali pallidiore, antennis pedibusque isabellinis; valde depressum, circumlitione ellipticum, fere 3/7 longius quam latius.

[1] *Boll. Lab. Zool.* v, p. 232 (1911).
[2] *Tijdschr. v. Entom.* xlv, p. 105, pl. 9, figs. 7-7c (1902).
[3] *Entomologisk Tidskrift*, p. 98. (1914).

Dorsum areolatum et tuberculis (Fig. II, 6–7) perparvis porigeris, denticulatis numerosis nec non poris sparsis instructum. Caput 4-lobatum lobis medianis quam laterales multo majoribus, lobulis marginalibus 8 instructis, lobis lateralibus lobulis tribus. Lobulorum setae clavatae, fere 2/3 longiores quam ad apicem latiores, pilosulae. Antennae articulo primo quam ultimus parum longiore, articulo secundo quam tertius aliquantum longiore, articulo ultimo aliquantum magis quam duplo longiore quam latiore. Rostrum ad mesosterni marginem anticum pertinens.

Thorax. Pronotum lateribus integris margine 10-lobulate, meso- et metanotum lateribus inter sese fusis incisione perparva vix distinctis, marginibus 6-7-lobulatis, metanoti medio dorso sulco secundario transversali, arcuato signato. Meso- et metasterni

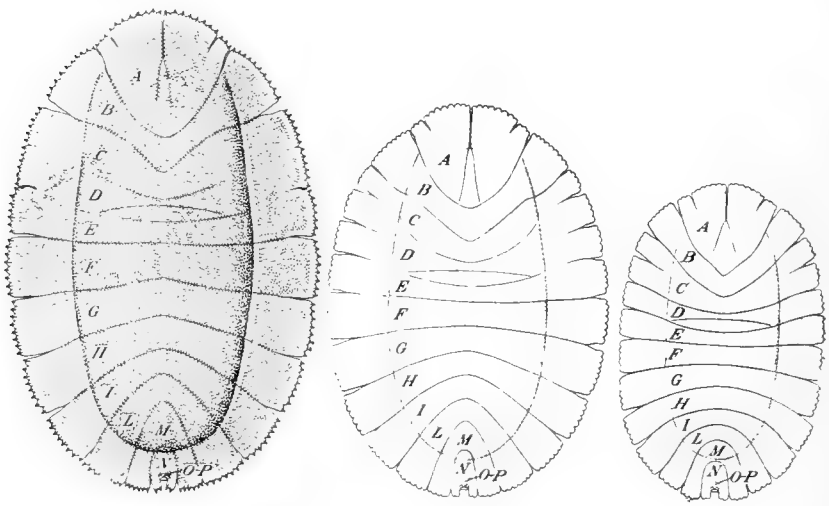


Fig. I.—*Termitaphis annandalei* : 1. femina adulta ; 2. larva ultimae aetatis ; 3. larva (?) secundae aetatis.

A caput, B prothorax, C mesothorax, D metathorax, E-P abdominis segmenta 1-10

superficies submediana setis brevioribus et brevibus nonnullis instructa est, carinarum superficies infera setis 3-4 praemarginalibus sat longis, et setis aliis brevibus et brevioribus aucta. Pedes forma et setis vide fig. II, 3-5, tibiis primi paris tantum setis apicalibus robustis et robustioribus instructis, tibiis secundi et tertii paris etiam spinis brevissimis robustis 2-3 armatis.

Abdomen. Segmentum primum lateribus partim a metanoti lateribus incisione parum profunda separatis. Segmenta 2-8 inter sese bene separata, segmenta nonum et decimum tubiformia obtecta. Marginum lobuli eisdem capitis et thoracis forma similes et segmenti primi 7-8, segmentorum 2-6 lobulis 8-10, segmenti septimi lobulis 5, segmenti octavi lobulis duobus. Segmentum octavum postice sat late et sat profunde incisum ; segmenta nonum

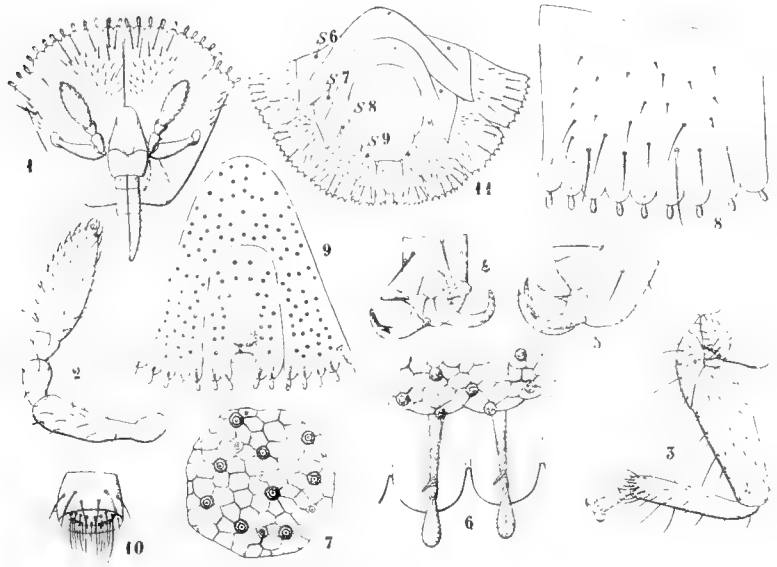


Fig. II.—*Termitaphis annandalei*: 1. caput pronum; 2. antenna; 3. pes paris tertii; 4. tarsi apex et praetarsus subtus inspecti; 5. idem lateraliter inspecti; 6. corporis particula marginalis cum lobulis duobus supra inspecta; 7. corporis superficiei particula submediana; 8. carina abdominis segmenti secundi supina; 9. feminae adultae segmenta abdominalia 7-10 prona; 10. feminae segmenta 9-10; 11. feminae abdominis segmenta 4-10 supina.
S6-S9 stigmata.

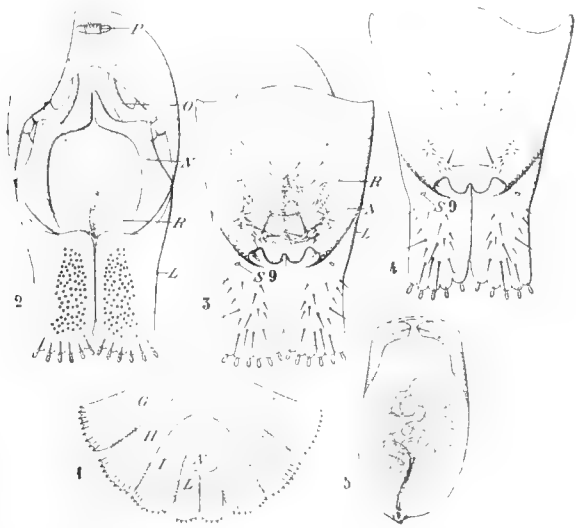


Fig. III.—*Termitaphis annandalei*, mas: 1. abdominis segmenta 4-10 supina; 2. abdominis segmenta 7-10 prona; 3. eadem supina; 4. segmentum septimum separatum; 5. penis. G-P abdominis segmenta 4-10, R penis, S stigma segmenti septimi abdominalis.

et decimun (Fig. II, 10) parva tubiformia a segmenti octavo obtecta; segmentum decimum setis brevioribus numerosis instructum.

Long. corp. mm. 3·5, lat. 2·1; long. antennarum 0·65, pedum paris tertii 1·62.

♂ A femina forma abdominis segmentorum 8-10 (Fig. III, 1-4) valde diversus: segmentum septimum abdominis apicem posticum formans carinis inter sese tangentibus et antice segmentum 8-10 continens, segmentum octavum supra lateraliter in processus acutos duos introrsum et antrorsum vergentes productum; segmentum nonum etiam supra in processus duos arcuatos, acuti antrorsum vergentes productum; penis percrassus forma vide fig. III, 5.

Larva ultima (Fig. 1,2). Ab adulto differt mesonoti carina a metanoti carina profunde separata, quam metanoti carina singula aliquantum minore, et metanoti carinis duabus bene distinctis.

Long. corp. mm. 3, lat. 2.

Larva (?) *secunda* (Fig. 1,3). Carina mesonoti quam metanoti carina singula haud minor et similiter 4-lobulata.

Long. corp. mm. 2·2, lat. 1·3.

Habitat.—India: Ins. Barkuda (Chilka Lake) in nido *Coptotermes Heimi* Wasm., in trunco arboris (*Ficus bengalensis*) emortui et super solum sistentis exempla nonnulla Dr. N. Annandale legit. (12. x. 1920).

XI. A LIST OF THE DRAGONFLIES RECORDED FROM THE INDIAN EMPIRE WITH SPECIAL REFERENCE TO THE COLLECTION OF THE INDIAN MUSEUM.

Part IV.—Suborder Anisoptera.

The Subfamily Aeschninae.

By F. F. Laidlaw, *M.A.*

This dominant subfamily has an almost universal distribution and many of its species range over vast areas.

The Aeschnines are for the most part large insects often of brilliant colouring, and with powerful and long sustained flight.

Probably some of the species are of great economic importance both in the larval and in the adult stages. A single individual in the complete course of its life-history must destroy an enormous number of Diptera.

Some of the species show migratory tendencies, for example *Anax* (*Hemianax*) *ephippiger*, which is one of the commonest of Indian dragonflies.

At present the subfamily is divided into three 'groups' of which the first '*Petalia*-group' is not found anywhere in the Orient, and so needs no notice here.

The second and third groups *Brachytron* and *Aeschna* are further subdivided into 'series' which are noticed below.

This classification though probably the best available on our present knowledge of the subfamily is not altogether satisfactory, as there is a likelihood of series of the *Aeschna* group, the mostly highly organized section of the family, being polyphyletic, and it is possible that some genera of the *Brachytron* group may be recessive rather than primitive.

For a general survey of the subfamily reference should be made to Walker's "Monograph of the North American species of *Aeschna*" (*University of Toronto Studies*, Biological series No. 11, 1912); to Tillyard's paper "Life-Histories and Descriptions of Australian Aeschninae" (*Journ. Linn. Soc., Zool.*, XXXIII, 1916) and lastly to Martin's "Monograph of the Aeschninae" (Catalogue systématique et descriptif. Collections Zoologiques du Baron Edm. de Selys Longchamps Fasc. XVIII, XIX, XX, referred to in this paper as "Cat. Coll. Selys Aeschninae.")

Group BRACHYTRON.

Series Boyeria.

The genera of this series are characterized by the absence of a fork to *Rs*, and by the single row of cells between *Rs* and *Rspl.*, and between M_4 and *Mspl.* respectively. These genera are but few in number, and are generally regarded as primitive. The oriental genus *Jagoria* shows some specialization in respect of the large eyes and of the dentigerous plate of the female.

Jagoria martini, n. sp.

1 ♀. Near pool, Tiger hill, 8,300 ft, Darjiling Distr., 26-vi-1918 (*S. W. Kemp*). 1407-2. The specimen is the type.

Length of hinder-wing 40 mm, of abdomen 40 mm.

Venation. That characteristic of the genus. Nodal indicator $\frac{8-17}{8} \mid \frac{16-7}{9} \mid \frac{11\ 10}{}$. Triangles of fore-wings of three cells, of hinder-wings four celled. Supra-triangles free. Space between M_4 and *Mspl.* of two rows of cells on all wings. Pterostigma dark brown, 2 mm. long, braced. Extreme base of wings saffron tinged, the colour not reaching Ax_1.

Head.—Lower lip, and all the anterior surface orange brown. Dorsal surface of frons very dark brown, black against the eyes: enclosing a yellow mark on either side in front of each eye, so that the dark colour forms a T-shaped median mark. Vertex and occiput black, the latter minute, with a tuft of black hairs.

Prothorax.—Dark brown.

Synthorax.—Dorsal surface very dark brown, with a pair of oblong oval bands of a blue green colour, running upwards and inwards almost to the upper end of the mid-dorsal carina, but not reaching it; a pair of small lines of the same colour start from near the upper end of the first pair and run transversely towards, but not so far as the humeral suture; meso- and meta-notum green.

Laterally the synthorax is very dark brown with a large, vivid green bar on the mesoepimerite and a second bar of the same colour nearly covering the whole of the metepimerite.

Undersurfaces orange brown.

Abdomen constricted sharply at the third segment, widened again from the fourth to the sixth, the remaining four being narrow; colouring, black above, the sternites orange brown. Segment 1 has a large, green, lateral mark, similar to those of the sides of the synthorax, but slightly more yellow in tone; 2 has a lateral yellow band. Dorsally segments 2–6 have each a pair of apical green spots, semilunar in shape, and very small on 6. In addition 2–4 have each a pair of small transverse marks of a green colour at about the centre of each. Further, 2 has a minute basal triangle of yellowish green.

The *legs* are black; the coxae, trochanteres and bases of the femora brown.

The dentigerous plate of the tenth segment is almost squarely truncate posteriorly, and carries apically a number of small irregularly placed teeth, about fifteen, on its ventral side.

The anal appendages are small, about 2 mm. long, and are carried in the specimen before me directed vertically upwards. The discovery of a species of this genus in the Himalaya extends its range greatly. Hitherto I can find records for Malaya and Japan only, nowhere within 1,500 miles of Darjiling.

Jagoria martini seems to come nearest to *J. venatrix*, Förster, from Buton in the Celebes group. The female of the latter species is unknown.

Series Brachytron.

This series is characterized by the symmetrical forking of *Rs* and by the presence of but a single row of cells between that sector and *Rspl*, as well as between M_4 and *Mspl*. The series contains genera which are probably rather primitive survivals of the main trunk of the subfamily, representing to some extent the ancestral line from which the dominant *Aeschna* group has been evolved.

India has at least three genera of the series, probably more. *Austroaeschna* represented here by a single species is noteworthy on account of its distribution; all the other species (if we exclude *Planaeschna milnei*, Maclach. treated by Martin as an *Austroaeschna*) are Australian

Periaeschna is also represented by a single species originally described from Tonkin.

Martin puts all the other Indian species in the Selysian genus *Caliaeschna*. He includes in it also an Australian species *C. conspersa*, Tillyard, since removed by Tillyard to a distinct genus *Dendroaeschna*.

Förster had already described a species, *Caliaeschna laidlawi*, from the Malay Peninsula. This species is evidently not a *Caliaeschna* at all but seems to find its proper place rather in *Periaeschna*. I have only two males and a female of *Caliaeschna microstigma* from Persia, and a single female of the *Caliaeschna* section of the series on which to base my observations, but as these insects are of exceptional interest and are all rare I take the opportunity of making a few comments on them. The single female above noted I refer to as *Cephalaeschna*? sp.

In his monograph Martin omits mention of the Selysian genus *Cephalaeschna* of which *Cephalaeschna orbifrons*, Selys, was the type. He also omits mention of Karsch's species *Cephalaeschna sikkima*.

De Selys in defining *Cephalaeschna* states that the apical margin of the dentigerous plate of the female is rounded and subdenticulate. He was not acquainted with the female of *Caliaeschna* at the time at which he wrote his "Synopsis des Aeschnines."

Karsch in his kritik accepts *Cephalaeschna*, but lays no stress on this particular character, depending on the large development

of the frons in *Cephalaeschna* compared with its relatively small size in *Caliaeschna* as sufficing to separate the two genera.

Martin on the other hand employed rather the Selysian character and finding that the dentigerous plate of *Caliaeschna microstigma* ♀ was rounded and subdenticulate, appears to have suppressed *Cephalaeschna* for that reason.

Unfortunately he does not appear to have used this character in all his species of *Caliaeschna*. For example, had he done so, he would surely have removed *C. laidlawi* from the genus, since it is stated by Forster to have a dentigerous plate like that of *Gynacantha*.

Hence we cannot rely in every case on his generic determination. The venation certainly does not, so far as my knowledge goes, support the view that all these species are congeneric. From published accounts I find that the dentigerous plate is rounded and subdenticulate or without denticles in the following:—

Caliaeschna microstigma, Schneider.
Caliaeschna acutifrons, Martin.
Cephalaeschna orbifrons, Selys.

It is armed with two stout spines in
Cephalaeschna sikkima, Karsch.
Cephalaeschna ? sp.

The venation is dense in *C. orbifrons* and *C. acutifrons*; 'moderate' in *C. microstigma*; and may be described as 'open' in *Cephalaeschna ?* sp. and perhaps in *C. sikkima* and *C. masoni*, Martin. For *C. lugubris*, Martin, I have no data. I hazard a guess that *Caliaeschna* will ultimately be restricted to *C. microstigma*, Schneider, that *Cephalaeschna* will contain the species *orbifrons* and *acutifrons*; whilst a new genus will be required for *C. sikkima* and for *Cephalaeschna ?* sp. This genus will perhaps include *Caliaeschna masoni*, Martin.

The following is a list of references to papers dealing with Oriental species of the group.

de Selys, "Synopsis des Aeschnines". *Bull. Acad. Belg.* (3), V (1883). The genera *Caliaeschna* and *Cephalaeschna* defined.

Karsch, "Kritik des Systems der Aeschniden." *Ent. Nachr.* XVII, 1891, No. 18, pp. 273–290. Suggests a classification of the Aeschnine genera based mainly on venation.

Karsch, *Ent. Nachr.*, XVII. 1891, No. 20, pp. 6–7. *Cephalaeschna sikkima*, Karsch, described.

Förster, *Ann. Soc. entomol. Belg.* LII, 1908, pp. 213–214. *Caliaeschna laidlawi*, Förster, described.

Martin, *Cat. Coll. Selys, Aeschnines*, XIX, XX, 1909. New species of *Caliaeschna*, *Periaeschna* and *Austroaeschna* described in a monograph of the whole subfamily.

Ris, *Supplementa Entomologica* No. 5. June 1916, pp 55–56, taf. 2, fig. 5. *Caliaeschna (?) acutifrons*, Martin, ♀ described.

Tillyard, *Journ. Linn. Soc., Zool.*, XXXIII, July, 1916. *Caliaeschna conspersa*, Tillyard, removed to a new genus *Dendro-*

aeschna. Species originally described by Tillyard as *Caliaeschna conspersa*, *Proc. Linn. Soc. N.S.W.*, XXXI, pp. 727–729, 1906.

Lastly, Ris following MacLachlan refers *Austroaeschna milnei* (Selys), from Japan and Formosa to the genus *Planaeschna*, *Supplementa Entomol.* No. V, 1916, pp. 57–58, taf. 2, fig. 6, text-fig. 39), whilst MacLachlan (*Ann. Mag. Nat. Hist.* (6), XVII, 1895, pp. 409–425) defines the genus *Planaeschna*, and refers to an undescribed genus probably identical with Martin's *Periaeschna*. He comments on the importance of the dentigerous plate of the female as a generic character, incidentally remarking on the distinctness of *Cephalaeschna sikkima*, Karsch, as demonstrated by this character, from the type of the genus, and from *Caliaeschna*, Tillyard, *Journ. Linn. Soc., Zool.*, XXXIII.

[Caliaeschna microstigma, Schneider.]

Caliaeschna microstigma, Kirby, *Cat. Odonata*, p. 93.
" " Martin, *Cat. Coll. Selys Aeschninae*, pp. 108–109, figs. 100–101.

2 ♂ ♂ 1 ♀. Shiraz, Persia, May '71.

Specimens named and labelled by de Selys.

This species has not been recorded from the Indian Empire and probably does not occur within its boundaries.

As stated above it is the only species included by de Selys in his genus *Caliaeschna*.

The eyes of this species are relatively smaller than in other members of the group seen by me, with more regularly rounded margins. The inter-orbital suture is shorter than in other species, but as this is not a plane line it is difficult to estimate accurately. Perhaps the most satisfactory way of describing it is to say that the interorbital suture of *Caliaeschna microstigma* is shorter than a line taken from its anterior end to the anterior apical point of the frons, whilst in *Cephalaeschna*? sp. as well as in *Periaeschna* and in *Austroaeschna intersedens* the interorbital suture is definitely longer than such a line. Further, in the three latter genera the anterior margins of the eyes meet the suture almost at a right angle, whilst in *Caliaeschna* the angle is about 115°.

The pterostigma of *Caliaeschna microstigma* is unbraced. The strong antenodal cross-nerves are the first and the fifth, the latter lies at, or a little distal to the level of the arculus. The discoidal triangles are relatively small.

The width of the frons is decidedly less than one-half of the total width of the head.

Lastly, the colouring of this species is 'heliochromatic,' that of the other species of the series 'hylochromatic.'

Austroaeschna intersedens, Martin.

Austroaeschna intersedens, Martin, *Cat. Coll. Selys Aeschninae*, p. 101, pl iv, fig. 14 (see also Tillyard, *loc. cit.*).

1 ♂ 1 ♀. Cherrapunji, Assam, 4,000 ft., 2—8-x-14, S. W. Kemp. 8186—87/20.

I have been unable to find any character of sufficient importance by which to separate this species generically from Australian Austroaeschnas. The pterostigma has a brace (save in the r. hinder-wing of the female) not shown in Martin's figure. The anal appendages of the male bear a considerable resemblance to those of *Austroaeschna parvistigma*, Selys, and the dentigerous plate of the female is a simple spout-like structure, its apical margin armed with a few small spines. The strong antenodals of the fore-wing are the first and seventh in the male, the first and sixth in the female.

The distal strong antenodal lies, as in Australian species, some two or three cells distal to the arculus.

Cephalaeschna? sp.

1 ♀. Cherrapunji, Assam. 4066/H2.

Wings relatively short and broad, with open venation. Pterostigma very short, well braced. Nodal indicator $\frac{9—19}{13—15}\Big|\frac{19—12}{16—13}$. On the fore-wing the second and seventh, on the hinder-wing the first and fifth antenodals are strengthened. All four triangles contain four cells, *Rs* forks rather nearer to pterostigma than to nodus. The median, basal and supratriangular spaces are all traversed by cross-nerves.

Head.—Upper-lip, clypeus and frons brownish-yellow; occiput small, black with a fringe of black hairs. Eyes large, yellowish green. The frons is very wide, seen from in front it is semi-circular with a prominent ridge separating the horizontal from the vertical part.

Thorax.—Dorsal surface black, with a pair of pale green antehumeral bands, squarely truncate above, pointed below.

The sides of the thorax are pale green, with a single broad black band on either side.

Text-fig. 1.—*Cephalaeschna?* sp.
Apex of dentigerous plate of female from below (specimen somewhat crushed).

Abdomen brownish black; segment 2 moderately inflated, 3—7 about equal in size, 8—10 progressively smaller. Segment 1 with small mid-dorsal green spot; 2 with longitudinal mid-dorsal band of green, interrupted at its middle and widening at the apex of the segment. At the level at which the longitudinal band is interrupted there are a pair of transverse marks of the same colour. Segments 3—6 with small median and apical spots of green divided into pairs by the mid-dorsal carina; 7 with minute median spots only. (The median spots on these segments lie on the structure I call the jugum, *vide infra*, under *Anax guttatus*). Segments 1—2 with lateral band of yel-

low, carried on to the apex of 3 laterally. *Legs* black-brown. Base of femora brown. Wings with saffron tinge at base, extending nearly to the arculus. Length of abdomen 44 mm., of hinder-wing 41 mm., of pterostigma 2 mm. Breadth of hinder-wing 12·5 mm.

The apex of the dentigerous plate of this specimen is produced into two stout processes, which are directed almost directly backwards.

The plate has been somewhat compressed in mounting the specimen, and the text-fig. accordingly shows a slightly distorted view of the apex of the plate.

Periaeschna magdalenae, Martin.

Periaeschna magdalenae, Martin, *Cat. Coll. Selys Aeschninae*, p. 157, fig. 157, pl. vi, fig. 22.

1 ♂ 1 ♀. Tura, Garo Hills, Assam. 7975/H 1.

These specimens agree closely with the type specimens described by Martin from Tonkin. Dr. Ris tells me that he possesses specimens of what is probably a distinct species from S. China. I have already noted that I believe *Caliaeschna laidlawi*, Förster is to be referred to this genus.

Periaeschna confronts us with the problem of the independent development of similar structures. It has the venation of the *Brachytron* series combined with a dentigerous plate scarcely distinguishable from that of *Gynacantha*.

Group AESCHNA.

Three series of genera are referred to this tribe, each series culminating in one of the three dominant genera of the subfamily, *Aeschna*, *Anax* and *Gynacantha*. The tribe is characterized by the curving of *Rspl* and *Mspl* so that they are concave to *Rs* and M_4 respectively, and separated from them by at least three rows of cells. Each series is represented in India, *Aeschna* is mainly a temperate genus and has but few representatives and those rather aberrant. *Anax* perhaps the most successful form of the subfamily is remarkable rather for the wide range and individual abundance than for the number of its species, whilst *Gynacantha*, a very specialized holotropical genus, includes a number of crepuscular or shade-loving insects, which are often caught at lights. In addition certain more primitive genera of the tribe are found in the Oriental Region, but so far as I know none have hitherto been recorded for the Indian Empire. Of these genera, which are mainly Malayan in distribution, *Amphiaeschna* seems to me to be a primitive member of the *Aeschna* series, whilst *Heliaeschna* is similarly related to *Gynacantha*. *Heliaeschna* is also closely related, possibly even ancestral to *Tetracanthagyna*, a genus which contains the most nearly gigantic of living dragonflies.

Series Anax.

I follow Tillyard (*loc. cit.*) in treating *Hemianax* as a division of subgeneric value only. *Anaciaeschna* approaches *Anax* in sufficient degree I think to make it advisable to refer it to the same series.

Anax guttatus, Burm.

Anax guttatus, Kirby, *Cat. Odonata*, p. 84.
,, ,, Martin, *Cat. Coll. Selys Aeschninae*, p. 23, fig. 17.
Anax bacchus ♂ *id.*, *op. cit.*, p. 22.

I have found it difficult to deal in a satisfactory manner with the specimens of *Anax* not included in the species *parthenope* and *immaculifrons*. I have adopted what seems to me the method least open to objection of grouping these specimens, all of which I regard as belonging to *guttatus* in its broadest interpretation, in three series which for the present I do not name but merely label A, B, C. Dr. Annandale has given me (*in litt.*) the following notes on the habits of this species:—

"The species of this family common round the little lakes "near Sitong in the Darjiling District in the rains (i.e. *A. guttatus* "series C) is different from that common in the same places in the "autumn after the rains (i.e. *Aeschna ornithocephala*). Kemp "collected the former and noted that it laid its eggs in water, and "not in mud at the edge of the lake like the *Aeschna*."

And of specimens of series A, from Barkuda Is.

"— a most active and pugnacious insect. One takes possession of the little pond on the island every morning as soon as "the sun is well up, and flies round it all day apparently never "resting. Frequently another individual flies out from the jungle "and begins the same manœuvres, but the original possessor sees "him at once, flies at him at once, and the two fight in the air "hitting one another with their wings, and I think sometimes "even biting with their mandibles. One captured after a fight "of the kind had lost the greater part of a hind-wing. I have "often seen one of the combatants hit down almost to the ground, "and have found a male apparently drowned in the pond, probably having been knocked into the water by another. Often, "whilst two males are fighting in this way a third makes its "appearance and a second encounter takes place with the victor "in the first.

"The Aeschnid however takes no notice of Libellulids and "Agrionids flying over the pond."

I have tried to facilitate the description of the abdominal colour pattern of the specimens, and to make accurate comparison between them by the use of a definite terminology applied to special areas of the tergites of the abdominal segments. The terms used need a short explanation (see text-fig. 2). On segments 2—8 of the abdomen each tergite is furnished with a transverse carina in addition to its terminal transverse carinae. On segments

2 and 3 this accessory carina lies at about the middle of the segment, but on 4—8 becomes progressively more approximated to its anterior end. I propose to call it the 'jugum'; that part of the segment in front of it the prejugal part of the segment, and that behind the post-jugal part. Further, the post-jugal part of segments 4—8 can be subdivided by the presence on each of these segments of the ventral longitudinal carinae, and of the accessory longitudinal carinae into supra-carinal, inter-carinal and infra-carinal areas on either side. The accessory longitudinal carinae do not extend to the prejugal part of the segment. Whether the ventral carinae mark the lateral margin of the tergite or no I am not sure. If they do it would follow that the infra-carinal area is formed on either side by the pleurite. But on the whole I think that this area is a part of the tergite.

Lastly, it may be noted that between segments 1 and 2 dorsally there is a remarkable development of the inter-segmental membrane. This brings it about that there is a considerable gap between the tergites of the two segments; this gap is covered by the uniformly buff-coloured membrane.

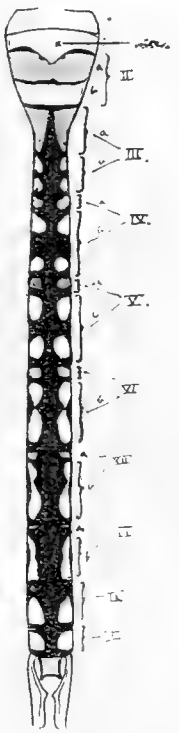
In some species of *Anax*, for example in *A. parthenope*, this development of the inter-segmental membrane is much less; but the character probably occurs to some extent in all, and is possibly of generic value.

Series A. (Text-fig. 2.)

The specimens belonging to this series I believe to be fairly typical examples of the true *A. guttatus*, Burm.

I have been able to compare them with examples from Borneo, the Malay Peninsula, and I have also seen specimens from various localities in the British Museum.

There are differences in details of coloration, size and shape of the anal appendages, but these differences do not exceed the limits of sub-specific variation in my opinion.



TEXT-FIG. 2.—*Anax guttatus* ♂ Series A.
Abdominal colour pattern (digrammatic).
a. Prejugal. *b*. Post-jugal.

The characters of this series may be given briefly as follows:—

♂. (spirit specimens) from Barkuda, 1479/H 2.

Wings.—Membranule with white, basal spot. Wing membrane slightly smoked, with an orange-brown tinge extending from the apex of the triangle to a little beyond the nodus.

Head.—Frons without T-mark, bases of mandibles and genae yellow: upper lip yellow, very narrowly and diffusely edged with

brown. Occipital triangle black with yellowish centre and posterior margin.

Thorax greenish-brown, without black markings, save along the suture lines of the coxae ; base of femora brown.

Abdomen.—Segment 1, and the inter-segmental membrane between 1 and 2 buff-yellow, posterior margin of 1 narrowly edged with brown. Segment 2 turquoise blue above. The rest of the abdomen is in general brownish-black dorsally, rather paler brown ventrally. Segment 2 has its terminal transverse carinae and jugum black, the blue colour of the dorsum passes laterally to a silvery yellow. Segment 3 has its prejugal division turquoise-blue, passing to silvery yellow ventrally, mid-dorsally a longitudinal black line, widening distally, is continuous with the black of the post-jugal part which carries on either side two large, rounded yellow spots. Segments 4—8 have each a pair of bluish-yellow spots on the prejugal division, almost obsolete on 8, and two rounded yellow spots in the supra-carinal area of the post-jugal division on either side. On 7—8 these supra-carinal spots coalesce to form a continuous yellow band. In addition 4—8 have a round lemon-yellow inter-carinal spot immediately behind the jugum.

Lastly, 9—10 have each a pair of large yellow lateral spots ; the homologues of the supra-carinal spots of the preceding segments, on 9 these spots are triangular with the apex directed forward, on 10 they are rounded.

The anal appendages are dark-brown, the upper pair have a blunt triangular projection at the middle of their inner margin.

Length of hinder-wing 50 mm., of abdomen 51 mm., anal appendages 6 mm.

Series B.

The single male of this series is from Calcutta. It is almost exactly intermediate between the males of series A and series C. 6187/20.

In the following account the characters in which it differs from series A are mainly noted ; where no remark is made, it may be assumed that the specimen is practically identical with the males of A.

♂ (spirit specimen from Calcutta).

Wings.—The yellow tinge of the hinder-wing less extensive, extending only to the level of the nodus. Basal white mark on membranule very small.

Head.—A small triangular area in front of the vertex is brown.

Abdomen.—The black of the dorsal surfaces is much more intense than in A. The post-jugal spots of segment 3 and the supra-carinal spots of 4—8 are greenish-yellow in colour, rather rectangular in shape, and much smaller than those of A. The supra-carinal spots on 7—8 do not coalesce to form a band and the anterior spot on each of these segments is obsolete. The spot on 9 is small, representing the posterior supra-carinal spot only ; and 10 is without markings. There are no inter-carinal spots.

Anal appendages as in A.

♀ not known.

In respect to the colour and colour-pattern of the abdomen this specimen differs strongly from A and approaches C.

In other respects it is not very different from A.

Length of hinder-wing 54 mm., of abdomen 56 mm., of upper anal appendages 6 mm.

Series C. (text-fig. 3).

3 ♂ ♂ 1 ♀. Sitong, Darjiling district, 1405/H 2 (with 2 exuviae); 1 ♂ (spirit specimen).

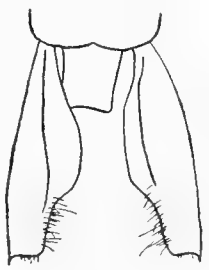
Wings smoky especially at the apices. Membranule entirely gray black. No yellow tinge on hinder wings.

Head.—Upper lip with well defined, narrow, black margin. Frons with large T-mark. Occipital triangle black.

Thorax with black mid-dorsal carina and sutural lines. Base of anterior femora yellow, the rest black.

Abdomen.—Segment 2 with a longitudinal, mid-dorsal line of black joining the black transverse carinae and the jugum, 3 with the dorsal black band broader in the prejugal division than it is in series A and B. The ground colour of the rest of the abdomen is an intense black, with pale blue spots.

On the post-jugal part of segment 3 both the lateral spots are small, the anterior one minute. On segments 4—8 the anterior supra-carinal spot remains very small, but is larger on 6, 7, 8 than on 4, 5. The prejugal spot is obsolete on 7, 8. Segment 9 has a single small spot homologous with the posterior supra-carinal spot of 8; 10 is black with indistinct lateral brown marks. Segments 4—7 have narrow blue inter-carinal spots close behind the jugum on either side.



TEXT-FIG. 3.—*Anax guttatus* ♂ Series C. Anal appendages.

The upper anal appendages are black, and differ in shape from those of series A and B. The middle third of the inner margin of each projects onwards as a straight-edged shelf. The lower appendage is whitish gray with black margins.

The female is in general very much like the male, but the spots of the last six segments of the abdomen are brownish-yellow and not blue, and the tenth segment carries a pair of well defined small spots. The blue colouring of the sides of 2, 3 is largely replaced by greenish brown, and in addition there is a pair of infra-carinal spots immediately below the intercarinal spots on segments 4, 5.

Length of hinder-wing, ♂ 56 mm., ♀ 57 mm.
,, of abdomen, ♂ 55 mm., ♀ 55 mm.
,, of upper anal appendages, ♂ 6·2 mm.

Were it not for the existence of the specimen of series B I should certainly regard those of series C as belonging to a species distinct from A.

Certainly the appearance of well preserved spirit specimens belonging to the two series is strikingly different.

I think we may without doubt regard those of series A as being fairly typical examples of the true *A. guttatus*, Burm. On the other hand series C is evidently identical with the specimens described by Martin (*loc. cit.* p. 22) as *A. bacchus*. These specimens are evidently I think not the true *bacchus* of Hagen which is at best only a slightly differentiated race of *parthenope* (see Calvert, *Proc. Acad. Nat. Sci. Pheladelphia*, 1875, pp. 148, 150, fig. 3).

The difficulty is increased by the close resemblance between the upper anal appendages of "form C" and those of *A. julius*, Brauer, which again is a close ally of *A. parthenope*.

But in 'form C' the inferior appendix of the male is very much longer relatively than it is in *A. julius* as figured by Martin (*op. cit.*, fig. 16).

The question as to whether these series should be taken as representing geographical subspecies is one I cannot answer. Series C comes from an elevation of 4000 ft. near Darjiling, and might be regarded as a northern and mountain-dwelling race. I have seen two males of the same form from Japan.

But the Indian Museum collection includes a fine female of series A from 4,900 ft. from Shillong 8252/20, and a second from Nepal valley, 4,500—6,000 ft., 7207/H 1; this latter, apparently mature, is without yellow on the wings.

It seems therefore best to note these series and leave any decision for the future.

Anax parthenope, Selys.

Anax parthenope, Kirby, *Cat. Odonata*, p. 85.
" " Calvert, *Proc. Acad. Nat. Sci Philadelphia*, 1898, pp. 148—149, fig. 3 A—E.
" " Martin, *Cat. Coll. Selys Aeschn.*, p. 21, fig. 15.

Spirit specimens from Kashmir, 2 ♂ ♂ 4212/H 1, 1 ♂ 4317/H 1, 1 ♀ 4008/H 1.

Mounted specimens, 1 ♀ 9775/15 Bangalore, 1 ♂ 6306/20 Bangalore from 3000 ft. (damaged, the abdomen from segments 4—10 has been replaced by that of a ♀ *Anax* sp.), 1 ♂ 9442/14 Seistan, 1 ♀ 5450/20 Srinagar, 1874, 1 ♂ 7200/H 1 Kashmir, 5200 ft.

Specimens mostly in poor condition. All appear to belong to the European race of the species. Its occurrence in Bangalore is comparable to that of *Sympetrum fonscolombei* in the Nilgiri Hills (see Calvert, *loc. cit.*, p. 154).

Anax immaculifrons, Ramb.

Anax immaculifrons, Kirby, *Cat. Odonata.*, p. 84.
" " Martin, *Cat. Coll. Selys Aeschn.*, p. 18, fig. 12.
" " Martin, *Bull. Soc. entomol. de France*, XII, p. 212 (1909).
" " Ris, *Supplementa Entomol.* No. V, 1916, pp. 63—65

1 ♂. Fort, Satara, Bombay Pres. 7930/H 1 (spirit).
1 ♀. Talawadi, N. Kanara Distr. 4383/H 1 (spirit).
1 ♂. Kurseong, E. Himalaya, 6000 ft., 25-x-09, E. A. D'Abreu (pinned).

I possess also a fine pair from Poona, given me by Major Fraser. Dr. Annandale notes that the species is very active, flies high, oviposits on the surface of the water, and rests on rocks.

The spirit specimens, both immature, have a striking appearance; the colour is mainly greenish-white with black bands.

Dr. Ris (*loc. cit.*) describes the Indian form as typical and distinguishable from specimens from Hong Kong.

Anax (Hemianax) ephippiger (Burm.).

Hemianax ephippiger, Kirby, *Cat. Odonata*, p. 85.
" " Martin, *Cat. Coll. Selys Aeschninae*, pp. 28—29, fig. 22.
" " Fraser, *Journ. Bombay Nat. Hist. Soc.*, 1919, p. 874.

1 ♂. Agra, Dr. Hankin. 4322/H 1.
1 ♂. At light, Rambha Rly. Station, Ganjam Distr., Madras Pres. 8217/20.
1 ♀. (fragmentary). At light in railway carriage.
1 ♀. Marikappam, S. India. 6505/20.

Anaciaeschna jaspidea, Burm.

Anaciaeschna jaspidea, Kirby, *Cat. Odonata*, p. 86.
" " Martin, *Cat. Coll. Selys Aeschn.*, pp. 30—31, fig. 25.

1 ♀. Calcutta (*N. Annandale*). 9270/14.
In very poor condition

The dentigerous plate is almost exactly like that of *Anax*. The median area of the sternite of segment 10 carries a considerable number of minute denticles rather crowded together; it is not specialized in any other way.

I have seen an example of this species from Burma. Its range seems to be chiefly Austro-Malayan.

Kruger notes that he has seen a specimen from Calcutta (*Stettin Entomol. Zeit.* 1898, p. 274).

Series AESCHNA.

Of the Indian species referred to *Aeschna*, two, *A. erythromelas* Maclach. and *A. ornithocephala*, Maclach., are remarkable for the special character of the dentigerous plate of the female which is rather elongate and spout-like, its margin, especially in *A. erythromelas*, beset with teeth more regularly arranged and longer than in other species of the genus. *A. petalura*, known to me only from Martin's description, should probably be removed to a separate genus.

Aeschna mixta.

Aeschna coluberculus, Kirby, *Cat. Odonata*, p. 87.
Aeschna mixta, Martin, *Cat. Coll. Selys Aeschninae*, p. 42, fig. 38.

2 ♀ ♀. Kashmir. 4319/H1.

This is an addition to the known fauna of Kashmir. Mr. Morton has kindly examined one of the specimens for me and tells me that it cannot be separated from European examples of the species.

Aeschna erythromelas, Maclachlan.

(Text-Fig. 4.)

Aeschna erythromelas, Maclachlan, *Ann. Mag. Nat. Hist.* (6), XVII, p. 419 (1896).
Aeschna erythromelas, Martin, *Cat. Coll. Selys Aeschninae*, p. 62, fig. 58.

2 ♀ ♀ 1 ♂. Gopaldhara, Darjiling District (per *H. Stevens*).

Maclachlan (*loc. cit.*) has noted the character of the dentigerous plate of which I give a figure (text-fig. 4). Perhaps with *A. ornithocephala*, Macl. it may require to be placed in a special section of the genus on account of this character. It is a magnificent species of great size and (in the case of the female at any rate) of striking coloration.

Fig. 4.—*Aeschna erythromelas* ♀.
Apex of dentigerous plate.

Length of abdomen, ♂ 62+5·5 mm., ♀ 59 mm.
,, of hinder-wing, ♂ 53 mm., ♀ 56·5 mm.

The anal appendages as in the case of the next species are small and pointed in the female.

Aeschna ornithocephala, Maclachlan.

Aeschna ornithocephala, Maclachlan, *Ann. Mag. Nat. Hist.* (6), XVII, p. 368 (1896).
Aeschna ornithocephala, Martin, *Cat. Coll. Selys Aeschninae*, p. 63, fig. 59.

1 ♂. Nam Ting Pokri, Sendim Spur, Sitong 4,000 ft. 3007/H1 (teneral).
1 ♂ 1 ♀. same locality, Oct. 22, 1917. 8005/H1.
2 ♀ ♀. same locality and date. 8006/H1.
1 ♀. same locality and date. 7574/H1 (teneral).
1 ♀. same locality and date. 7570/H1 (adult).

Dr. Annandale has sent me the following interesting note on this species, "A number of females were observed ovipositing (in October, after the rains) in a bank of fairly dry earth at the edge of the lake, one or two feet above the water level. After hovering, with a buzzing sound, a few inches off the bank for some seconds they settled upon it with the head uppermost. The body was raised on the legs, but the tibio-femoral joint was flexed. The abdomen

was turned down in an arch. The median ventral appendage (terebra) was pulled out from between the lower paired appendages (valves), and rapidly inserted into the earth, in which it left a small hole. In this hole an egg was evidently laid. The terebra was then rapidly withdrawn, the abdomen turned aside a little and a new hole made at a different spot. Five or six eggs were thus laid in succession at one place. It was difficult to observe details of the process as it was executed with great speed, but the action of the terebra was easily seen."

The colouring of teneral specimens of both sexes is very similar to that of adult females of *A. erythromelas*. The dentigerous plate of the female also resembles that of *A. erythromelas* more than any other *Aeschna* that I know of, but is rather nearer the typical aeschnid plate, having some irregularly placed spines on its ventral surface near the apex.

♂ (Teneral). Anterior surface of head dull brown, vertex and occiput very dark brown almost black.

Thorax dark brown, with broad antehumeral bands, pointed below, truncate above, of pale yellow colour, on either side of the thorax two broad pale yellow bars.

Abdomen brownish red, each segment except the last with a narrow terminal black ring. Segments 1 and 2 with a lateral yellow band, 3 with a small lateral yellow triangle anteriorly.

In the teneral female the colouring is almost identical with that of the male. It differs from that of *A. erythromelas* chiefly in not having the last three segments of the abdomen entirely black.

The more mature female has the summit of the frons black. The abdominal colour deepens to a dull dark brown. A narrow sub-apical ring of greenish yellow appears on each segment from 2-8, and in addition the position of the 'jugum' is marked by a narrow transverse mark of the same colour, interrupted in the mid-dorsal line.

The species is remarkable for the open character of the venation, in which respect it approaches *Aeschna* (?) *petalura*, Martin. The anal appendages however are small and pointed in the female. The wings in the adult female have a yellow tinge which is most marked distal to the nodus and on the anal margin.

Length of abdomen in adult ♀, 52 mm., of hinder-wing 57·5 mm.

Aeschna (?) petalura, Martin.

Aeschna petalura, Martin, *Cat. Coll. Selys Aeschn.*, pp. 78–79, figs 24–77.

As above remarked this species is scarcely a true *Aeschna*.

The shortness of the triangle of the hinder-wing and the narrow intervals above the radial and median supplements mark it off from the more typical species of the genus. Found near Darjiling and in the Khasi Hills.

Series Gynacantha.

This series contains a large number of highly organized tropical insects in both hemispheres which are crepuscular or at any rate shade-loving.

The dentigerous plate of the female is remarkably specialized and bears a remarkable similarity to that of *Periaeschna.*

Gynacantha hyalinia, Selys.

Acanthagyna hyalinia, Kirby, *Cat. Odonata*, p. 95.
Gynacantha hyalinia, Kruger, *Stettin Entomol. Zeit.* 1898, p. 275 seq
,, ,, Martin, *Cat. Coll. Selys Aeschninae*, pp. 198—199, fig. 203.

1 ♂ 5455/20. loc. ?, 1 ♀ 5454/20 Darrang, 1 ♂ 8313/4, 1 ♀ 8306/4 Sibsagar. These specimens all in bad condition bear labels in de Selys' handwriting.

1 ♂ 1478/H 2. Chilka Lake (*N.A.*), Zool. Surv.

1 ♀ 8287/20. Calcutta, 'flying at dusk.'

1 ♀ 7939/H 1. Calcutta, 'flew to light in Museum,' 14-viii-17 (*N.A.*).

1 ♀ 8189/20. Cherrapunji.

Gynacantha basiguttata, Selys.

Acanthagyna basiguttata, Kirby, *Cat. Odonata*, p. 95.
Gynacantha basiguttata, Kruger, *Stettin Entomol. Zeit.* 1898, pp. 283—284, fig. p. 279.
,, ,, Martin, *Cat. Coll. Selys Aeschninae*, pp. 192—193.
,, ,, Ris, *Ann. Soc. Entomol. Belg.* LV, pp. 246—247, fig. 13 (1911).

1 ♀ (in fragments) 5456/20. "Sibs." (Sibsagar, N. E. Assam) (labelled by de Selys).

I have examined 3 males of this species from Lower Siam. It ranges from the Philippine Islands to Burma and Assam. Martin's figure is not that of the appendages of this species (see Ris, *loc. cit.*).

Gynacantha khasiaca, Maclachlan.

Gynacantha khasiaca, Maclachlan, *Ann. Mag. Nat. Hist.* (6), XVII, p. 411 (1896).
,, ,, Laidlaw, *Rec. Ind. Mus.* VIII, p. 340 (1914).
,, ,, Martin, *Cat. Coll. Selys Aeschninae*, pp. 202—203, fig. 207.

1 ♂. Mangaldai, Assam. 6417/20.

Gynacantha saltatrix, Martin.

Gynacantha saltatrix, Martin, *Cat. Coll. Selys Aeschninae*, pp. 194—195, fig. 199.

1 ♂. Mazbat, Mangaldai District, Assam, 11—19-x-10 (*S. W. Kemp*), 6419/20.

This is the smallest of the Indian species that I know of. Length of abdomen 42 + 6 mm., of hinder-wing 39 mm.

In addition *Gynacantha subinterrupta*, Ramb. and *Gynacantha furcata*, Ramb. have been recorded from Ceylon by Kirby, together with *Anax* (*Hemianax*) *ephippiger* and *Anax guttatus* (Kirby, *Journ. Linn. Soc., Zool.*, XXIV, p. 558).

Gynacantha millardi, Fraser.

Gynacantha millardi, Fraser, *Journ. Bombay Nat. Hist. Soc.*, XXVII, p. 147.

1 ♂ teneral. Chota Nagpur.

This interesting new species differs from other Indian Gynacanthas in having but little constriction of the abdomen at the second and third segments, a feature which makes it easily distinguishable from its allies.

There is also a ♀ specimen from Mangaldai, N.E. Assam, which I am not able to determine, it does not seem to be *G. khasiaca*, Maclach.

XII. ON AN ANISOZYGOPTEROUS LARVA FROM THE HIMALAYAS (Order ODONATA.)

By R. J. Tillyard, *M.A., Sc.D. (Cantab.), D.Sc. (Sydney), F.L.S., F.E.S., Entomologist and Chief of the Biological Department, Cawthron Intitute, Nelson, New Zealand.*

(Plate XIII).

The Order Odonata is usually subdivided into two Suborders, the Zygoptera and the Anisoptera, of which the principal characters are by now so well known that it is not necesary to recapitulate them here. Besides these two universally recognised types, there existed in Liassic times an extensive group of Dragonflies, which, to a considerable extent, appears to have combined the characters of the two Suborders in approximately equal measure. Handlirsch, who has studied these insects carefully, has separated them out into a new Suborder, to which he gave the name Anisozygoptera.[1]

There exists at the present day, so far as is known, a single genus and species of Dragonfly, *Epiophlebia superstes* (Selys), from Japan, which appears to combine the characters of the Zygoptera and Anisoptera in such a manner that it may legitimately be classified in the Anisozygoptera, if Handlirsch's decision regarding the Liassic types be accepted. This remarkable dragonfly possesses a Gomphine type of coloration, a Gomphine form of head, thorax and abdomen, and an archaic Zygopterous type of wing-venation. In my book on the "Biology of the Odonata",[2] I included Handlirsch's Anisozygoptera within the Suborder Zygoptera, and have placed *Epiophlebia* in the family Lestidae, making it form by itself a subfamily Epiophlebiinae.

Up to the present time, the larva of *Epiophlebia* has remained undiscovered, though it is certainly the greatest prize awaiting discovery in this Order. It was safe to assume, considering the large number of larval characters in which the Zygoptera differ from the Anisoptera, that the discovery of this larva would definitely settle whether *Epiophlebia* was a true Zygopteron, as I had provisionally assumed, or whether it combined Zygopterous with Anisopterous characters in such proportion that it would support the recognition of Hardlirsch's new Suborder Anisozygoptera.

For a number of years Mr. F. F. Laidlaw, of Uffculme, Devon, has been working on the Odonate fauna of India. He has a wide knowledge of the whole Oriental fauna, and is our recog-

[1] *Die Fossilen Insekten*, p. 463 (Leipzig, 1908).
[2] Pp. 276, 307 (Cambridge Univ. Press, 1917).

nised expert on the Dragonflies of this region. Recently a small collection of Dragonflies from the Himalayas was sent to him for determination. These were collected in June, 1918. In the consignment was a single larva, at first sight very much like a Gomphine larva, which was taken from a rapidly running stream, between Ghum and Sonada, (S. Kemp coll.) at the very high elevation of 7000 feet. The larva, to judge from the length of its wing-sheaths, which reach slightly beyond the end of the second abdominal segment, is in the penultimate instar. The wing-sheaths, of which a pair were dissected off, show the imaginal venational pattern fairly plainly, though the tracheation, of course, had collapsed through long immersion in alcohol. The result of Mr. Laidlaw's study of this interesting larva was to lead him to believe that it belonged to the genus *Epiophlebia*. This result was so startling that he had the larva and its wing-sheaths photographed at the British Museum, where he also consulted Mr. Herbert Campion as to its probable identity. As will be seen from the photographs, which are reproduced in plate XIII, it was scarcely possible to come to a definite conclusion on the matter, though Mr. Laidlaw felt very strongly that his original determination would prove correct.

On June 1st, 1920, I arrived in London from Sydney to attend the Imperial Conference of Economic Entomologists. Shortly after, I met Mr Laidlaw and Mr. Campion at the British Museum, where the photographs of the larva were submitted to me for my opinion. I must confess that from the photographs alone, I could see little evidence in support of Mr. Laidlaw's opinion. The general appearance of the larva is distinctly that of a Gomphine or Petaline, while the photographs of the wing-venation did not seem to me sufficiently definite to go upon one way or another. As the antennae were five jointed, the labial mask Gomphine-like and the tarsi of normal form and not formed for burrowing, I was inclined to see in this new form the missing larval type of one of the Chlorogomphinae, and suggested the genus *Orogomphus*.

The outcome of the discussions at the British Museum was that Mr. Laidlaw urged me to come down to Devonshire and study the specimen itself, and the slides which he had prepared from it. In July I had to go to Bristol for a few days, and this gave me the necessary opportunity of visiting Mr. Laidlaw for a week-end. I spent the greater part of the time studying this problematical larva, with the result that I came away fully convinced that it belonged to a new species of the genus *Epiophlebia*. I urged Mr. Laidlaw most strongly to write a paper upon it at once; but he most generously and insistently urged me, on the other hand, to undertake the work myself, and finally I consented to do so. He also lent me his notes and description of the larva, for use in the preparation of this paper.

I desire here to thank Mr. Laidlaw for his generous help and to state that full credit for the original determination of this larva as belonging to the genus *Epiophlebia* is due to him alone. I consider

that the evidence obtained from a study of the larva itself, and from the slides of the two wing-sheaths and the gizzard, prepared from it, is sufficient to prove this. Most unfortunately, Mr. Laidlaw did not succeed in obtaining a good preparation of the rectal region; the larva, when I came to study it, had had the contents of the distal half of the abdomen removed, so that we cannot now say whether it possessed any rectal gills, or, if it did, what type of gills they were.

In describing this larva, I propose to depart from a practice which I have hitherto followed most stringently, viz. never to give a name to a larval type. The reasons for this departure may be shortly stated here. Firstly, the larva is of such absorbing interest, that it seems necessary to give it a name, to facilitate future discussions upon it. Secondly, it seems reasonably certain that, if I refrain from naming it, after having described it, some, body else will certainly step in and do so seeing that the precedent for the naming of larval types has already been set up in America. And thirdly, as this is only the second species of the Suborder known to exist in the world to-day, the other being in Japan, the likelihood that *two species* of the same genus *Epiophlebia* would occur in one locality on the Himalayas, at such a high elevation, seems so remote that it may be reasonably ignored. That being so, it is clear that the figure given of the imaginal venation on the wing-sheath of the larva is, to all intents and purposes, an imaginal character, and sufficiently clear and detailed to make the recognition of the imago, when it is at last captured, a certainty. For these reasons, I have decided to name the larva, and now have much pleasure in dedicating the new species to my old friend Mr. Laidlaw in recognition of the fact that he was the first to determine its true affinities.

Epiophlebia laidlawi, n. sp.

(Plate XIII and text-figures 1–4.)

Description of the penultimate larval instar.

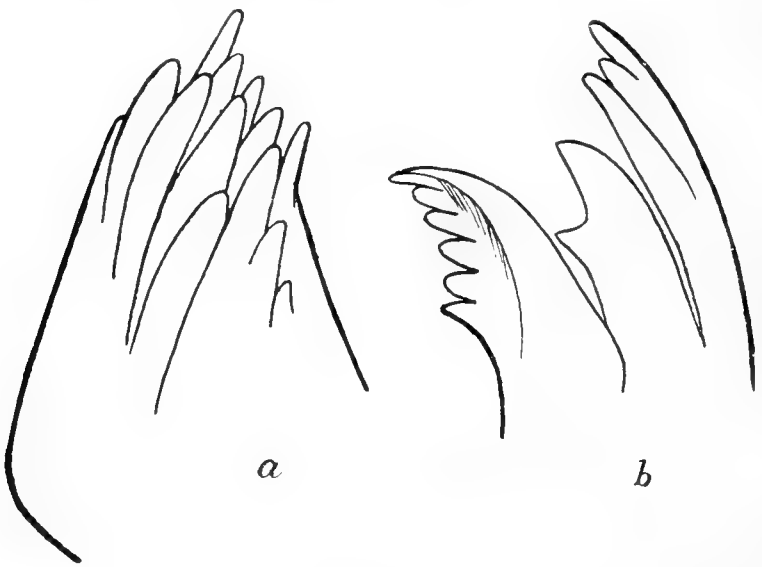
Total length 20.2 mm.; *length of abdomen* 11·5 mm.; *breadth of head across eyes* 5·3 mm.; *greatest breadth of abdomen at seventh segment* 5·4 mm.

Build stout, in general appearance superficially Gomphine-like but more closely resembling the larval type of the Petaliini. Hairs are entirely absent (except those of the maxillae, and a few small ones on the underside of the tarsi). Surface of the body and wing-sheaths strongly rugose, being covered with small, but very distinct, wart-like prominences. *General colour*, a medium brown.

Head.—Eyes large, dark brown, well-rounded, placed at the antero-lateral angles of the head. Postocular lobes well developed, somewhat projecting, convex externally, but cut off rather straight internally, where they converge inwards to the rather narrow occipital region. *Ocelli* present, small but well marked, and placed far apart to form a triangle. *Antennae* (text-fig. 2*a*) stoutly

built, five-jointed, arising from the outer ends of an epicranial ridge bordering the crescentic line which marks the division of the epicranium from the clypeus; first and second joints (scape and pedicel) stouter than the rest, the pedicel about twice as long as the scape, its surface pitted all over; of the distalia, the third joint is as long as the fourth and fifth together, and slighty longer than the pedicel; the fourth joint is slightly narrower than the third, while the fifth is much narrower, fusiform, and ending in a minute conical sense-organ. A deep groove separates the *clypeus* from the *labrum*, which is wide, and arched slightly from side to side.

The *mandibles* are shown in text-fig. 1. Each mandible is short with a broad base, and carries two series of teeth, one apical and

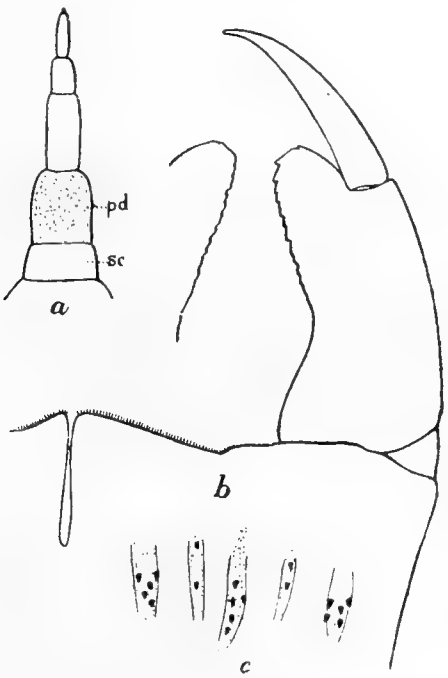


Text-fig. 1.

Mandibles of the larva of *Epiophlebia laidlawi* n. sp. *a*, right mandible viewed from the inner side; *b*, left mandible, similarly viewed but with the two lobes somewhat split apart.

one internal. They were studied by laying the larva on its back and pressing each mandible in turn outwards with the point of a dissecting needle. In doing this, the left mandible split apart down its middle, thus exposing more clearly the separate teeth forming the two series. The two mandibles differ greatly as may be seen from the figure. The right mandible (text-fig. 1*a*) has five prominent teeth in the apical series, all more or less conical, but the two end ones somewhat narrower than the others; the internal series consists of four larger teeth, conical, with somewhat rounded apices, together with a much smaller flattened tooth appressed to the surface of the outermost larger tooth, two smaller teeth placed internally from the fourth large tooth, and a large

tooth placed lower down and somewhat appressed into the space between the bases of the third and fourth teeth of the internal series. In the left mandible (text-fig. 1*b*), the apical series carries three narrow conical teeth on the outside, followed internally by a single large unequally bifid tooth, separated from the rest by a deep notch; the internal series consists of six smaller conical teeth with well rounded apices, all set in a row along the internal edge of the internal lobe of the mandible, from which the apical lobe was torn away somewhat during examination.



TEXT-FIG. 2.

a. Antenna of larva of *Epiophlebia laidlawi* n. sp.; *pd*, pedicel, *sc*, scape. *b*. Part of the labial mask of the same larva, showing a small portion of the mentum, the median lobe with its median cleft, the right lateral lobe and movable hook, and part of the left lateral lobe (displaced), for comparison of its denticulation with that of the right side. *c*. Portion of the gizzard of the same larva, showing five consecutive dental folds, three major and two minor.

The *maxillae* have a well developed inner lobe, with five strong teeth; the palps carry some stiff hairs, and their tips are considerably hardened.

The *labial mask* (text-fig. 2*b*) is of the generalised type found in the Gomphinae and Petaliini. The submentum is short; the mentum somewhat longer than broad, the distal portion squarish, but narrowing towards the base; a median groove runs up from the base for more than two-thirds the length of the mentum. The median lobe is small, only slightly projecting, furnished with a

row of short hairs, and split in the middle by a moderately deep, very narrow, cleft. The lateral lobes are large, slightly concave internally, the distal border rounded, with a slight notch near the apex; the inner border is slightly and irregularly denticulate along the distal half of its length; the denticulations of the right and left lobes do not correspond, as may be seen from text-fig. 2*b*. The movable hook is large, strongly built, nearly as long as the outer margin of the lateral lobe below its insertion, and with a slightly nodding apex. No setae present either on the mentum or on the lateral lobes.

A comparison between this labium and the types found in the Gomphinae and Petaliini shows that it differs from them mainly in the relative proportionate length of the parts of the lateral lobes and movable hook. In the two groups mentioned the movable hook is always either longer than, or at least equal to, the length of the margin below its insertion: the shorter movable hook here decribed suggests a comparison with the Megapodagrioninae and Synlestinae. The proportionate amount of projection of the apical portion of the lateral lobe, internally to the movable hook, is again much less than in the Gomphinae and Petaliini, while the notching of the apex, and the appearance of the most prominent denticulations just below it, suggest the beginnings of the division of this part of the lobe into distinct teeth, as in Zygoptera.

Thorax stoutly built, the *prothorax* without spines, but with its antero-lateral angles produced somewhat cephalad, as two lobes with rounded apices. The prothorax and median portion of the synthorax are very strongly rugose or tuberculated.

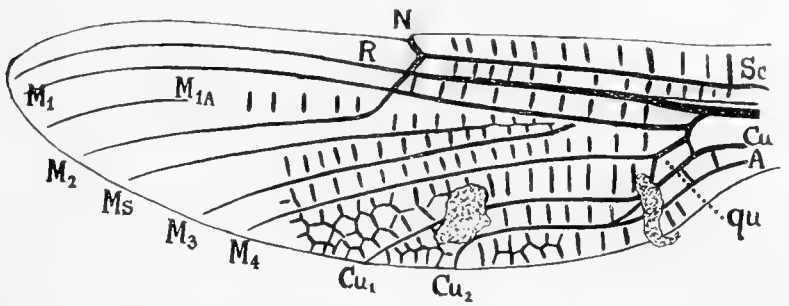
Wing-sheaths laid parallel along the middle line, those of the hindwing projecting backwards to about the middle of the second abdominal segment. This probably indicates that the larva was in the penultimate instar. The sheaths are hairless, but with some patches of dirt adhering to them; the sheath of the hindwing is a little broader and very slightly shorter than that of the forewing. (The right pair of wing-sheaths was dissected off by Mr. Laidlaw, as shown in plate XIII, fig. 1, and mounted on two separate slides, from which the photomicrographs in plate XIII, figs. 2, 3, were taken).

The *wing-venation* is of the very greatest interest. But a study of the photomicrographs shown in plate XIII, figs. 2, 3, although it reveals many points of interest, does not yield enough evidence to allow of a definite placing of the larva in its correct systematic position. After examining these, and also the slides from which they were prepared, I obtained Mr. Laidlaw's permission to cut off the *left* hindwing and examine it separately on a slide. The canada balsam mounts prepared from the right fore and hind wings were not satisfactory; hence I examined this further wing in 70% alcohol only. By using a strong light, transmitted vertically upwards through the wing, it was possible to bring out much more definitely the pale bands foreshadowing the actual imaginal venation, especially on the basal part of the wing, which,

owing to its greater thickness, did not yield any very clear result in the photomicrographs. In drawing the left hindwing, I used an Abbe camera-lucida, and prepared a "negative" by the simple process of blacking in all the pigment bands which appeared pale on the wing itself. This "negative", which, of course, would represent very closely a "positive" of the imaginal wing, (in which the veins are black on a hyaline background), is reproduced in text-fig. 3.

The cross-venation of the distal part of the wing was not definitely enough outlined to allow of the drawing being completed distally; but a fairly good idea of the position of the cross-veins in this part of the wing may be obtained from a study of the photograph of the *right forewing* in plate XIII, fig. 2.

In the left hindwing, the number of actually visible antenodals of the first series is twelve, of the second series fourteen; none of these appear to correspond exactly except the first and fourth



TEXT-FIG. 3.

"Negative" of imaginal venation in left hind-wing of larva of *Epiophlebia laidlawi* n. sp. *A*, anal vein; *Cu*, cubitus with its branches Cu_1, and Cu_2; *M* media with its branches M_1, M_2, M_3, and M_4, ; M_{1A}, postnodal sector; *N*, nodus; *qu*, quadrilateral; *R*, radius; *Sc*, subcosta.

of the first series, which are in line with the first and sixth respectively of the second series. These, moreover, are much more strongly marked than any of the others. Consequently it seems a legitimate assumption that they represent the two so-called "hypertrophied" antenodals, which are found in all the Anisoptera, but outside of that Suborder only in the genus *Epiophlebia*. From the photograph of the right forewing (plate XIII, fig. 2) it can be seen that there are eight or more postnodals, though the exact number cannot be determined.

The nodus is <—shaped and very clearly marked, with *M* arising directly from the subnodus below it. I have not marked the position of the oblique vein in text-fig. 3, as I could not make out the cross-veins clearly in this region of the wing, but in the photograph of the right hindwing (plate XIII, fig. 3), the oblique vein can be clearly seen, lying about three cells distad from the origin of M_2, below it.

In the right forewing the pterostigma can be seen to be about three times as long as broad and covering several cells.

There are no interpolated veins, except only M_{1+2}, which can be clearly seen, both in text-fig. 3, and in the photograph of the right forewing.

Ms is a nearly straight vein lying below, and almost parallel with, M_2. Its anterior portion, forming the so-called "bridge vein", is clearly marked, though the pigment-band becomes very thin basally, so that it is impossible to determine whether it arises from M_{1+2} above, or from M_3 below. It is quite clear, however, that its point of origin lies not far distad from that of M_3, far basad from the subnodus. The origin of M_3 appears to be placed closer to the arculus than to the level of the nodus, viz. about four or five cells distad from the arculus. M_3 and M_4 are nearly parallel for most of their lengths, and are separated by a single row of cells, except for a short space distally.

The arculus is strongly marked, with the sectors arising separately near its middle. The quadrilateral can be quite clearly seen in the left hindwing; it is broad, strongly built, with the lower distal angle about 45°, and the upper or costal side only about two-thirds as long as the lower or anal side. The basilar space is broad and free. The discoidal field is broad, but carries only a single row of cells for the first half of its length; distad from this, M_4 and Cu_1 diverge widely, so that the number of cell-rows rapidly increases. In the right forewing, the quadrilateral can be seen to be considerably narrower than in the left hindwing.

Between the cubitus and anal vein, basally, there is a clearly marked cross-vein lying basad from the quadrilateral; this is certainly the *anal crossing*, *Ac*. Further distad, under the quadrilateral itself, there is another cross-vein. The anal vein itself appears to run without any break below the quadrilateral, and Cu_2 leaves the distal angle of the latter obliquely, and joins the anal vein at a fairly acute angle. Thus the continuation of the vein which we usually call Cu_2 appears, in the wings of this larva, rather as if it were really *A*, with Cu_2 descending like an oblique vein upon it.

Cu_1 and Cu_2 are separated by a single row of cells for most of their lengths. Distally, however, Cu_2 arches strongly over before reaching the wing-margin, so that the number of cell-rows above it is much increased. Cu_1 ends up very slightly beyond the level of the nodus, Cu_2 somewhat before the same level, the ends of the two veins being separated by six very small but quite clearly marked cells.

The very distinct narrowing of the base of the larval wing shows quite clearly that the imaginal wing is of a somewhat petiolate type. The most basal cross-vein visible in the anal space is situated distad from the level of the arculus; in fact, it lies distinctly beyond the level of the cross vein already noted as occurring in the subquadrangular space, below the quadrilateral itself.

Two patches of dirt which I failed to remove from the wing are shown *in situ* in text-fig. 3. They do not hide any important details.

The *legs* are fairly short, the hind femora reaching nearly to the middle of the sixth abdominal segment. The femora are fairly wide, flattened; they carry two longitudinal ridges anteriorly and a single well marked ridge posteriorly. The tibiae are much narrower than the femora, but similarly ridged. The tarsi are three-jointed, not constructed for burrowing or digging, and having the third or apical joint longest. The claws are well developed, with strongly hooked ends. Ventrally, the last tarsal joint carries a well defined ridge furnished with hairs on either side, and projecting slightly as a small rounded prominence between the claws.

Abdomen broad, subcylindrical from base to seventh segment, then tapering rapidly to anal end. Dorsal surface generally convex, carrying a low median ridge interrupted segmentally, and having on each segment, from 1 to 8 on either side of this median ridge, a set of four shallow hollows separated by narrower, low ridges. On segments 2 to 9 the median ridge is notched anteriorly by a somewhat triangular, narrow slit or hollow. The ridges are more strongly rugose or tuberculated than the hollows. Neither dorsal nor lateral spines are present, but the lateral angles of the segments, dividing the dorsal from the ventral surface, are strongly marked. The ventral surface is somewhat flattened, trilobate in form, the middle division being slightly convex, the two lateral divisions flattened. From 1 to 7, the segments become consecutively slightly longer and wider; 8 is somewhat longer than 7, but not quite so wide; 9 is both shorter and narrower than 8, but is produced backwards on either side so as to embrace 10, which is very narrow, and about half as long as 9 measured mid-dorsally. The rudiments of the male valvules are visible ventrally on segment 8.

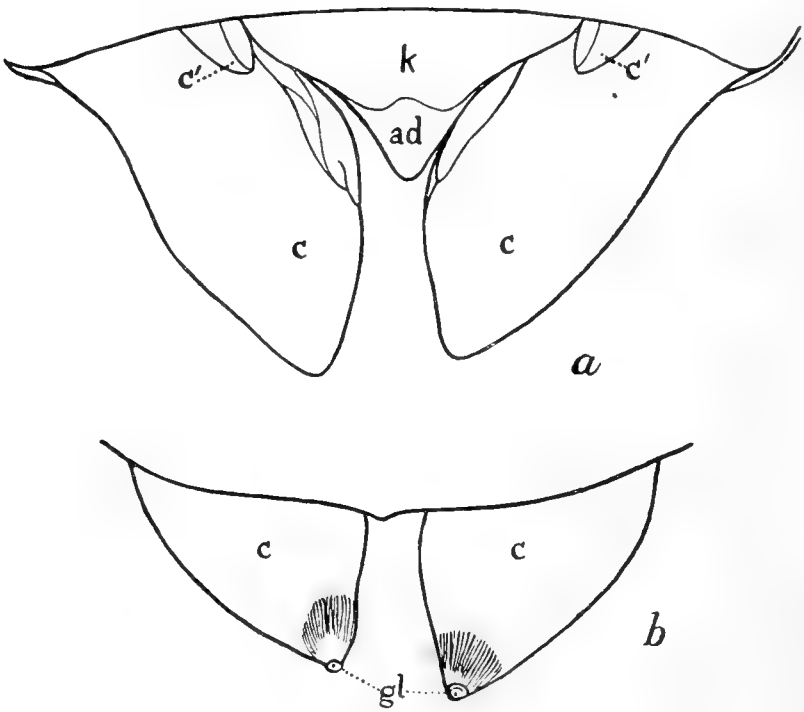
Anal Appendages:—Caudal gills are not present. The appendages may be said to be generally similar to those of the Anisoptera, but possess at least one feature not before noted in any type of anal appendage within the Odonata (text-fig. 4).

The *appendix dorsalis* (text-fig. 4 *ad*) is small, not as long as segment 10, and triangular in shape. Dorsally it carries a raised area which is somewhat bifid in the middle of its distal margin (text-fig. 4, *k*); this would appear to indicate the position of the involucre of the male inferior appendage.

On either side of the appendix dorsalis can be seen the small and somewhat conical *cercoids* (*c'*), which become the superior appendages of the imago.

The *cerci* (text-fig. 4*c*) are broad and somewhat leaf like appendages, more than twice as long as the appendix dorsalis. They are placed far apart at their bases, which are broad, and converge inwards towards their tips, which are well pointed. Their internal sides, bordering the appendix dorsalis, appear to be rather complexly folded; but this may be partly due to the mode of preservation of the specimen.

Viewed ventrally, the cerci show at their apices a very conspicuous whitish swollen area, which is protected by a brush of strong, stiff hairs arising from around its base. The tip of this swelling, which is also the apex of the cercus itself, carries a tumid pore (*gl*) evidently the opening of some gland or internal cavity. One might perhaps hazard the guess that water may be drawn in through these pores, and that by this means the cerci first began to function as gills. These structures are, in any case, unique amongst Odonate larvae, and are therefore of the greatest interest.



Text-fig. 4.

Anai appendages of larva of *Epiophlebia laidlawi* n. sp. ; *a*, dorsal view ; *b*, ventral view. *ad*, appendix dorsalis ; *c*, cerci ; *c'*, cercoids ; *gl*, pore at apex of cercus ; *k*, involucre of male inferior appendage of imago.

If more material of this species, properly fixed, could be obtained, the internal morphology of these organs should most certainly be carefully worked out.

Gizzard :—The gizzard was extracted by Mr. Laidlaw, and the following description is made from a study of his slide.

The armature consists of sixteen *dental folds*, eight of these being major folds and eight minor. All the folds carry only generalised, separate teeth. A feature not before noted, I believe, in any Odonate gizzard, is the further specialisation of the eight major folds into four distinctly broader and shorter, and four

distinctly narrower and longer ones; in text-fig. 2*c*, two of the former and only one of the latter are shown. The minor folds alternate, as usual, with the major, and the two types of major folds also alternate with one another. Each major fold carries from four to six, or even in one case, seven teeth, the usual number being five. Each minor fold carries from two to four teeth only, the usual number being two. The teeth are placed irregularly on the fold, those of the broader major folds tending to become grouped close together, while those of the narrower tend to become arranged into a single longitudinal line. The teeth are subconical, set on fairly broad bases, and having their apices somewhat hooked.

It will be seen that this type of gizzard comes closest to the more generalised type of sixteen-folded gizzard, which is found in the Calopterygidae and the older sub-families of the Agrionidae. The folds are, however, more reduced than in the generalised type and carry a much smaller number of teeth; in this respect the gizzard shows some affinity with that of the Synlestinae, though this latter has undergone reduction to a total number of eight folds. One might also see some affinity with the eight-fold gizzard of the Petalurinae, in which the reduction of the individual folds has proceeded even further, there being seldom more than two teeth on any given fold.

The structure of the rectum could not be studied, as it had been removed. In his notes, Mr. Laidlaw remarks: "I have failed to make any satisfactory preparation of the rectum."

Type.—Specimen No. 1448/H2 in the collection of the Indian Museum at Calcutta.

Habitat.—Rapidly running stream, 7000 feet above sea-level, between Ghum and Sonada, Darjiling district, Himalya Mountains.

Discussion of the systematic position of the larva.

In dealing with this problem, we may begin by listing those characters which appear to be Anisopterous into one column, and then arranging in another column those characters which appear to be Zygopterous. We then get the following result:—

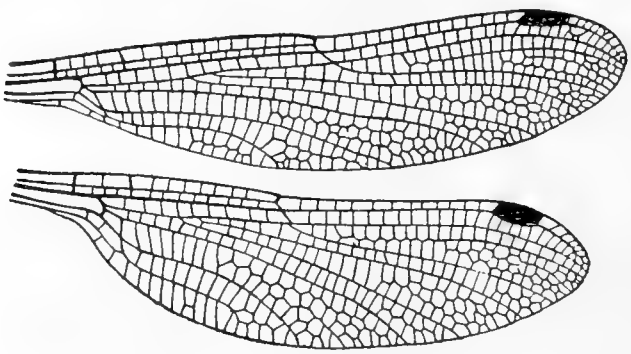
Anisopterous Characters.	*Zygopterous Characters.*
General build and facies of the larva.	Wing-venation.
Labial mask.	Gizzard.
Anal appendages.	

In addition to these, we may say that the characters offered by the antennae and legs do not incline us perceptibly towards the one Suborder more than the other.

Bearing in mind the fact that the Petalurinae alone of all known Anisopterous types possesses a gizzard of eight folds, while all the rest of the Anisoptera have only four, I have always been prepared to admit the likelihood of eight folds occuring in the gizzard of the so far undiscovered larva of the Chlorogomphinae,

though I think it much more unlikely that there should be sixteen. Apart from this, the general build of this larva, the form of its labial mask, and the structure of the anal appendages, might very well be those belonging to this sub-family. It is, therefore, to the wing-venation that we must finally turn for a decision. That is absolutely conclusive. After a careful study of the two slides of the right wings prepared by Mr. Laidlaw, and a more detailed study of the left hindwing dissected off by myself, I have no hesitation in saying that this larva belongs to the family Epiophlebiidae and that there is no character visible in the venation which would require its allocation to any other genus than to *Epiophlebia* itself.

In text-fig. 5, I show the venation of the imago of *Epiophlebia superstes* (Selys) from Japan, in order to institute a close compar-



Text-fig. 5.

Venation of *Epiophlebia superstes* (Selys) from Japan, (Hw. 31 mm.) After Needham.

ison with that of the larva here dealt with. It will be seen at once that, if we allow for the fact that the wing is not yet expanded, the comparison is overwhelmingly in favour of the conclusion that the larva belongs to the genus *Epiophlebia*.

The characters in which *Epiophlebia* differs from all other known non-Anisopterous genera are the following :—Presence of the two thickened or "hypertrophied" antenodals; difference in the shape of the fore and hindwing quadrilaterals, the latter being much wider than the former, and both being acutely angled distally; form of the discoidal field, which is strikingly broader than the spaces above and below it, but at the same time possesses, for most of its length, only a single row of cells.

Each of these three important characters appears to be present in the larval wings exactly as in *Epiophlebia*.

This evidence should be sufficient to place the larva within the family Epiophlebiidae. But we may reinforce it by enumerating the other venational characters, which, though not peculiar to *Epiophlebia*, are to be found in that genus, and which, taken together with the three characters mentioned above, practically define the genus as far as its wing-venation is concerned. These

are:—the slightly petiolate wing-base; the <-shaped nodus placed about half-way along the wings; the form of the pterostigma, strongly built, elongated, about thrice as long as broad; the presence of the oblique vein; the absence of any straight or well formed supplementary sectors except M_{1+4}; the positions of the points of origin of *Ms* and M_3; the origin of M_2 directly from the subnodus; the great divergence of Cu_2 from Cu_1 distally, with the strong arching of the former, especially in the hindwing. All these characters are to be seen in the wings of the larva here under discussion.

We may now reinforce the argument from the wing-venation by considering the general build and facies of the larva. This is undoubtedly Anisopterous. What non-Anisopterous types are there known which could conceivably possess a stout larva of this type? Most certainly only those genera of stout, heavy build. The only two non-Anisopterous types known which could possibly satisfy these conditions are *Philoganga* and *Epiophlebia*. *Philoganga* is such a huge, clumsily built insect for a Zygopterid that it might well possess such a larva as this; also, the locality in which the larva was found might well be a habitat for this Oriental genus. Many details of the venation, however, preclude our acceptance of this solution. *Philoganga*, for instance, to mention only a few obvious characters, has no hypertrophied antenodals; its nodus is much closer to the base of the wing than to the pterostigma; it has no oblique vein between M_2 and *Ms*; its quadrilateral is almost rectangular, and extraordinarily short, nor does it differ much in fore and hind-wings; its discoidal field is much narrower than the space below it; and Cu_2, instead of diverging from Cu_1 distally, converges towards it. Thus we may with safety rule *Philoganga* out.

There remains, then, *Epiophlebia* as the only possible known genus in which the general build of the imaginal body would lead us to expect a stoutly built larval type of the form we have here. The general build of *Epiophlebia*, apart from the wings, is distinctly Gomphine; the same may be said of the larva before us.

To settle the question whether we ought to place this larva in the genus *Epiophlebia* itself, or relegate it to a new genus in the family Epiophlebiidae, we have to rely only upon the wing-venation, since the larva of the only known species of *Epiophlebia* has not yet been discovered. Against the overwhelming array of characters which we have marshalled, in which the wings of this larva agree with those of *Epiophlebia superstes*, we can only mention the following doubtful points: the peculiar condition of the anal vein which appears to run continuously through to Cu_2, receiving the basal portion of that vein from above like an oblique vein; and the presence, in the hind-wing, of a double row of cells for five cells' length, between Cu_2 and the posterior margin of the wing; whereas, in text-fig. 5, the hind-wing of *E. superstes* is shown with only one divided cell in this area.

Regarding these points, it can easily be seen that, in the process of expansion of the wing at metamorphosis, the slight angula-

tion of *A* at its junction with Cu_2 might be brought about as a purely imaginal character. Also, the pigment bands of the larval wing are so wide that, even if some slight angulation is really present there, it might easily be overlooked. As regards the double row of cells below Cu_2 in the hind-wing, it may be noted that a closely similar set occurs in the *forewing* of Needham's specimen (text-fig. 5); so that we may regard this character as being probably a variable one in the different wings of separate individuals of *E. superstes*. Even if we grant the presence of these differences, they are not of greater moment than such as we should expect to find in two species of the same genus, from such widely different localities as Japan and the Himalayas.

From the above evidence, it may, I think, be legitimately concluded that the larva belongs to the genus *Epiophlebia*.

The Suborder Anisozygoptera.

We have still to answer the question as to whether the erection of the Suborder Anisozygoptera by Handlirsch was justifiable; and, in particular, whether the discovery of this larva adds to or detracts from Handlirsch's opinion.

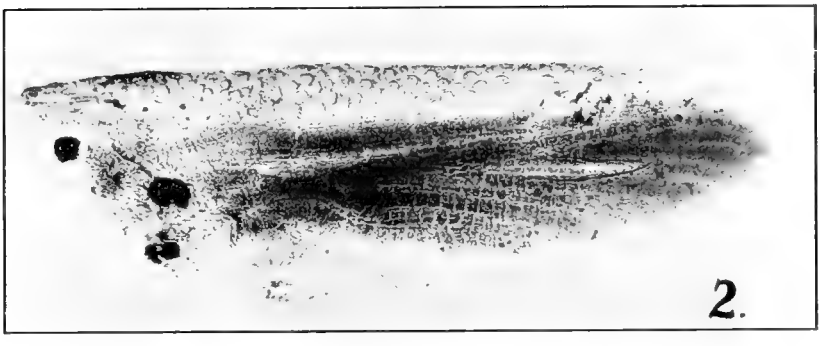
It seems clear that we must now answer this question in Handlirsch's favour. For a more complete blending of Anisopterous with Zygopterous characters, within one single larval type, could scarcely have been hoped for, even by the most ardent supporter of Handlirsch's view. The larval evidence is so strong that, taking it in conjunction with the imaginal characters already known, I have no hesitation now in accepting Handlirsch's Suborder Anisozygoptera; and, consequently, a family *Epiophlebiidae* must also be recognised. Also, as it is clear for many reasons that the fossil type *Heterophlebia*, from the English Lower Lias, is a close ally of *Epiophlebia*, and the same is true of the genus *Triassolestes*, from the Upper Trias of Ipswich, Queensland, it follows that this Suborder is the oldest of the three at present existing, so far as our evidence goes. The fact that we have, in *Heterophlebia*, a type in process of changing from an Anisozygopteron to a true Anisopteron, by formation of a true triangle and supertriangle in the hind-wing, seems to indicate clearly enough that the Anisoptera are descended from the Anisozygoptera; and, indeed, true Anisoptera do not appear in the fossil record before the Upper Lias. There does not seem to be as definite evidence that the Zygoptera are descended from the Anisozygoptera; for there are certainly *some* venational characters, notably the absence of an oblique vein, in which the Calopterygidae still remain more generalised than *Epiophlebia* and its allies. Our decision in this case would probably rest upon what forms amongst the earliest known fossil Odonata we were prepared to accept as Anisozygopterous, on the evidence of their wing-venation, and what forms we considered Zygopterous. Probably the earliest true Odonate type combined the more generalised characters of the Calopterygidae on the one hand with those of the Epiophlebiidae on the other. Such a type

might very well have arisen, in its turn, from that remarkable group of Protodonata of which *Typus permianus*, discovered by Dr. Sellards in the Lower Permian of Kansas[1] was a representative.

[1] *Amer. Journ. Sci.* (4) XX, pp. 249-258 1906.

EXPLANATION OF PLATE XIII.

FIG. 1.—Larva of *Epiophlebia laidlawi* n. sp. (× $4\frac{1}{2}$).
„ 2.—Right forewing of same, dissected off. (× 30).
„ 3.—Right hind-wing of same, dissected off. (× 30).



LARVA OF *EPIOPHLEBIA LAIDLAWI*.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

XIII. *PHAYREA ISABELLINA*, THEOBALD, RE-DESCRIBED.

By Colonel F. Wall, *C.M.G., I.M.S.*

Theobald in 1868 alluded to a snake in his Catalogue of Reptiles in the Asiatic Society's Museum (p. 51) for which he proposed the name *Phayrea isabellina*. His remarks are so brief that they do not amount to a description, and he has made a serious mistake in one very important particular, viz. in the number of the costal rows. Boulenger on the data available made a guess at its identity, and in his Catalogue refers to it under the name of *Psammophis condanarus* (Cat. Vol. III, 1896, p. 165).

I have recently examined the type-specimen in the Indian Museum, and find that it is not an Opisthoglyph species at all, but is nearly allied to the Aglyphous genus *Tropidonotus*. The specimen is faded, and the surface of the scales rubbed, but otherwise is in good preservation.

Description.—Head moderately elongate. Snout moderately rounded. Eye moderate with round (?) pupil. Neck hardly evident. Body of moderate girth and of nearly uniform calibre throughout. Belly rounded. Tail moderate, being about one-fourth the total length.

Lepidosis.—Rostral. Depth about two-thirds the breadth; touching six shields; portion visible above subequal to the suture between the internasals. *Internasals.* Two; the suture between them three-fourths that between the praefrontal pair, four-fifths the internaso-praefrontals. *Praefrontals.* Two; the suture between them about five-thirds the praefronto-frontal sutures; in contact with the postnasal, loreal, praeocular, and supraocular. *Frontal.* Rather longer than the snout, rather shorter than the parietals; in contact with six shields, the fronto-supraocular sutures three times the length of the fronto-parietals. *Nasals.* Divided; the posterior shield rather deeper and longer than the anterior. Nostril entirely in the anterior shield, and in the upper two-thirds of the suture. *Loreal.* Small, square, less than half the length of the nasals. *Praeocular*, one. *Postoculars*, two. *Temporal*, one. *Supralabials*, eight; the second and third touch the loreal, third and fourth the praeocular, fourth and fifth the eye, and the sixth and seventh the temporal. *Posterior Sublinguals.* Subequal to the anterior, touching the fifth and sixth infralabials. *Infralabials*, six, the sixth about three-fourths the length, and twice the breadth of the posterior sublinguals, in contact with two scales posteriorly.

Costals.—In 19 rows two heads-lengths behind the head, 19 in midbody, 17 two heads-lengths before the vent. Vertebrals not

enlarged, smooth. No apical pits or facets. Not emarginate apically. *Ventrals*, 166. Anal divided. *Subcaudals*, 82, divided. *Length*, 520 mm. (1 foot, 8½ inches). *Tail*, 146 mm. (5¾ inches).

Colouration.—Buff dorsally with a dark dorso-lateral stripe beginning on the snout and continuing to the vent. A similar rather broader subcostal stripe. Belly yellowish.

Dentition.—The maxillary dentition is that of the genus *Amphiesma*. The teeth are diacranterian. The praecranterian are anododont, and coryphodont and number dubiously 17. The cranterian are 2, subequal, and about twice the length of the last praecranterian.

Locality.—Bassein, Burma. No. 8730.

I think the species is entitled to rank in a genus apart from *Amphiesma*, the costals not being keeled, and not emarginate. The postoculars are two instead of three, the posterior sublinguals touch three instead of two infralabials, and the 6th infralabial touches only two scales posteriorly.

XIV. NOTES ON LAMELLIBRANCHS IN THE INDIAN MUSEUM.

By B. Prashad, *D.Sc., Offg. Superintendent, Zoological Survey of India.*

(Plate XV.)

3. The Genus *Villorita* Griffith and Pidgeon (= *Velorita*, Gray).

The genus *Villorita*, Griffith and Pidgeon, hitherto known from shell-characters only, has been the subject of interesting controversy. Some of the authorities did not consider it distinct from the genus *Cyrena*, Lamarck, but others, owing to the differences in the shape of the shell and the hinge-teeth in the two genera, separated *Villorita* as a distinct genus. The soft parts now described uphold this latter view.

Iredale[1] recently has rightly questioned the propriety of the name *Velorita*, Gray, by which name the genus was hitherto known in literature. He considers that it should be replaced by Griffith and Pidgeon's name *Villorita*, which was by all subsequent authors regarded as only a misprint for Gray's *Velorita*. A short review of the whole question will not be out of place here. The type-species of the genus was described by Gray[2] as *Cyrena cyprinoides* in 1825, and figured by Wood[3] as *Venus cyprinoides* three years later. Griffith and Pidgeon[4] in 1833 published a figure of Gray's type-specimen under the name *Villorita cyprinoides* with the following meagre description in the alphabetical list of figures "*Villorita cyprinoides*, Gray (*Cyrena cyprinoides*, Wood). Olive green." Iredale assumes from this and the following note in Griffith and Pidgeon's preface "Most of the inedited shells in this work are from the collection in the British Museum" that Gray had, prior to 1833, probably labelled his specimens as *Villorita cyprinoides*, though in his later work[5] he published the name as *Velorita*. Whatever may have been the sequence of events, there is no doubt that Griffith and Pidgeon were the first authors to introduce the name *Villorita* in literature, and their name, prob-

[1] Iredale, *Proc. Malacol. Soc. London* XI, p. 178 (1914); see also *ibid.*, X, pp. 294—309 (1913).

[2] Gray, *Ann. Philosophy*, n.s., IX, p. 136 (1825).

[3] Wood, *Index Test. Supplement*, pl. ii, fig. 14 (1828).

[4] Griffith's *Animal Kingdom*, XII, pl. xxxi, fig. 5 (1834), the date on the plate is 1833.

[5] Gray, *Syn. Brit. Mus.*, p. 149 (1840) and *ibid.*, p. 78 (1842).

ably also the original manuscript name of Gray, must have precedence over Gray's later name *Velorita*.

Gray believed his specimen of *V. cyprinoides* to have come from Japan, but Prime[1] considered it doubtfully to be an inhabitant of the Philippines. The second species *V. cochinensis*[2] was described by Hanley from Cochin on the Malabar Coast of Peninsular India, while Prime[3] was not sure as to the habitat of his new species *V. parvula*. I know of no authentic records of the occurrence of this genus outside the limits of the Malabar Coast in Peninsular India since both Gray's and Prime's localities can not be accepted as correct, and all authentic specimens in the Indian Museum are from the same area. Fischer[4] considered the genus to be strictly confined to India, and Preston[5] following him was of the same opinion though, without giving any reasons, he included the Philippine Islands in the range of distribution of the genus. It appears, therefore, from all authentic records available, that the genus is a true Indian one occurring only in the brackish water areas on the Malabar Coast of Peninsular India.

Leaving aside the scattered references in literature to this genus the only works of importance are (i) Prime's Catalogue of of Corbiculidae (*loc. cit.*), (ii) Sowerby's Monograph in Reeve's Conchologia Iconica, (iii) Clessin's revision of the genus in Martini and Chemnitz's *Conch. Cab.*, and (iv) Preston's account of the two species (*loc. cit.*) and later his description[6] of a new species (*V. delicatula*) from the Cochin backwaters. Prime's earlier papers on the various species are referred to in his later catalogue and need no further remarks, beyond the fact that from his short description it appears that his new species *V. parvula* is probably a young shell of *V. cyprinoides* only. His catalogue includes most of the earlier references on the subject. Sowerby's monograph as was shown in Smith's review[7] is not a work of any importance. Not only are references to the species *V. recurvata* and *V. parvula* omitted, but the species *V. cochinensis* is erroneously referred to Smith instead of Hanley. His descriptions and figures also are very poor and the habitat of the two species dealt with is incorrectly stated. It may be noted here, that *V. recurvata* is not a *Villorita*, but should, as Deshayes and Prime have done, be referred to the genus *Corbicula*. Clessin's Monograph, though better than Sowerby's, appears mainly to be a compilation. No critical analysis of the three species dealt with is given, and was very probably based on an examination of very scanty material of *V. cyprinoides* alone. Preston omits all reference to *V. recurvata* and *V. parvula*, and recognizes two Indian species *V. cyprinoides*

[1] Prime, Cat. Corbiculidae, in *Amer. Journ. Conch.* V, p. 141 (1870).
[2] Hanley, *Proc. Zool. Soc. London*, p. 543 (1858).
[3] Prime, *Ann. Lyceum Nat. Hist. New York* VIII, p. 418 (1867).
[4] Fischer, *Man. Conchyliologie*, p. 1092 (1887).
[5] Preston, *Faun. Brit. Ind., Freshw.-Moll.* p. 209 (1915)
[6] Preston, *Rec. Ind. Mus.* XII, p. 37, figs. 13, 13*a*, *b* (1916).
[7] Smith, *Journ. Conchyliologie*, XXIX, pp. 38—42 (1881).

and *V. cochinensis*. As stated already he later described a new species from the Cochin backwaters as *V. delicatula*. I have examined the types of this species and find that it is based on very young shells; this is discussed fully further on.

The collections in the Indian Museum have recently been greatly enriched by a large series of specimens of both dry shells and spirit preserved specimens from Travancore backwaters on the Malabar Coast received through the courtesy of Mr. N. P. Panickkar of the Travancore Fisheries Department. This large collection has rendered it possible to go into the question of the validity of the different species of the genus, and to describe the soft parts of this interesting genus.

Villorita, Griffith and Pidgeon.

1825. *Cyrena* (in part), Gray, *Ann. Philosophy*, n.s., IX, p. 137.
1828. *Venus* (in part), Wood, *Index Test. Supplement*, pl. ii, fig. 14.
1834. *Villorita*, Griffith and Pidgeon, *Animal Kingdom* XII, pl. xxxi, fig. 5.
1847. *Velorita*, Gray, *Proc. Zool. Soc. London* XV, p. 184.
1853. *Velorita*, Gray, *Ann Mag. Nat. Hist.*, ser. 2, XI, p. 38.
1854. *Velorita*, Deshayes, *Cat. Brit. Mus. Conchifera* II, p. 240.
1858. *Velorita*, Adams, H. and A., *Gen. Rec. Moll.* II, p. 449.
1878. *Velorita*, Sowerby, *Conch. Icon.* XX, p. 1, figs. 1*a*—*c*.
1879. *Velorita*, Clessin, *Cycladea* in Martini-Chemn., *Conch. Cab.*, p. 244.
1887. *Velorita*, Fischer, *Man. Conchyliologie*, p. 1092.
1914. *Villorita*, Iredale, *Proc. Malacol. Soc. London* XI, p. 178.
1915. *Velorita*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, p. 209.

The question regarding the name and the validity of the genus has already been discussed in the introductory part. A detailed description of the genus was given by Fischer and a translation of it in English will be found in Preston's volume. No accurate description of the hinge has so far been published, I have, therefore, thought it desirable to give a detailed description of the two valves separately.

Right valve.—Anterior lateral tooth short and thick, nearly straight or only slightly slanting, with its posterior edge cut off at an obtuse angle and having a rather deep groove above it for the fitting in of the elbow-shaped anterior lateral tooth of the left valve; posterior lateral elongate, about $1\frac{1}{2}$ times as long as the anterior, somewhat blade like and extending up to the anterior border of the scar of the adductor muscle; of the three cardinal teeth, middle one best developed and the anterior one very small and feeble, all three slanting in an antero-posterior axis.

Left valve.—Anterior lateral fairly large, elbow-shaped, separated from the margin of the shell by a narrow chink but having a deep groove for the anterior lateral of the right valve, posterior lateral less developed than in the right valve, somewhat curved, arising as a thick ridge out of a cavernous hollow; of the three cardinal teeth the posterior most is the most feebly developed while the middle is the stoutest.

The muscle-scar for the anterior adductor muscle is somewhat pressed in below the anterior lateral tooth and is fairly deeply impressed, while that of posterior adductor is quite shallow. The palleal line shows a distinct though poorly developed sinus in its course very near its origin from the posterior adductor impression.

Soft parts.—A detailed description of the soft parts is given further on; the following characters may, however, be noted:—animal with the mantle having a regular row of finger-shaped papillae on its inner surface slightly internal to the edge; two siphons of moderate size, the anal much the shorter; siphonal orifices papillose; foot triangular, acutely pointed at the apex, rather large but not very muscular; gills of unequal size, inner much broader; palpi triangular, elongate.

As a result of a careful study of the large collection before me I am unable to recognize *V. cochinensis*, *V. parvula* and *V. delicatula* as species distinct from *V. cyprinoides*. Both *V. cochinensis* and *V. delicatula*, however, are sufficiently characterized to be designated as distinct varieties, while *V. parvula*, from its meagre description of the unique type of Prime, appears to be only based on young shells of *V. cyprinoides*. I also take this opportunity to describe a very characteristic new species from Travancore under the name *V. cornucopia*.

Villorita cyprinoides (Gray).

Plate XV, figs. 1—4.

1825. *Cyrena cyprinoides*, Gray, *op. cit.*, p. 136.
1828. *Venus cyprinoides*, Wood, *op. cit.*, pl. ii, fig. 14.
1834. *Villorita cyprinoides*, Griffith and Pidgeon, *op. cit.*, pl. xxxi, fig. 5.
1854. *Velorita cyprinoides*, Deshayes, *op. cit.*, pp. 240, 241.
1870. *Velorita cyprinoides*, Prime, *op. cit.*, p. 141.
1878. *Velorita cyprinoides*, Sowerby, *op. cit.*, p. 1, figs. 1*a*, 1*b*, 1*c*.
1879. *Velorita cyprinoides*, Clessin, *op. cit.*, p. 244, pl. xlii, figs. 3, 4.
1915. *Velorita cyprinoides*, Preston, *op. cit.*, p. 209.

I give below a full description of the *forma typica*, as the previous descriptions of the species are not quite complete.

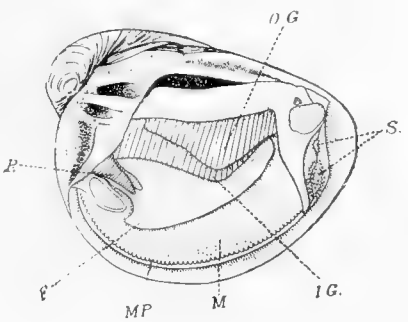
Shell fairly large, somewhat trigonal, cordate, very oblique; swollen in the umbonal and middle regions of the shell, greatly compressed below, umbones lying near the anterior margin being recurved anteriorly and somewhat inwards, hollow, separated from the hinge and one another by a narrow chink only; anterior margin short, regularly curved above, nearly straight in the middle, then rapidly curving backwards in continuation of the ventral border; the latter greatly curved upwards posteriorly to meet the posterior side in an acuminate or narrowly rounded point; posterior side nearly straight, much larger than the anterior and with a low keel; shell very thick with concentric ridges better marked in the anterior than in the posterior half, umbones also striated, often weathered; a narrow lunule anteriorly and a large, thick external ligament posteriorly; hinge as in the genus; epidermis olivaecous

to dark brown or even black, nacre whitish, light yellow near the margin and having a violet border.

Geographical Distribution.—The species, so far as is known, is endemic in Peninsular India on the Malabar Coast only. It occurs in brackish water areas though specimens are sometimes carried into nearly fresh water.

Soft parts.—The animal is somewhat trigonal, but the greater part of the umbonal region is occupied by a triangular structure formed by the union of the mantle flaps of the two sides only, the rest of the soft parts being somewhat elliptic in outline and lying below this hollow structure. Specimens preserved in spirit are of a whitish colour with dark brown black border in the region of the mantle papillae on the inner surface only, but seen through the translucent mantle flaps, the adductor muscles are dark yellow.

The mantle is very thin and translucent up to the palleal junction, below which, owing to the large numbers of radiating muscle fibres, it becomes much thicker; in the region of the papillae it is very thick and opaque. The border is entire without any papillae on the edge, but a continuous row of small finger-like papillae of a dark brownish colour with whitish tips is present on the internal surface a little distance from the margin. The papillae are of the same size throughout, and are not reduced in the middle region of the bucco-pedal orifice as in the genus *Corbicula*.[1] The papillae are also present on the line of union of the mantle flaps in the siphonal region above and below the two siphonal orifices. The two mantle flaps are united with each other anteriorly to a little above the anterior adductor muscle, the two then separate but in the region of the muscle itself the free portion is not very broad owing to the muscle lying near the border; behind the muscle, however, the two flaps are quite separate forming the large bucco-pedal orifice, which extends posteriorly in line with the posterior margin of the posterior adductor muscle. From the point of termination of the bucco-pedal orifice the siphonal orifice starts. The flaps of the mantle are united in this region in the situation of the mantle papillae except for the openings of the two siphons; the line of union is indicated by the row of papillae in this region.



TEXT-FIG. 1.—Soft parts of *V. cyprinoides* (Gray).

F. = foot; *I. G.* = inner gill; *M.* = mantle; *M. P.* = mantle papillae; *O. G.* = outer gill; *P.* palp; *S.* = siphons.

[1] Prashad, *Rec. Ind. Mus.* XVIII, pp. 209—211 (1920).

Above the siphonal orifice, which terminates about the middle of the posterior adductor muscle, the two flaps are again united intimately as on the anterior margin.

Of the two siphons the upper or the anal siphon is about two-thirds the size of the lower or branchial siphon. Both the siphons are fully retracted in the preserved specimens, but from their structure appear to be sufficiently extensile. The anal siphon has only a single circle of papillae surrounding the orifice, but the branchial has in addition another circle of much larger papillae situated inside the smaller papillae. Both the siphons are of a dark brown colour.

The two adductor muscles are of about the same size, but the posterior is more internally situated. The retractor muscles are similar to those of *Corbicula*. The radiating muscles of the mantle have already been mentioned; they arise from the palleal line and are connected with the papillae of the mantle. The siphonal retractor fibres are distinctly marked off from the rest and are connected with the siphonal sinus.

The attachments of the two pairs of gills are similar to those in the genus *Corbicula* except that a very narrow chink-like opening is distinguishable between the united edge of the inner lamellae of the inner pair of gills and the foot. The outer pair of gills is much narrower than the inner pair particularly in the anterior half.

The two pairs of palps are rather narrow, elongately triangular in outline; they are attached at the base with the apex pointing backwards and downwards. The surface of the palps is marked with very fine transverse ridges.

The abdominal mass is comparatively small, while the foot is of a fair size, not very thick, triangular and acutely pointed at the apex.

Var. **cochinensis** (Hanley).

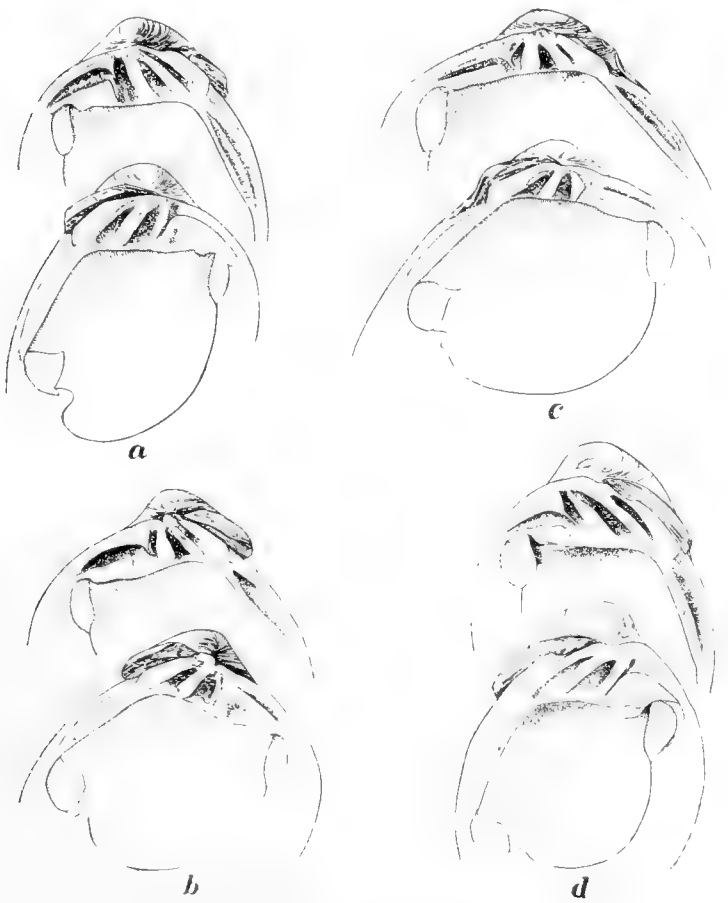
Plate XV, figs. 5—8.

1858. *Cyrena cochinensis*, Hanley, *Proc. Zool. Soc. London* XXVI, p. 543.
1860. *Cyrena corbiculiformis*, Prime, *Proc. Acad. Nat. Sci. Philadelphia*, p. 80.
1860. *Corbicula Quilonica*, Benson, *Ann. Mag. Nat. Hist.*, 3rd ser. VI, p. 260.
1866. *Velorita cochinensis*, Hanley, *Ann. Lyc. Nat. Hist. Soc. New York* VII, p. 236, fig. 66.
1870. *Velorita cochinensis*, Prime, *op. cit.*, p. 141.
1878. *Velorita cochinensis*, Sowerby, *op. cit.*, p. 1, figs. 2*a*, 2*b*.
1879. *Velorita cochinensis*, Clessin, *op. cit.*, p. 225, pl. xxxvi, figs. 5, 6.
1915. *Velorita cochinensis*, Preston, *op. cit.*, p. 210.

Hanley's original description is very complete and needs no amplification. With a large collection before me I have found it impossible to consider Hanley's *V. cochinensis* as a species distinct from *V. cyprinoides*. The differences, however, are quite sufficient to recognize it as a distinct variety. These are:—(i) more centrally situated and less oblique umbones, (ii) much shorter and

more regularly curved anterior side, (iii) greatly reduced lunules, and (iv) the ridges on the surface more marked than in the typical form, but quite obsolete near the margins.

Geographical Distribution.—Hanley's specimens were collected in Cochin, while in the British Museum there are specimens from the Malabar Coast (precise locality not stated). In the Indian



TEXT-FIG. 2.—Hinge-teeth of *Villorita*, Griffith and Pidgeon.
(*a*) *V. cyprinoides* (Gray), typical form.
(*b*) *V. cyprinoides* var. *cochinensis* (Hanley).
(*c*) *V. cyprinoides* var. *delicatula* (Preston).
(*d*) *V. cornucopia*, Prashad.

Museum there are specimens from Beypore, south end of Vembanaad Lake, Travancore, and from various backwaters in Travancore. It appears, therefore, that the range of this variety is the same as that of the typical form of *V. cyprinoides*.

The soft parts are similar to that of the typical form.

Var. **delicatula** (Preston).

Plate XV, figs. 9, 10.

1916. *Velorita delicatula*, Preston, *Rec. Ind. Mus.* XII, p. 37, figs. 13, 13*a*, *b*.

Preston described his new species from a series of four very young shells, one of these he designated as the type of his new species and the others as the co-types. The Indian Museum has since received many adult shells from Travancore, all of which show the distinctive characters of the young shells. As a result of the study of this large collection I do not think that Preston's species can be considered as distinct from *V. cyprinoides*, though it must be designated as a distinct variety. The name *delicatula*, however, is unfortunate, since the full-grown shells are no more delicate than those of the *forma typica*, some indeed are even thicker and stouter.

The main distinguishing characters of this variety are the more triangular shape of the shells due to a great elongation in the antero-posterior axis and a corresponding shortening in altitude, the greatly produced posterior angle due to the posterior side being much longer, sloping rapidly backwards and meeting the distinctly rostrate lower margin in an angularly rounded point. The umbones though very oblique in the young shells are less so in adults and the lunule becomes more marked while the ligament becomes comparatively shorter. The hinge differs from that of the typical form in having all the teeth more delicate and much sharper, the laterals more slanting and the posterior laterals more elongate.

Geographical Distribution.—The type-series of young shells was collected in Cochin, in backwater near Ernakulam, while the adult shells are all from backwaters in Travancore. A full grown shell measures 32·2 mm. in length, 26 mm. in height and 20·5 mm. in maximum thickness.

The soft parts are identical with those of the typical form.

Villorita cornucopia, sp. nov.

Plate XV, figs. 11—14.

The shell of this species is large, subovoidal, very high and comparatively narrow, with a very prominent umbonal region; dark brown to black; both valves sculptured in the umbonal region with coarse concentric ridges, which become obsolete lower down, and are represented by the lines of growth only; part of the inwardly curved region of the umbones eroded; umbones solid, comparatively broad and high, retroverted inwards and somewhat to the anterior side; dorsal margin broadly arched, but the greater part of it hidden behind the prominent umbones; anterior margin comparatively long and regularly curved, a little below the middle the curve becomes very sharp and is continued

with the nearly straight ventral margin; posterior margin much longer than the anterior, very gradually sloping downwards and meeting the ventral margin in a broadly rounded angle, lunule very small or even absent, ligament very long and thick; hinge as in the genus but with short and nearly transverse anterior laterals and very long, curved posterior laterals; anterior adductor scar greatly impressed, that of the posterior adductor only feebly marked; palleal line greatly curved upwards anteriorly and with a very shallow sinus; nacre whitish with a narrow and indistinct violet band on the margin.

Measurements (in millimetres).

	1	2
Length	31·8	31
Height	44·6	41·8
Thickness	33·7	31·2

Type-specimen—No. M 11896/2 in the registers of the Zoological Survey of India (Indian Museum).

Locality.—Two dry shells of this species were collected by Mr. N. P. Panickkar at Komarakam in the Vempanad backwater, Travancore, with a large series of specimens of *V. cyprinoides*. The shells of the genus *Villorita* are locally known in those parts as *kayal kaka* or backwater shells, no distinction being made between the various species.

Remarks.—This new species is distinguished by the shells being much higher than broad, the very prominent and recurved umbones, irregular sculpture and the different type of hinge.

EXPLANATION OF PLATE XV.

Estuarine shells of the genus *Villorita*.

All the figures are natural size photographs of dry shells.

V. cyprinoides (Gray).

FIG. 1.—Right valve of an adult specimen from the Travancore backwaters.

,, 2.—Left valve of the same.

,, 3.—Right valve of a half-grown specimen from Beypore River, Malabar Coast.

,, 4.—Left valve of the same.

V. cyprinoides var. **cochinensis** (Hanley).

FIG. 5.—Right valve of an adult shell from the Malabar Coast.

,, 6.—Left valve of the same.

, 7.—Right valve of a half-grown specimen from the Travancore backwaters.

,, 8.—Left valve of the same.

V. cyprinoides var. **delicatula** (Preston).

FIG. 9.—Right valve of an adult shell from the Travancore backwaters.

,, 10.—Left valve of the same.

V. cornucopia, Prashad.

FIG. 11.—Right valve of the type-shell.

,, 12.—Left valve of the same.

,, 13.—Right valve of the co-type.

,, 14.—Left valve of the same.

(Both the above specimens are from the Travancore backwaters.)

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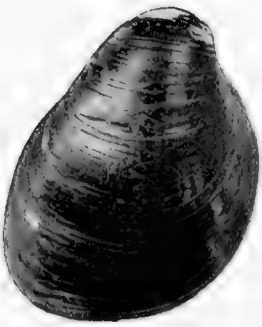

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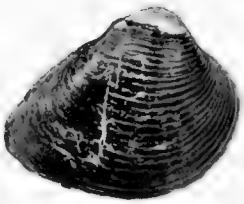

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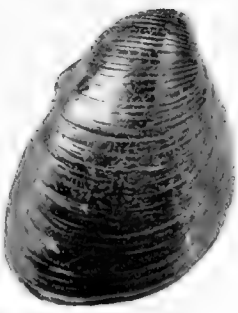

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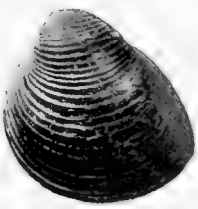

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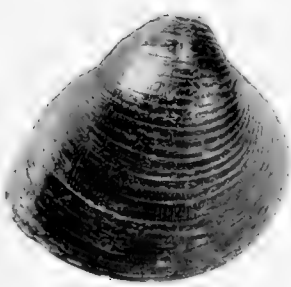

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S. C. Mondul, photo

VILLORITA.

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XV. THE INDIAN MOLLUSCS OF THE ESTUARINE SUBFAMILY STENOTHYRINAE.

By N. ANNANDALE, *D.Sc., F.A.S.B., Director and* B. PRASHAD, *D.Sc., Offg. Superintendent, Zoological Survey of India.*

(Plate XVI).

Among the estuarine Gastropods of the coasts of India, Malaysia and China few are commoner and more characteristic, but smaller and less conspicuous, than the Hydrobiidae of the subfamily Stenothyrinae. These little water-snails, the shell of which is rarely more than 5 mm. long, are found mainly in brackish water. A few make their way far inland, but it is doubtful whether any species [1] exists only in fresh water. The species seem to be fairly numerous and individuals are often abundant. Their habits are very uniform. They frequent submerged vegetation or stones covered with algae and scrape therefrom the minute organisms that form their food. Their mobile and extensile snouts enable them also to feed easily on the algae that grow on the shells of their companions and even on their own. The eggs are sessile, relatively large and few. Some species are markedly gregarious. In eastern waters they apparently replace the Hydrobiinae of the western parts of the Palaearctic Region.

Subfamily *STENOTHYRINAE.*

1887. Stenothyrinae, Fischer, *Man. Conchyliol.*, p. 724.

Fischer includes in this subfamily of the Hydrobiidae two fossil genera (*Briartia* and *Nystia*) as well as the living *Stenothyra*. His description is short and he does not appear to have been acquainted with some of the most characteristic features of the shell or the animal. The subfamily, however, is well differentiated from both the Bithyniinae and the Hydrobiinae and has no particular resemblance to the Mysorellinae. It may be redefined as follows:—

SHELL minute, ovate or subcylindrical, *compressed in its dorso-ventral axis;* the aperture small, oblique or transverse, oval or subcircular, with a complete and uniform peristome, which is never very prominent or incrassate. The surface smooth, rarely ornamented with periostracal spines, more commonly with minute punctures arranged in spiral lines.

OPERCULUM horny but containing a considerable amount of calcareous matter, paucispiral externally, *with two prominent transverse ridges on the internal surface.*

[1] *S. foveolata*, Benson, is only known from Sikrigalli, a distance of 300 miles from the sea and about 200 miles above the extreme tidal influence, but the species may occur lower down as well in the Gangetic Delta.

Radula as in the Bithyniinae but with the teeth relatively broader and the laterals and marginals less differentiated, baso-lateral denticulations present on the centrals.

Soft parts. Foot long and narrow when expanded, *spindle-shaped*, pointed or produced behind, with the antero-lateral angles produced and the anterior margin excavate or truncate. *Snout cylindrical, extremely mobile and extensile.* Tentacles filiform, bearing the eyes on slight prominences at their base. *Penis without a lateral process.*

The statements in italics in this description serve to differentiate the subfamily. The small size of the shells causes them to resemble those of the genus *Hydrobia* (*Paludestrina*) superficially, but their peculiar compressed form is most characteristic, while the structure of the operculum and that of the central tooth of the radula are different. With the Bithyniinae they agree in the structure of the radula but not in other characters.

The position of the subfamily, at least so far as the genus *Stenothyra* is concerned, may now be discussed. Benson [1] in describing the genus did not assign it to any family or subfamily. Woodward [2] included it amongst the Littorinidae as a subgenus of *Rissoa*. Gray [3] followed Woodward in retaining *Nematura* in the Littorinidae but differed from him in giving it a generic rank. Adams [4] placed it among the Viviparidae and the same course was adopted by von Frauenfeld.[5] Troschel [6] who still designated the genus as *Nematura* placed it with *Bythinia* in his group Bythiniae. Stimpson [7] recognised its exact position more nearly, but guided by both the shell and radular characters placed it in the subfamily Hydrobiinae. Clessin,[8] after discussing the courses adopted by previous authors, separated the subfamily Bythiniinae from the Hydrobiinae, both of which he included in the family Rissoidae, and placed the genus *Stenothyra* in the subfamily Bythiniinae. Nevill, [9] following Adams and von Frauenfeld, assigned it to the family Viviparidae or what he called the Paludinidae, while as to its subfamily rank he agreed with Stimpson in including it amongst the Bythiniinae. Fischer [10] as already stated separated *Stenothyra* with two fossil genera into a new subfamily of the Hydrobiidae-Stenothyrinae. Heude [11] placed the Chinese *Stenothyra* amongst the Bithyniidae. The species from the Dutch East Indies were assigned by von Martens [12] to the family Paludinidae, but nothing was said as to their subfamily rank. Fischer and Dautzenberg [13]

[1] Benson, *Journ. As. Soc. Bengal*, V, p. 782 (1836), and *Ann. Mag. Nat. Hist.* XVIII, p. 496 (1856).
[2] Woodward, *Manual of Mollusca*, p. 137 (1851—1856).
[3] Gray, *Guide Syst. Dist. Moll. Brit. Mus.* I, p. 99 (1857).
[4] Adams, H. and A., *Genera of Recent Mollusca* I, p. 342 as *Nematura* (1858).
[5] von Frauenfeld, *Verh. Zool.-bot. ges. Wien*, XII, pp. 1157, 1158 (1862).
[6] Troschel, *Gebiss der Schnecken* I, p. 104 (1856—1863).
[7] Stimpson, *Smithsonian Misc. Pub.* No. 201, p. 40 (1865).
[8] Clessin, *Malakozool. Blatt.* n. s. II, p. 193 (1880).
[9] Nevill, *Hand-List Moll. Ind. Mus.* II, p. 42 (1885).
[10] Fischer, *Man. Conchyliol.* p. 724 (1887).
[11] Heude, *Mem. Hist. Nat. Chinois* I, p. 173 (1880—1890).
[12] von Martens, *Suss-und Brackw.-Moll.* in *Zool. Ergeb. Nieder. Ost. Indien* IV, p. 210 (1897).
[13] Fischer and Dautzenberg, *Mission Pavie Indo-China*, p. 420 (1904).

included it in the family Hydrobiides. Preston [1] followed Fischer in keeping Stenothyrinae as a subfamily of Paludestrinidae (=Hydrobiidae). We have already given our reasons for following Fischer.

The position of the fossil shells assigned to the subfamily by Fischer is doubtful. The Indian, Chinese and Malaysian species we have examined belong to the single genus *Stenothyra*, Benson, which seems to be divisible into two subgenera, which we call *Stenothyra* (*s.s.*) and *Astenothyra* nov.

The subgenera may be distinguished on shell-characters [2] as follows:—

1. Ventral surface of body-whorl flattened; mouth very small, not at all prominent, separated from the outer edge of the shell above by a well-defined triangular area ... ... *Stenothyra.*
2. Ventral surface of body-whorl convex; mouth larger and slightly prominent, less regular in outline; area separating it from the edge of the shell small and ill-defined ... ... *Astenothyra.*

Genus **Stenothyra**, Benson.

The shell is small, rarely [3] exceeding 5 mm. in length, but relatively thick, ovate or subcylindrical, distinctly compressed in the dorso-ventral axis, with at least 4 whorls, without prominent sculpture. The umbilicus is closed or rimate. The aperture is relatively broad, ovate, oval or subcircular, oblique or transverse. The peristome is continuous and uniform, never prominent and barely thickened. The periostracum is well developed.

The operculum is horny, but thick and containing much calcareous matter, very brittle, paucispiral on the external surface. The internal surface is somewhat convex, smooth and polished with a thickened rim. On it are developed two short, prominent tranverse ridges, situated nearer the upper and lower extremities than the centre. In the complete shell the operculum fits tightly into the mouth, but in periods of active growth it is retracted as far as the old peristome.

The radula.—The central tooth is broad and has an enlarged central cusp with much smaller lateral cusps on either side. It is produced into a lateral process on either side and each process bears a series of latero-basal denticulations. The outer teeth are also relatively broad and have their denticulations rather poorly developed. There is an enlarged central or internal cusp on the inner lateral.

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[1] Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 79 (1915).

[2] In differentiating shells of this subfamily (and, indeed, those of all Hydrobiidae) it is important that fully formed specimens should be selected. Those collected in periods of active growth have the peristome incomplete. The operculum, moreover, can be retracted as far as the old mouth and has its margin distinctly ciliate.

[3] The shells of the Bornean species *S. strigilata*, Benson, measure as much as 8 mm. in length.

The soft parts.—The foot is long and narrow, fusiform as a whole but with the antero-lateral angles produced. The posterior extremity is pointed or produced into a filament. The central region of the sole is somewhat dilated, the dilation corresponding with the position of the operculum on the upper surface. The snout is long and cylindrical, extremely mobile and extensile. The tentacles are filamentous and have the eyes situated on slight prominences at their base. The male organ, which is situated on the " neck," lacks a lateral appendage.

Subgenus **Stenothyra**, s.s.

1836. *Nematura*, Benson, *Journ. As. Soc. Bengal* V, p. 781.
1856. *Stenothyra*, Benson, *Ann. Mag. Nat. Hist.* ser 2, XVII, p. 496.
1857. *Nematura*, Gray, *Guide Syst. Dist. Moll. Brit. Mus.* I, p. 90.
1858. *Nematura*, Adams, H. and A., *Genera Rec. Moll.* I, p. 342.
1858. *Stenothyra, ib., id.*, II, p. 626.
1862. *Nematura*, von Frauenfeld, *Verh. Zool.-bot. ges. Wien* XII, pp. 1157, 1158.
1865. *Stenothyra*, Stimpson, *Smithsonian Misc. Pub.* No. 201, p. 40.
1885. *Stenothyra*, Nevill, *Hand-List Moll. Ind. Mus.* II, p. 42.
1887. *Stenothyra*, Fischer, *Man. Conchyliol.*, p. 731.
1915. *Stenothyra*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 79.

The body-whorl of the shell is distinctly flattened on the ventral surface and the aperture is relatively small and not at all prominent, the peristome being not at all or only slightly thickened or dilated and of regular subcircular or oval outline. The upper and outer region of the mouth is separated from the outer edge of the whorl by a well-defined *boss* or triangular area that is usually more or less tumid. The periostracum is relatively thin and, except for the frequent occurrence of punctured lines and of the horny spines in some species, smooth. The operculum is oval or subcircular. The radula has the generic characters well developed. The foot is produced into a filament behind.

Type-species.—*Stenothyra deltae* (Benson).

The species of this subgenus have hitherto stood in need of revision, and in recent years several quite unnecessary names have been set up by Preston. The number actually known from the coasts of India have, therefore, proved, as Annandale and Kemp suggested,[1] smaller than had been supposed, but we have to describe several hitherto undescribed forms.

We can now recognise 12 Indian species but are doubtful about the Burmese species described as *Nematura puncticulata* by Gould.[2] Of these species we have examined the types in most cases and authentic specimens in others. The Indian species, with the exception of Gould's *Nematura puncticulata*, which we are unable to recognise, may be distinguished by the help of the following key :—

[1] Annandale and Kemp, *Mem. Ind. Mus.* V, p. 345 (1916).
[2] Gould, *Proc. Boston Nat. Hist. Soc.* II, p. 220 (1847).

I. Shell bearing a spiral row of large spines on some of the whorls in addition to the microscopic sculpture.
  A. Spines restricted to basal whorls of the spire only; the whorls evenly inflated and not keeled — *S. echinata.*
  B. Spines present on almost all the whorls including the body-whorl; the whorls especially those of the spire ridged or keeled in the middle — *S. ornata.*

II. Shell without any definite spines, with or without a definite spiral sculpture.
  A. Shell elongate-ovate, nearly cylindrical.
    I. Shell rather small and narrow ($2\frac{1}{2} \times 1\frac{1}{8}$ mm.); subperforate, rimate; with the whorls of the spire increasing regularly and having a microscopic sculpture ... ... — *S. hungerfordiana.*
    II. Shell much larger ($4\frac{1}{2} \times 3$ mm.), imperforate; with the whorls of the spire increasing irregularly and with relatively large pits on the surface of the shell ... ... — *S. monilifera.*
  B. Shell ovate or ovoid never elongate cylindrical.
    I. Mouth opening large, more than $\frac{1}{3}$ the size of the body-whorl.
      A. Body-whorl not at all flattened on the ventral surface, and with a very small boss separating the mouth from the body-whorl ... — *S. soluta.*
      B. Body-whorl distinctly flattened on the ventral surface, at least in its anterior half, and with a well-developed boss separating the mouth from the body-whorl.
        1. Shell small (1·4 mm. long), with a very short spire and with a well-developed boss above an elongate circular mouth ... ... — *S. atomus.*
        2. Shell large, over 3 mm. long, subventricose-ovate, with a short spire, the whorls of the spire increasing irregularly; a greatly swollen body-whorl and a biangulate suboval mouth ... ... — *S. blanfordiana.*
        3. Shell large, 3 mm. long, elongate-ovate; the spire more produced, with regularly increasing whorls; body-whorl less tumid and the mouth nearly circular or having only a faint notch above ... ... — *S. minima.*
    II. Mouth-opening small, less than $\frac{1}{3}$ the size of the body-whorl.
      A. Shell without any spiral pitted sculpture ... — *S. woodmasoniana.*
      B. Shell with a definite spiral pitted sculpture.
        1. Shell minute, 2·2 mm. long, with a very short spire and a bluntly rounded apex ... — *S. nana.*
        2. Shell relatively large, with a prominent conical spire and an acuminate apex.
          a. Shell globose-conical, having a large and swollen body-whorl, and with a well-developed boss ... ... — *S. deltae.*
          b. Shell ovate, acute, having a smaller and not greatly swollen body-whorl, and with a much smaller boss ... ... — *S. foveolata.*

Stenothyra echinata, Annandale and Prashad.

1919. *Stenothyra echinata*, Annandale and Prashad, *Rec. Ind. Mus.* XVI, p. 247, pl. xx, fig. 5.

S. echinata, as was noted in the original description of the species, is closely allied to *S. deltae* (Benson), which also shows traces of spines in some specimens, but is easily distinguished by

its much smaller size, narrower and less inflated body-whorl and the larger but relatively broader mouth.

Stenothyra ornata, sp. nov.

Plate XVI, figs. 1, 2.

The shell in this species is relatively large, conoidal-ovate in form, and of a brownish colour. The apex is acutely pointed, and the shell has $5\frac{1}{2}$ whorls. The suture is moderately impressed, somewhat oblique but irregular. The whorls of the spire are distinctly keeled in the middle and a continuation of the keel is to be made out on the body-whorl as well; they increase regularly in size but owing to their keeled nature do not appear to be very much swollen. The first two whorls are rather minute, the third is about as broad as the penultimate, which is somewhat band-shaped. The body-whorl, as seen from the dorsal side, is sub-quadrate, ventrally it appears to be somewhat ovoidal with the inverted apex sharply truncated. The mouth of the shell is very minute, oblique and regularly subcircular. The rim of the mouth does not project at all and the shell is not umbilicate. All the whorls are covered with a clayey deposit, but in some places show distinct vertical vermiform striae of a darker colour. The last 4 whorls have a persistent spiral row of fairly large, blunt, flattened, horny spines in the region of the keel; the spines are directed towards the apex and are of a blackish colour.

Measurements of type-shell (in millimetres).

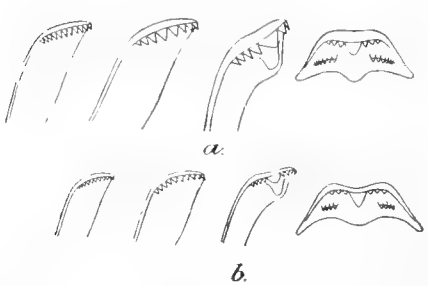
Length	5
Breadth of the body-whorl	3·2
Length of the spire (dorsal view)	2·7
Aperture	1·3

We figure the radular teeth.

Type-specimen.—No. M 11565/2 in the collections of the Zoological Survey of India (Indian Museum).

Locality.—Two shells of this species were collected by Dr. S. W. Kemp in a pool of brackish water at Dhappa near Calcutta.

Remarks.—The species is closely allied to *S. deltae* (Benson) and *S. echinata*, Annandale and Prashad, but is distinguished by the larger and more acute spire, the form of the body-whorl, the keeled nature of the whorls, the sculpture and by the comparatively shorter and more circular mouth.



Text-fig. 1.—Radular teeth of *Stenothyra*, Benson.
(*a*) *S.* (*S.*) *ornata*, sp nov. ×250.
(*b*) *S.* (*A.*) *miliacea* (Nevill) ×500.

Stenothyra hungerfordiana, Nevill.

1880. *Stenothyra hungerfordiana*, Nevill, *Journ. As. Soc. Bengal*, XLIX, pt. ii, pp. 159, 160.
1881. *Stenothyra hungerfordiana*, *ib.*, *id.*, L, p. 156, pl. vii, fig. 9.
1885. *Stenothyra hungerfordiana*, Nevill, *op. cit.*, II, p. 44.
1915. *Stenothyra hungerfordiana*, Preston, *op. cit.*, p. 80.

This interesting species was hitherto known from the original specimens collected in the Andaman Islands by the late Dr. F. Stoliczka and Rev. J. Warneford, but we have found another young specimen in the Indian Museum, also collected in the Andamans (precise locality and donor not stated), which had been wrongly labelled as *S. minima* (Sowerby). The types are preserved in the Indian Museum, but according to Nevill the species was also represented in the collections of Dohrn, Warneford, Theobald, Blanford and Hungerford.

Nevill's description of the species is excellent, and we have nothing to add to it. The distinguishing characters of the species are also well shown in the figure in his second paper cited above.

Stenothyra monilifera, Benson.

1856. *Stenothyra monilifera*, Benson, *op. cit.*, p. 497.
1858. *Stenothyra monilifera*, Adams, H. and A., *op. cit.*, II, p. 626.
1862. *Nematura monilifera*, von Frauenfeld, *op. cit.*, XII, p. 1159.
1864. *Stenothyra monilifera*, Crosse and Fischer, *Journ. Conchyliol.* XII, p. 331.
1867. *Stenothyra monilifera*, Blanford, *Journ. As. Soc. Bengal* XXXVI, pt. ii, p. 58, pl. xiii, fig. 15
1875. *Stenothyra monilifera*, Morelet, *Ser. Conchyliol.* IV, p. 314.
1876. *Stenothyra monilifera* (as *Nematura* in *Syst. Ind.*), Hanley and Theobald, *Conch. Ind.* p. 17, pl. xxxvii, fig. 4.
1876. *Stenothyra monilifera*, Theobald, *Cat. Land. and Freshw. Shells India*, p. 15.
1885. *Stenothyra monilifera*, Nevill, *op. cit.*, II, p. 44.
1915. *Stenothyra monilifera*, Preston, *op. cit.*, p. 80.

S. monilifera was described by Benson from specimens collected by the late Mr. W. Theobald at Mergui, Tenasserim. The same collector had also found specimens at Rangoon. Blanford obtained specimens at Port Dalhousie in the Bassein River, Burma. Crosse and Fischer recorded its occurrence in a marshy area in Cochin-China. In the Indian Museum collection the species is represented by specimens from Akyab, Amherst and Penang.

Benson's description of the species needs no amplification, while in Blanford's and Hanley and Theobald's figures the species is delineated very well.

Nevill doubtfully considered *S. puncticulata* (Gould) as being synonymous with this species; we discuss this at length in our remarks on that species (p. 133).

The species is closely allied to *S. hungerfordiana*, Nevill, but is distinguished by the shell being much larger, the shape of the body-whorl, the irregular increase of the whorls and the sculpture.

Stenothyra soluta, Annandale and Prashad.

1919. *Stenothyra soluta*, Annandale and Prashad, *Rec. Ind. Mus.* XVI, pp. 247, 248, fig. 3; pl. xx, fig. 6.

We have nothing to add to our recent account of the species beyond noting the intermediate character of the shell, so far as the form of mouth and the narrow boss are concerned, between the forms separated by us into the subgenera *Stenothyra, s.s.* and *Astenothyra*. *S. soluta*, however, has a closer relationship with other species of the subgenus *Stenothyra* than with any of the known forms of *Astenothyra*. Its existence prevents us from separating *Astenothyra* generically.

Stenothyra atomus, Nevill, MS. (Prashad).

Plate XVI, figs. 3, 4.

1885. *Stenothyra*, n. sp., Nevill, *op. cit.*, p. 45.

In the reference cited above Nevill referred to a single specimen from Arakan, Burma, in the collections of the Indian Museum, as a new species of *Stenothyra*. He called this species by the name *S. atomus* on a label, but did not publish any description or figure of it. I describe it here under Nevill's manuscript name.

The shell of this species is very small, thick, and in the single specimen bleached white. It is of a regularly ovoid form with the body-whorl only slightly flattened ventrally in its anterior half. The apex is obtuse and there are $4\frac{1}{2}$ whorls. The suture is moderately impressed, but much less so dorsally than ventrally. The whorls of the spire increase rapidly and irregularly; the first whorl is very minute, the second is fairly prominent but narrow, while the penultimate whorl is much larger, band-shaped and moderately inflated. The body-whorl is large but rather narrow, in dorsal view it has a somewhat triangular outline owing to the outer border forming a continuous curve with the lower margin, the inner margin is also regularly curved; seen from the ventral side it appears somewhat pyriform. The mouth is subcircular or rather elongate-circular, with a thickened margin which, however, does not show any trace of being recurved No sculpture can be made out in the unique type.

Measurements of type-shell (in millimetres).

Length	.. 1·4
Breadth of the body-whorl ..	.. ·8
Length of the spire (dorsal view)	.. ·65
Aperture	.. ·4

Type-specimen.—No. 2214 in the collections of the Zoological Survey of India (Indian Museum).

Locality.—The only specimen of this species we have seen is the unique type from Arakan, Burma collected by the late Dr. F. Stoliczka.

Remarks.—The species, though allied to *S. minima*, is distinguished easily from the latter by the spire being very short and

ending in an obtuse apex, the boss being well developed, and by the mouth being nearly round.

Stenothyra blanfordiana, Nevill.

1880. *Stenothyra blanfordiana*, Nevill, *op. cit.*, p. 160.
1881. *Stenothyra blanfordiana*, Nevill, *op. cit.*, p. 156, pl. vii, fig. 10.
1885. *Stenothyra blanfordiana*, Nevill, *op. cit.*, p. 45.
1907. *Bithinella canningensis*, Preston, *Ann. Mag. Nat. Hist.*, ser. 7, XIX, p. 216, fig. 6.
1914. *Stenothyra chilkaënsis* and *S. orissaënsis* (in part not the fig.), Preston, *Rec. Ind. Mus.* X, p 300, fig. 1.
1915. *Stenothyra blanfordiana*, *S. chilkaënsis*, *S. orissaënsis* and *S. minima* (in part), Preston, *op. cit.*, pp 81, 82.
1915. *Stenothyra obesula*, Preston, *Rec. Ind. Mus.* XI, pp. 292, 293, fig. 4.
1916. *Stenothyra blanfordiana*, *S. minima* and *S. orissaënsis* (in part), *S. chilkaënsis* and *S. obesula*, Annandale and Kemp, *Mem. Ind. Mus.* V, p. 346.

Nevill's description of the species is very concise and accurate, and the figure of the species published in his second paper, cited above, is a very good representation of the species. It is unfortunate, therefore, that Preston should have described specimens of this species from the type-locality—the Chilka Lake, under the new names *S. chilkaënsis* and *S. obesula*. The latter was based by him on a single specimen only. We have carefully compared Preston's types of his new species with Nevill's type of *S. blanfordiana* and many other specimens of the species in the Indian Museum, and can detect no constant differences. Preston further identified specimens of this species as *S. minima* and *S. orissaënsis*; the latter of which names is no more than a synonym of *S. minima*. As to *Bithinella canningensis*, we found on examination of the type-shell that it was a young shell of *S. blanfordiana*; as is one of the co-types. The rest of the series identified by Preston as *B. canningensis* consists of shells of the *forma typica* and var. *subangulata* of *S.* (*Astenothyra*) *miliacea*.

We have nothing to add to Nevill's original description beyond noting the near relationship of this species to *S. minima* (Sowerby), which also occurs in the Chilka Lake. The two are so closely allied that one is liable to mistake specimens of the one for those of the other, unless the shells are carefully examined under a fairly strong lens from both the dorsal and ventral sides. When so examined the regularly increasing whorls of the spire of *S. minima* at once mark it of from *S. blanfordiana*.

S. blanfordiana is known from the Chilka Lake, Madras, and Port Canning in the Gangetic Delta.

The types of *S. blanfordiana*, *S. obesula* and *S. chilkaënsis* are all preserved in the collections of the Zoological Survey of India (Indian Museum).

Stenothyra minima (Sowerby).

1837. *Nematura minima*, Sowerby, *Charlesworth's Mag.* I, p. 217, fig. 22 *b*, *b*.
1851. *Stenothyra minima*, Adams, *Proc. Zool. Soc. London*, p. 225

1856. *Stenothyra minima*, Benson, *op. cit.*, pp. 500, 501.
1858. *Stenothyra minima*, Adams, H. and A., *op. cit.*, p. 626.
1862. *Nematura minima*, von Frauenfeld, *op. cit.*, p. 1160.
1876. *Stenothyra minima* (as *Nematura* in *Syst. Ind.*), Hanley and Theobald, *op. cit.*, p. 17, pl. xxxii, fig. 1.
1876. *Stenothyra minima*, Theobald, *op. cit.*, p. 15.
1885. *Stenothyra minima*, with var. *perobvia*, Nevill, *op. cit.*, p. 45.
1914. *Stenothyra orissaënsis*, Preston, *Rec. Ind. Mus.* X, pp. 300, 301, fig. 2.
1915. *Stenothyra orissaënis*, *ib.*, *id.*, XI, p. 293.
1915. *Stenothyra orissaënsis*, *ib.*, *op. cit.*, p. 82.
1916. *Stenothyra orissaënsis* and *S. minima* (in pt.), Annandale and Kemp, *op. cit.*, p. 316.

Sowerby's description and figures of the type-shell of the species are very poor; Adam's and von Frauenfeld's descriptions also are no better; Benson's description, however, is excellent and Hanley and Theobald published a good figure.

Nevill gave the name *perobvia* to some specimens from Kathiawar, these specimens are subfossil, but do not materially differ from the large series from various places to deserve distinct varietal rank. We have not been able to trace the three specimens from Arakan, Burma, which Nevill referred to as "var. (? distinct sp.)."

Preston wrongly identified specimens of this species as belonging to a new species, which he described under the name *S. orissaënsis*, while the large series of specimens from the Chilka Lake which he named *S. minima* is a very mixed lot of specimens of *S. blanfordiana* and *S.* (*A.*) *miliacea*.

The specimens we now assign to this species are from the Little Rann of Cutch at Kura, Kathiawar; Bombay; Ceylon (types of the species labelled originally "*St. ceylonica*, n. sp. by Nevill) and the Chilka Lake, in which it is abundant in thickets of *Potamogeton pectinatus*.

Stenothyra woodmasoniana, Nevill.

1880. *Stenothyra woodmasoniana*, Nevill, *op. cit.*, p. 159.
1881. *Stenothyra woodmasoniana*, Nevill, *op. cit.*, p. 156, pl. vii, fig. 8.
1885. *Stenothyra woodmasoniana*, Nevill, *op. cit.*, p. 46.
1915. *Stenothyra woodmasoniana*, Preston, *op. cit.*, pp. 81, 82.

Nevill's description and the notes appended to it together with the excellent figure in his second paper make the identification of this interesting species an easy matter.

The only specimens of the species in the collections of the Zoological Survey of India are the types and a series of co-types from Port Canning in the Gangetic Delta, but Nevill noted that the species was also represented in the collections of Dohrn, Beddome, Theobald, Blanford and Hungerford.

Stenothyra nana, Nevill, MS. (Prashad).

Plate XVI, figs. 5, 6.

1885. *Stenothyra*, n. sp., Nevill, *op. cit.*, p. 43.

The shell of this species, as the name indicates, is very small, solid, rather opaque and yellowish brown in colour. The form is

subovoid, except that the body-whorl, in ventral view, is slightly angulate on the outer side. The apex in the unique type is eroded and appears bluntly rounded. There are only 4 whorls. The suture is faintly impressed, but regular and somewhat oblique. The whorls increase very rapidly; the first one is very minute, the second is much larger and only slightly swollen, the penultimate whorl is band shaped and moderately swollen. The body-whorl is large and in dorsal view sub-rhomboidal; in this view the right side is nearly straight to about half its length and then suddenly slopes down to the base, the opposite side is regularly curved except for a slight angulation about the middle. In ventral view the body-whorl is nearly flat in the anterior $\frac{2}{3}$ of its length. The mouth is subcircular, rather small, being less than $\frac{1}{3}$ of the size of the body-whorl; its margin is slightly reflected but does not project very much above the surface of the shell. The shell is not umbilicate, but has a very prominent boss as in the other species of the genus. Owing partially to erosion and partially to a deposit on the surface the sculpture is not clear all over the surface, but on certain parts of the penultimate whorl 6—7 spiral rows of punctured lines are distinctly to be made out.

Measurements of type-shell (in millimetres).

Length	2·2
Breadth of the body-whorl	1·9
Spire (dorsal view)	1·1
Aperture	·7

Type-specimen.—No. 2196 in the collections of the Zoological Survey of India (Indian Museum).

Locality.—A single specimen was collected by the late Mr. G. Nevill at Chandipal, Calcutta.

Remarks.—Nevill, in the paper cited above, did not give this species any name, nor did he publish a description of it; with the specimen, however, there is a label with the above name, which I have adopted.

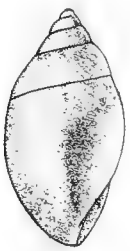
The species belongs to the group of *S. deltae*, but differs in its very small size, in having a very short spire with a rounded apex and relatively larger aperture.

Stenothyra deltae (Benson).

1836. *Nematura Deltae*, Benson, *Journ. As. Soc. Bengal.* V, p. 782.
1837. *Nematura Deltae*, Sowerby, *op. cit.*, pp. 216, 217, figs. *a*, *a*.
1856. *Stenothyra Deltae*, Benson, *op. cit.*, p. 499.
1857. *Nematura Deltae*, Troschel, *Gebiss der Schnecken*, I, p. 104, pl. vii, fig. 11.
1858. *Nematura Deltae*, Adams, H. and A., *op. cit.*, I, p. 342, pl. xxxv, fig. 5, and II, p. 626.
1862. *Nematura deltae*, von Frauenfeld, *op. cit.*, p. 1159.
1865. *Stenothyra deltae*, Stimpson, *op. cit.*, p. 40.
1876. *Stenothyra Deltae*, (as *Nematura* in *Syst. Ind.*), Hanley and Theobald, *Conch Ind.*, p. 17, pl. xxxvii, fig. 2.

1876. *Stenothyra Deltae*, Theobald, *op. cit.*, p. 15.
1888. *Stenothyra deltae*, with subvars. *minor* and *minima*, Nevill, *op. cit.*, p. 43.
1915. *Stenothyra deltae* with subvars. *minor* and *minima*, Preston, *op. cit.*, p. 79.

S. deltae, the type-species of the genus, has been described at length by a number of authors, we, however, think it necessary to note its distinctive characters once again :—The ventral surface of the body-whorl is flattened, and the shell is ornamented with spiral punctured lines; the mouth is very small, subcircular with merely the trace of a notch above ; the peristome, though quite continuous, is very little raised above the surface of the body-whorl and, though not at all incrassate, hardly thinner than the shell immediately inside the lip. In some specimens the periostracum is very thick and bears traces of spines arranged in spiral lines. They are probably present in the young.



Text-fig. 2.—*Stenothyra deltae* (Benson), side view of the shell to show the compressed nature of the same in the dorso-ventral.

The radula has been figured by Troschel.

We are not aware of the location of the types, but some of the specimens preserved in the collections of the Zoological Survey were presented by Benson. The species occurs far above the area of tidal influence in pure fresh water as well as in brackish water. In the Indian Museum, it is represented by specimens from Port Canning, Calcutta (Chandipal Ghat), Patna and Bhagalpur.

Stenothyra foveolata, Benson.

1856. *Stenothyra foveolata*, Benson, *op. cit.*, p. 497.
1858. *Stenothyra foveolata*, Adams, H. and A., *op. cit.*, p. 626.
1876. *Stenothyra foveolata* (as *Nematura* in *Syst. Ind.*), Hanley and Theobald, *op. cit.*, p. 17, pl. xxxvii, fig. 3.
1876. *Stenothyra foveolata*, Theobald, *op. cit.*, p. 15.
1858. *Stenothyra foveolata*, with var. *minor*, Nevill, *op. cit.*, p. 44.
1915. *Stenothyra foveolata* with var. *minor*, Preston, *op. cit.*, pp. 80, 81.

Benson described this species from a single specimen giving a full description but no figure. Hanley and Theobald, however, later figured the unique type. In the collections of the Indian Museum there is a single specimen collected at Sikrigalli by Dr. T. Oldham. Nevill considered it to belong to a new variety, which he named *minor*, but did not describe. We have compared the specimen with Benson's description and with Hanley and Theobald's figure and consider it to be an almost typical specimen of the species, differing from Benson's description only in being a little smaller and in the body-whorl being less swollen. Owing to erosion the sculpture unfortunately is not clearly to be made out.

These differences, in our opinion, are not sufficient for separating this single shell as a distinct species or variety.

As already noted the species is known only from a place at least 200 miles above the extreme tidal limit.

Stenothyra puncticulata (Gould).

1847. *Nematura puncticulata*, Gould, *Proc. Boston Soc. Nat. Hist.* II, p. 220.
1876. *Stenothyra puncticulata*, Theobald, *op. cit.*, p. 15.

Gould described this species from specimens sent to him from Tavoy, Burma. He stated that the species was of the shape and size of *deltae*, but had the aperture much more distorted; there was no umbilicus and the shell had a characteristic sculpture.

Nevill doubtfully considered it to be a synonym of *S. monilifera*. We have seen no specimens and it is not possible to be definite about it from the description only. We, therefore, hesitate in accepting Nevill's suggestion. Should, however, the two prove to be synonymous, then the name of the species must be *S. puncticulata* with *S. monilifera* as a synonym, and a new name will probably have to be given to *S. puncticulata*, Adams,[1] from the 'Eastern Islands.'

Subgenus **Astenothyra**, nov.

1880. *Hydrobia* (*Belgrandia*), Nevill, *op. cit.*, p. 161.
1881. *Hydrobia* (*Belgrandia*), Nevill, *op. cit.*, p. 158.
1885. *Hydrobia* (*Bythinella*), in pt., Nevill, *op. cit.*, p. 49.
1915. *Bithinella*, Preston (*nec* Moquin-Tandon), *op. cit.*, p. 66.
1915. *Paludina* (*Belgrandia*), Preston (*nec* d'Orbigny and Bourguignat), *ib.*, *id.*, p. 67.

The shell is of more normal Hydrobiid facies in the dorsal and ventral aspects than in *Stenothyra* (*s.s.*); the surfaces of the body-whorl being convex, and the aperture being larger, slightly prominent and of ovate form. There is no definite triangular area between it and the outer edge of the body-whorl. The operculum naturally corresponds in outline with the aperture, but agrees in structure with that of *Stenothyra* (*s.s.*) and we have not discovered any difference in the radula or soft parts, except that the foot is not produced posteriorly.

Type-species.—Hydrobia (*Belgrandia*) *miliacea*, Nevill.

We recognize two species of this subgenus, (i) *A. miliacea* (Nevill), and (ii) *A. burmanica*, nov.; of the former we are able to distinguish three varieties (i) *forma typica*, (ii) var. *subangulata*, and (iii) var. *gibbosula*. These species and varieties may be distinguished with the help of the following key:—

I.	Shell elongate-conical, somewhat turreted with a very long spire and having a smooth shell		*A. miliacea.*
A.	Body-whorl with a distinct keel		var. *gibbosula.*
B.	Body-whorl smooth.		
I.	Aperture evenly rounded		*forma typica.*
II.	Aperture subangulate		var. *subangulata.*

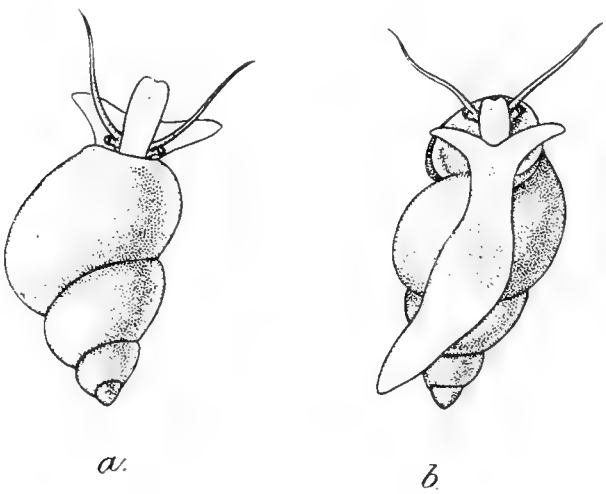
[1] Adams, *Proc. Zool Soc. London*, p. 226 (1851).

II. Shell ovate, not at all elongate, with a short spire and with a distinct pitted sculpture on its surface ... *A. burmanica.*

Astenothyra miliacea (Nevill).

1880. *Hydrobia* (*Belgrandia*) *miliacea*, Nevill, *op. cit.*, p. 161
1881. *Hydrobia* (*Belgrandia*) *miliacea*, Nevill, *op. cit.*, p. 158, pl. vii, fig. 7.
1885 *Hydrobia* (*Bythinella*) *miliacea* and var. *minor*. Nevill, *op. cit.*, pp. 52, 53.
1915. *Paludestrina* (*Belgrandia*) *miliacea*, with var. *minor* Preston, *op cit.*, pp. 67, 68.
1915. *Stenothyra trigona* (in part), Preston, *op. cit.*, p. 293, fig. 3.
1916. *Stenothyra trigona* (in part), Annandale and Kemp, *op. cit.*, p. 340.
1916. *Stenothyra perpumila* (in part), Preston, *Rec. Ind. Mus.* XII, p. 31, fig. 9.

We have nothing to add to Nevill's elaborate description of this species beyond the fact, that, in view of the large series of



Text-fig. 3.—Animal of *S.* (*A.*) *miliacea* (Nevill). (*a*) Dorsal view. (*b*) Ventral view.

shells now available, we consider his var. *minor* as a synonym of the same species, the types of his variety being only young shells. His figure of the type-shell is excellent and shows the diagnostic characters very well.

As has been stated already (p. 129) some of the shells identified by Preston as *Bithinella canningensis* belong to this species.

Type-series.—No. M 11865/2 in the collections of the Zoological Survey of India (Indian Museum).

Var. gibbosula, Nevill, MS. (Prashad).

Plate XVI, figs. 7, 8.

1885. *Hydrobia* (*Bythinella*) *miliacea* subvar. *gibbosula*, Nevill, *op. cit.*, p. 52.
1915. *Paludestrina* (*Belgrandia*) *miliacea* subvar. *gibbosula*, Preston, *op. cit.*, p. 67.

The unique type of this variety differs from the shells of the *forma typica* in (i) all the whorls of the spire and particularly the penultimate whorl being proportionately larger and more tumid, (ii) body-whorl a little smaller, but distinctly keeled, (iii) suture more deeply impressed and (iv) the peristome thicker owing to its margins being greatly retroverted.

Type-specimen:—No. M 11866/2 in the collections of the Zoological Survey of India (Indian Museum).

Locality.—A single shell was collected at Port Canning in the Gangetic Delta by the late Dr. F. Stoliczka.

Remarks—This may possibly represent a distinct species, but we prefer to leave it as a variety of *A. miliacea* owing to there being a single specimen in which also the apex of the spire is eroded.

Var. **subangulata**, Nevill, MS. (Prashad).

Plate XVI, figs. 9, 10.

1885. *Hydrobia* (*Bythinella*) *miliacea* subvar. *subangulata*, Nevill, *op. cit.*, p. 52.
1915. *Paludestrina* (*Belgrandia*) *miliacea* subvar. *subangulata*, Preston, *op. cit.*, p. 68.
1916. *Stenothyra perpumila* (in part), Preston, *op. cit.*, p. 31.

This variety, which is fairly common at Port Canning and in the Chilka Lake, occurs at the former place with the *forma typica*. Specimens of it were found in the Cochin backwaters on the Malabar Coast by Dr. F. H. Gravely; they were identified as *S. perpumila* by Preston.

The variety differs from the typical form in having a proportionately smaller body-whorl and in the aperture being subangulate instead of the evenly rounded one of the typical form.

Type-series.—No. M 11867/2 in the collections of the Zoological Survey of India (Indian Museum).

Astenothyra burmanica, sp. nov. (Prashad).

Plate XVI, figs. 11, 12.

The shell of this species is minute and of a dirty creamy colour. It is ovate, and has a bluntly pointed apex. There are six whorls, and the suture is deeply impressed, somewhat canaliculate and only slightly oblique. The whorls increase gradually though a little irregularly; the first two are very minute, the third is a little more than half the breadth of the fourth, while the penultimate whorl is more than twice as broad as the fourth. The body-whorl is large, moderately inflated and, in dorsal view, somewhat trumpet-shaped. The mouth is oblique, ovate but acutely pointed posteriorly; the peristome is continuous and only slightly thickened with a rather broad callus. The entire surface of the shell is covered by spiral pitted lines; these are specially well marked on the body-whorl.

Measurements of type-shell (in millimetres).

Length of shell	1·5
Breadth of the body whorl	1·0
Length of spire	·8
Mouth	·5×·4.

Type-specimen.—No. M 11868/2 in the collection of the Zoological Survey of India

Locality.—The unique type was collected by the late Dr. F. Stoliczka at Arakan, Burma.

Remarks.—The species comes near *A. miliacea* but has more whorls, is more compressed, shorter and has a different type of sculpture.

EXPLANATION OF PLATE XVI.

Stenothyra ornata, sp. nov.

FIG 1.—Dorsal view of the type-shell.
,, 2.—Ventral view of the same.

Stenothyra atomus, Prashad.

FIG. 3.—Dorsal view of the type-shell.
,, 4.—Ventral view of the same.

Stenothyra nana, Prashad.

FIG. 5.—Dorsal view of the type-shell.
,, 6.—Ventral view of the same.

S. (Astenothyra) miliacea, var. **gibbosula**, Prashad.

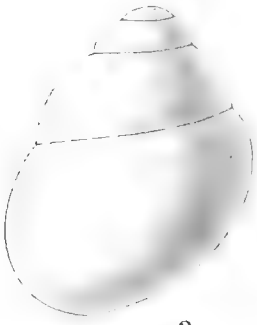
FIG. 7.—Dorsal view of the type-shell.
,, 8.—Ventral view of the same.

S. (Astenothyra) miliacea, var. **subangulata**, Prashad.

FIG. 9.—Dorsal view of the type-shell.
,, 10.—Ventral view of the same.

S. (Astenothyra) burmanica, Prashad.

FIG. 11.—Dorsal view of the type-shell.
,, 12.—Ventral view of the same.



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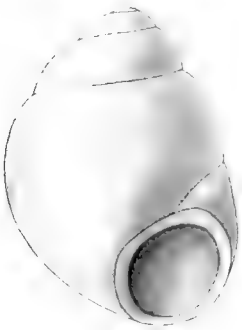

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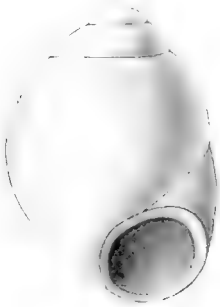

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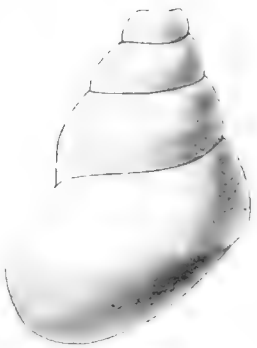

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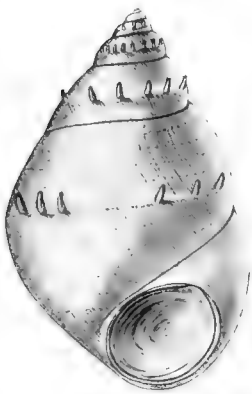

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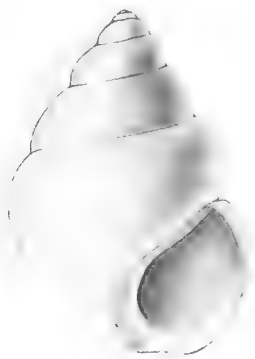

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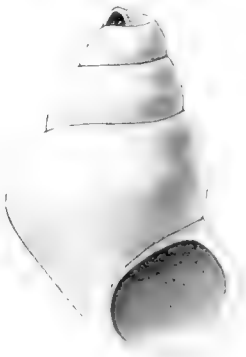

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S. C. Mondul, and D. Bagchi, del

STENOTHYRA.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

XVI. NOTES ON LAMELLIBRANCHS IN THE INDIAN MUSEUM.

By B. PRASHAD, *D.Sc., Offg. Superintendent, Zoological Survey of India.*

(Plate XX.)

4. INDIAN SPECIES OF THE GENUS *CYRENA*.

The present revision of the Indian species of the genus *Cyrena*, Lamarck, might appear superfluous in view of the recent treatment of the subject by Preston in his volume on Mollusca in the "Fauna of British India," but the above work is mainly a compilation from the earlier monographs by Prime,[1] Clessin[2] and Sowerby.[3] It was found on examination of the collections in the Indian Museum that the descriptions of the Indian species in these works were very faulty and inadequate being based on insufficient material and that too, in most cases, consisting of young or half-grown shells only. These descriptions, owing to the great changes that usually take place in the shape of the shells during growth, are not applicable to adult shells, and are incomplete so far as the description of the hinge is concerned, while the geographical distribution of the various forms is not correctly given. I have, therefore, thought it desirable to re-describe some of the species and in other cases to point out the distinguishing characters.

According to Preston the following species occurs within the limits of British India, Burma and Ceylon, *C. ceylonica*, *C. impressa*, *C. sinuosa*, *C. bengalensis*, *C. tennentii*, *C. proxima* and *C. galatheae*. Of these species *C. sinuosa*, Deshayes, was included in the list on Sowerby's authority. The species is known from Java and except for Sowerby no other author has recorded its occurrence in Ceylon. In the Indian Museum collection there are large collections from various parts of Ceylon, but none of these specimens are referrable to Deshayes' *C. sinuosa*, and I am very doubtful whether Sowerby's record can be accepted as correct. Sowerby probably confused some specimens of the nearly allied *C. ceylonica* with those of Deshayes' species or the localities on his specimens must have been incorrectly stated. With the above exception I have found Preston's list to be quite correct, but I have also to

[1] Prime, Cat. Corbiculidae in *Amer. Journ. Conch.* V (1869—1870), and other papers cited further on.

[2] Clessin, *Cycladeen* in Martini and Chemnitz *Conch.-Cab.* (1879).

[3] Sowerby, *Conch. Icon.* XX (1878)

include *C. siamica*, Prime, in the list of Indian species, as there are specimens of this species in the Indian Museum collected at Rangoon, Burma and from the Nicobar Islands.

As to the grouping of the various species of this genus the two attempts of Deshayes [1] and von Martens [2] have to be considered. The former is only an arbitrary classification of all the species of the genus; von Martens' work, however, in which the shape and form of the shell are utilised for the grouping of the Indo-Pacific forms into four sections, is more satisfactory and is followed in this paper. The Indian species fall into the following groups :—

A. Proclives .. *C. bengalensis*, *C. siamica*, *C. impressa*.
B. Suborbiculares .. *C. proxima*, *C. tennentii*.
C. Expansae .. *C. ceylonica*.
D. Cyperinoideae .. *C. galatheae*.

As a result of my study of the Indian Museum collection the geographical distribution of the various species has had to be greatly extended. *C. bengalensis* is confined to Bengal, *C. ceylonica* and *C. tennentii* are endemic in Ceylon, *C. galatheae* is widely distributed in the Andaman and Nicobar Islands, *C. siamica* has a wide range in Cochin-China, Siam, Burma and the Nicobar Islands, *C impressa* occurs in the Philippines, Dutch East Indies, Ceylon and on the West Coast of Peninsular India while *C. proxima* is found only in Siam and the Mergui Archipelago.

Cyrena bengalensis, Lamarck.

Plate XX, figs. 1, 2.

1915. *Cyrena bengalensis*, Preston, *Faun. Brit. Ind. Freshw. Moll.* pp. 205, 206.

Preston in the work cited above has given a complete synonymy of the species but the descriptions of the shell in all previous memoirs are very inadequate. I, therefore, give below a detailed description of the shell based on the large series of specimens in the Indian Museum.

Shell large, solid, subtrigonal, rather swollen but not very high, very inequilateral, covered with a brownish black epidermis with coarse striae, and with the regions of growth distinctly marked by still coarser lines; dorsal margin very small, somewhat angulate; anterior margin rather short, concave in its upper or proximal $\frac{3}{4}$ of the length then regularly curving round to the podium; posterior margin very long, high, markedly convex and regularly curving down to the gonium, where it meets the ventral border in a broadly rounded acute angle; ventral border nearly straight except in the podial and gonial angles where it is curved upwards; umbones of fair size, situated anterior to the middle,

[1] Deshayes, *Cat. Conchifera Brit. Mus.* I, pp. 241, 242 (1853).
[2] Von Martens in Max Weber's *Zool.-Ergeb. Nieder. Ost.-Ind.* IV, p. 9 (1897).

often weathered and wormed in fully grown specimens, greatly recurved anteriorly and separated from one another by a narrow chink only; lunule well marked rather narrow but deep; ligament prominent but not very thick, about thrice as long as the lunule. Hinge in general facies quite similar to that of *C. ceylonica*, but much more curved and with the lateral teeth more delicate though comparatively much longer; the cardinal teeth more slanting, stouter and not so deeply bifid.

Measurements (in millimetres).

Length	..	27	32·2	44	50	68	80
Height	..	23·5	30	39·4	43	62	72
Thickness		14	16	27	29·8	44	52

Distribution.—Clessin was certainly wrong in including the East Indies in the range of distribution of this species, as it is confined to Bengal only. In Bengal the species is fairly common in the estuarine areas of the Gangetic Delta and is burnt in large quantities for making lime. It is probably the species referred to by Benson as *C. sumatrana* from the Sunderbans.[1]

Remarks.—The species is distinguished from the other Indian species of the genus by its shape, the concave anterior border and the greatly recurved umbones.

Cyrena siamica, Prime.

Plate XX, figs. 3—5.

1861. *Cyrena siamica*, Prime, *Proc. Acad. Nat. Sci. Philadelphia*, p. 126.
1863. *Cyrena siamica*, Prime, *Cat. Corbiculidae*, p. 6.
1864. *Cyrena siamica*, Prime, *Ann. Lyceum Nat. Hist. New York*, VIII, p. 86, fig. 35.
1869. *Cyrena siamica*, Prime, *Cat. Corbiculidae* in *Amer. Journ. Conch.* V, p. 147.
1879. *Cyrena siamica*, Clessin, *Cycladeen* in Martini-Chemn. *Conch. Cab.*, p. 123, pl. xix, fig. 4.
1897. *Cyrena siamica*, von Martens, *Süss. und Brackw. Moll.* in Weber's *Zool. Ergeb. Nieder. Ost. Ind.* IV, p. 91.

Two separate valves from Rangoon, Burma, two specimens from the Nicobars, one from Cochin-China and one from Cambodia in the Indian Museum collection belong to this species. The Nicobar and Cambodian species were found labelled *C. sumatrensis*, but they differ from the true *sumatrensis* in the shell being less tranverse, less inflated, the hinge more curved and broader, all the teeth stouter and the laterals much more solid and curved, the umbones less prominent and not so recurved and in colour.

I have nothing to add to Prime's description of the species, but give below measurements of the various specimens in the

[1] Benson, *Journ. As. Soc. Bengal* VII, pt. i, p. 421 (1838).

Indian Museum collection. Some of these shells are much larger in size than Prime's type-specimen.

Measurements (in millimetres).

	A.	B.	C.	D.	E.	F.
Length ..	68	66	55	49	43	70
Height ..	59	59	49	45	40	66
Thickness ..	38	39	31	27	—	—

Specimen A is from Cochin-China, B from Cambodia, C and D from the Nicobars while E and F are single valves only from Rangoon, Burma.

Distribution.—The species was hitherto known from Siam only but from the series of specimens in the Indian Museum collection it appears to have a very wide range from Cochin-China, Cambodia to Burma and the Nicobar Islands.

Cyrena impressa, Deshayes.

Plate XX, figs. 6, 7.

1854. *Cyrena impressa*, Deshayes, *Proc. Zool. Soc London*, p. 18.
1854. *Cyrena impressa*, Deshayes, *Cat. Brit. Mus. Conchifera* II, p. 249.
1863. *Cyrena eximia* (in part), Prime, *Cat Corbiculidae*, p 6.
1869. *Cyrena eximia* (in part), Prime, *Amer. Journ. Conch.* V. p. 114.
1879. *Cyrena ceylonica* (in part), Clessin, *Cycladeen* in Martini-Chemn *Conch.-Cab.*, p. 103, pl. xviii. figs. 1, 2.
1879. *Cyrena eximia* (in part) *id*, *ib.*, p. 239
1897. *Cyrena impressa*, von Martens, *Süss und Brackw. Moll.* in Weber's *Zool. Ergeb Nieder. Ost.-Ind.* IV. p. 93.
1915. *Cyrena impressa*, Preston, *Faun. Brit. Ind. Freshw.-Moll.* pp. 202—204, figs. 25. 26.

Prime and Clessin after him considered *C. impressa* as a synonym of *C. eximia*, Dunker, but von Martens has shown that the two species are quite distinct and even belong to different groups in his scheme of classification cited already. Deshayes' description is fairly detailed and accurate, while von Martens added a few further notes on the species. Recently Preston has published good figures of the type-shell. The following distinguishing characters of *C. impressa* may, however, be noted. The anterior margin is straight or nearly so, while the posterior margin is only slightly convex in its upper or proximal half and then sharply turns down at an obtuse angle, this distal half is nearly straight and the margin here may be described as subtruncate, the ventral border is regularly but not greatly curved and the umbones are not very prominent.

Distribution.—According to Deshayes *C. impressa* is found in the Philippines, Java and Australia. Preston, on the basis of specimens in the British Museum, included Ceylon in the range of

distribution of this species. In the Indian Museum there are specimens from Ratnagiri near Bombay on the west coast of Peninsular India and from the west coast of India (exact locality not stated). All these specimens agree closely with Preston's figures of the type-specimen and with Deshayes' description. The species therefore, has a wide range comprising Australia, the Philippines, Dutch East Indies, Ceylon and Peninsular India. The following are the measurements of the specimens from the two localities in the Indian Museum collection.

Measurements (in millimetres).

	Ratnagiri.			West Coast of India.	
Length ..	87	64	55	61	52
Height ..	81	58	51	60	48
Thickness ..	47	35	30	33	31

Cyrena proxima, Prime.

Plate XX, figs. 8, 9.

1863. *Cyrena proxima*, Prime, *Cat. Corbiculidae*, p. 6.
1864 *Cyrena proxima*, Prime, *Ann. Lyceum Nat. Hist. Soc. New York*, VIII, p. 85, fig. 34.
1869. *Cyrena proxima*, Prime, *Cat. Corbiculidae* in *Amer. Journ. Conch.* V, p. 147.
1879. *Cyrena proxima*, Clessin, *Cycladeen* in Martini-Chemn. *Conch.-Cab.* p. 127, pl. xxi, fig. 2. [165.
1889. *Cyrena proxima*, von Martens, *Journ. Linn. Soc. Zool.* XXI, p.
1915. *Cyrena proxima*, Preston, *Faun. Brit. Ind. Fresh-Moll.* pp. 206, 207.

In the Indian Museum collections *C. proxima* is represented by a large series of shells collected by Dr. J. Anderson in Sullivan Island (not Sulliman Is.) in the Mergui Archipelago, and referred to by the late Dr. E. von Martens in the paper cited above. The specimens are stated to have been collected in fresh water, but it is unlikely that the water was quite fresh as no species of the genus occur in quite fresh water. It is probable that the water in the streams, from which the specimens were collected, was subject to the influence of the tides and had variable salinity, as is the case with the estuarine areas in the streams of the Gangetic Delta where *C. bengalensis* is found.

The distinguishing characters of the species are the suborbicular and nearly equilateral shell with the anterior and posterior borders curving regularly downwards to the podial and gonial angles, the greatly arcuate ventral border and the inwardly curved and somewhat approximate beaks.

The largest specimen in the Indian Museum measures 64 mm. × 59 mm. × 37 mm., and is much larger than the specimens in the British Museum.

The species is known from Sullivan Island and Siam only.

Cyrena tennentii, Hanley.

Plate XX, fig. 10.

1858. *Cyrena tennentii*, Hanley, *Proc. Zool. Soc. London* XXVI, p. 23.
1869. *Cyrena tennentii*, Prime, *Amer. Journ. Conch.* V, p. 148.
1879. *Cyrena tennentii*, Clessin, *Cycladeen* in Martini-Chemn. *Conch. Cab.*, p. 240.
1915. *Cyrena tennentii*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 206.

The two specimens from Ceylon, which I assign to this species, agree fairly well with Hanley's description except that the shells of both these specimens, owing to the greatly arcuate ventral border, have become suborbicular instead of being ovato-subtrigonal. This might partly be due to age as the larger of my specimens is much larger than Hanley's, while both the specimens are much deeper. I figure the larger of the two specimens and give below the measurements.

Measurements (in millimetres).

Length	42	37
Height	40	35
Thickness	21	20

Habitat.—The species is only known from Ceylon. Hanley's specimens were taken in the Ariho River flowing into the Gulf of Manaar, but the exact locality of the specimens in the Indian Museum is not stated. It seems to be rather scarce in Ceylon also, as in the large collections made in the island by the late Mr. G. Nevill no specimens of the species are present.

Remarks.—The shell of this species is comparatively thinner and shorter than that of the other Indian species of the genus. The hinge is comparatively broad and greatly curved, the umbones are small but prominent, recurved anteriorly and inwards and nearly approximating with each other in the middle line. The shape of the shell and the position of the umbones is very characteristic of this species and easily distinguishes it from all other Indian forms.

Cyrena ceylonica (Chemnitz).

Plate XX, figs. 11—13.

1915. *Cyrena ceylonica*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 202.

Preston's work cited above gives all references to literature, but the description of the species taken from Sowerby's *Conchologia Iconica* is very inadequate, nor is there any other complete account of the shell available. I have, therefore, thought it desirable to give a detailed description.

Shell very large, solid, oblong-ovate or even sub-rhomboidal, somewhat compressed, very high, markedly inequilateral; covered with a thin dark yellowish to brownish or even black epidermis with thin fringed striae; regions of growth marked as coarser and

deeper ridges; dorsal margin short, regularly curved, convex; anterior margin fairly large but shorter than the posterior, concave and rather sinuous in the proximal or upper half, then regularly curved to the broad podium, from the latter the ventral margin sharply curves downwards and backwards until in line with the umbo it forms a broad arc and then rapidly curves up again to the gonium; posterior margin biangulate, regularly and convexly curved above in continuation of the dorsal margin but nearly straight below the upper obtuse angle; umbones prominent but rather small, curved inwards and forwards and separated from one another in the middle line; ligament long and thick but not greatly projecting; lunule broad, but not very deep, carinate in the middle. *Hinge.*—Right valve with four laterals, two anterior and two posterior; upper anterior small but thick and knob-like; lower, seen from above, triangular, thick, pad-like with the anterior and posterior margins of approximately the same length; upper posterior more elongate but less prominent than the upper anterior, appearing only as a slight callosity; the lower one elongate, ridge-like but with a low apex a little further off from the centre; between the two anterior and two posterior laterals there is a deep concavity for the fitting in of the single laterals of the opposite valve, the anterior concavity is much the deeper of the two; of the three cardinals the anterior one is sharp or with only a very shallow furrow across its free edge; it is inclined forwards, the middle and posterior are both deeply furrowed, appearing somewhat bifid and both inclined backwards. Left valve with two laterals, anterior one very short, thick and stumpy, somewhat conical; posterior elongate, triangular with the apex lying further from the middle; 3 cardinals, anterior forwardly inclined, middle and posterior backwardly, the first two deeply bifid, posterior single. Pallial line with only a shallow sinus. The young shells differ from the adult in being subtrigonal or even subcircular, with the anterior margin nearly straight in its proximal portion and evenly rounded below without a projecting podium; the posterior margin not or only indistinctly showing the biangulate nature; the shells are comparatively thicker in diameter, the umbones a little more prominent and the periostracal ridges comparatively more regular and distinct. The series of shells in the Indian Museum well illustrates the change in shape from the young to the adult form.

Measurements (in millimetres).

Length ..	46	52	54	63	74	88	90	103
Height ..	44	48	51	62	73	85	85	87
Thickness ..	26	27·5	28·4	34	38·2	50	52	53

Distribution.—According to the earlier authors the species was considered to have a wide range from Ceylon to Java, but it has been established by later workers that the Javanse species is quite distinct, and that *C. ceylonica* is confined to Ceylon only.

Remarks.—This species along with other species of the group are distinguished by their somewhat elongate, comparatively narrow and rather compressed shells. *C. ceylonica* is characterized by the rather large and sinuous anterior border, broadly truncate and elongate posterior border and the forwardly recurved um bones; the hinge of this species is also very different from that of the other Indian species.

Cyrena galatheae Mörch.

Plate XX, figs. 14—17.

1915. *Cyrena galatheae*, Preston, *Faun. Brit. Ind. Freshw.-Moll.*, p. 207.

I give below a detailed description of the shell of this species as the original description by Mörch is not quite complete.

Shell very large, solid, thick, greatly swollen in the upper third, compressed below, roughly trigonal, much longer than high, very inequilateral with the umbones situated much nearer to the anterior than the posterior edge, with a yellowish brown to blackish epidermis with regular concentric striae, growth-regions not distinctly marked; anterior margin much shorter than the posterior, somewhat concave in the upper region or just next to the umbones, then after a short straight course curving in to form the podium; posterior margin in its proximal part only slightly curved, but rapidly descending downwards, further part straight owing to the truncate nature of the region next to the gonium, with an obtuse angle between the straight lower and the slightly curved upper region; ventral border only slightly arched; umbones prominent, greatly eroded in adult shells, in young shells recurved forwards and inwards but not meeting each other in the middle line, and sculptured with closely situated concentric striae, with a broad but shallow lunule, carinated in the middle; ligament long, thick and prominent. *Hinge* as in the genus but greatly curved and rather forwardly placed owing to the position of the umbones, with the lateral teeth more compact and solid, the upper pair of laterals in the right valve reduced to small thickenings only; cardinals very slanting and strong.

Measurements (in millimetres).

	a.	*b.*	*c.*	*d.*	*e.*	*f.*	*g.*	*h.*	*i.*	*j.*
Length ..	31	49	80	78	94	95	121	104	98	120
Height ..	27	41	68	73	85	84	105	92	82	106
Thickness ..	16	25	49	47	55	51	71	52	51	75

Specimens *a*—*c* are from the Andaman Islands, *d* from John Lawrence Island, *e* from Kondul Island, *f*, *g*, from Trinkat Island and *h*—*j* from the Nicobars.

The specimens from various localities differ to some extent

as regards proportionate measurements, but in the large series before me intermediate forms connecting the different types from the different localities are present, and I have found it impossible to detect any constant differences between them. A few notes on the form of the young shells may be included here. The young shells are nearly subtrigonal with the posterior margin regularly arched the truncate distal half being not distinctly marked as yet, the umbones are placed more symmetrically and the hinge is of a more normal type.

Distribution.—*C. galatheae* had hitherto been recorded from the Galatea River in the Nicobar Islands; in the collections of the Indian Museum it is represented by a large series of specimens from the Nicobars (Kar Nicobar, Kondal and Trinkat Islands in the Nicobar group) and Andaman Islands (John Lawrence and Havelock Islands in the Andaman group). The species, therefore, has a wide range in the Andaman and Nicobar Islands.

Remarks.—A few specimens of this species in the collection were found labelled *C. patima*, Benson, which is apparently a manuscript name only as I have been unable to find any reference to it in literature except in Theobald's catalogue.[1]

The shells of this species are of a very characteristic type and are easily distinguished by the greatly inequilateral, greatly vaulted shells with a highly truncate distal half of the posterior margin, anteriorly placed umbones and the curved and forwardly placed hinge with very compact but strong laterals.

5. INDIAN SPECIES OF THE GENUS *BATISSA*.

Up till recently the only known species of the genus *Batissa*, Gray, from within the limits of India, Burma and Ceylon were *B. similis* and *B. inflata* described by Prime from the Nicobar Islands in 1859[2] and 1860[3] respectively. In 1908[4] Preston described a unique specimen from the Andaman Islands, collected by the late Rev. J. Warneford, under the name *B. capillata*. In the Indian Museum collection I found two boxes of specimens from the Andaman Islands provisionally labelled *B. violacea*, Brug., by the late Mr. G. Nevill; in addition there were a fair number of specimens from the Andaman Islands which had not been identified. Through the courtesy of Professor Max Weber I received a specimen of *B. violacea* var. *celebensis*, Martens,[5] collected by Prof. M. Weber in the Celebes and identified by the late Dr. E. von Martens. The specimen is preserved in spirit and is in an excellent state of preservation. With this material I have drawn up the following notes on the collection in the Indian Museum including a detailed description of the soft parts of the genus *Batissa*

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[1] Theobald, *Cat. Rec. Shells, Mus. As. Soc. Bengal*, p. 140 (Calcutta, 1860).
[2] Prime, *Ann. Lyceum Nat. Hist. Soc. New York* VII, p. 112 (1859).
[3] *Id.*, *Proc. Zool. Soc. London* XXVIII, p. 320 (1860).
[4] Preston, *Rec. Ind. Mus.* II, p. 207, pl. xvi, fig. 39 (1908).
[5] Von Martens, *Süss. und Brackw.-Moll.* in *Zool. Ergeb. Nieder. Ost. Ind.* IV, p. 104 (1897).

On a careful comparison of Preston's unique type with the other specimens in the Indian Museum I find that it is only a half-grown shell of *B. similis*, Prime. It is not possible to be quite definite as to the validity of *B inflata*, Prime, as a species distinct from *B. similis*; it will probably, when larger series are available, have to be considered as only a variety of *B. similis*, but for the present I have not adopted this course. Both the species belong to the group Ellipticae of von Martens' classification. In this group the shell is elongated in an antero-posterior direction, the ventral border is only slightly arched and the shells have no radial sculpture.

Within the limits of British India, Burma and Ceylon, the genus *Batissa* is known to occur in the Andaman and Nicobar Islands only and has not so far been found on the mainland.

Soft parts.—The following description of the soft parts is based on the Celebes specimen sent to me by Prof. Max Weber and may be considered as a supplement to the short description of the animal in von Martens' paper cited above.

Corresponding to the shape of the shell the animal is trigonal-elliptical, and is not much swollen in the umbonal region. The specimen preserved in spirit is of a deep yellowish brown colour, the palps and the gills being somewhat greyish.

The mantle is comparatively thicker than in the genus *Corbicula* or in *Villorita*, but the free region below the pallial line is not definitely marked off as in those genera, owing to the radial muscle fibres being not very thick and distinct even though they are well developed. The margin of the mantle is entire and bears a continuous row of small conical papillae on the inner surface slightly internal to the edge as in *Villorita*, but the papillae all along are not of the same size as in *Villorita*. The condition is intermediate between that found in *Corbicula* in which they are absent in the pedal region and that in *Villorita* where they are approximately the same size all along

The arrangement of the siphonal and pedal orifices is similar to that in the genera *Corbicula* and *Villorita*, but the limits of the two are different. The pedal orifice is limited anteriorly by the ventral margin of the thick anterior adductor muscle and is separated from the siphonal orifice by a long connection, about half an inch long, of the mantle flaps of the two sides with one another in line with the posterior side of the foot; in this region of union also the papillae of the mantle are present in two rows along the line of union. The siphonal orifice is rather extensive extending above to very nearly the upper margin of the posterior adductor muscle. The mantle is not externally notched to mark off the regions for the two siphonal apertures.

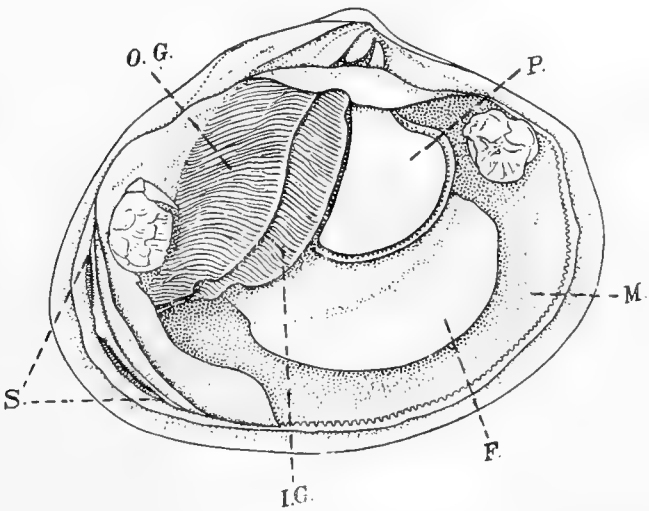
Of the adductor muscles, the posterior is much larger than the anterior and both are nearly subquadrate in outline. The pallial muscle-fibres have already been mentioned, in these the siphonal retractors are not distinctly indicated.

The two siphons are fully contracted, but appear capable of

sufficient extension. The two siphons are quite separate and are of an ashy-grey to violet colour. The aperture of the branchial siphon is about one and a half times as high as the anal; it bears two rows of elongate papillae along its margins while the anal has only a single row.

The attachments of the gills are similar to those in the genera *Corbicula* and *Villorita*, except that the attachments of the outer lamellae of the outer pair of gills with the mantle is very much curved and rather sinuous. Both pairs of gills are of the same length, but the outer pair is broader in its entire length than the inner.

The palps are very large, broad, very thin and somewhat leaf-shaped; the inner pair is somewhat larger than the outer one.



TEXT-FIG. 1.—Soft parts of *B. violacea* var. *celebensis*, Martens. *F.* foot, *I.G.* inner gill, *M.* mantle, *O.G.* outer gill, *P.* palp, *S.* siphons.

The foot is large and well developed with a sharp margin, but is not very thick.

Remarks.—The soft parts of *Batissa* resemble those of *Corbicula* and *Villorita* in general, but differ in the mantle being thicker, the pallial muscle-fibre region not distinctly separated, the larger gills, the shape, form and large size of the thin leafy palps, and the form of the foot.

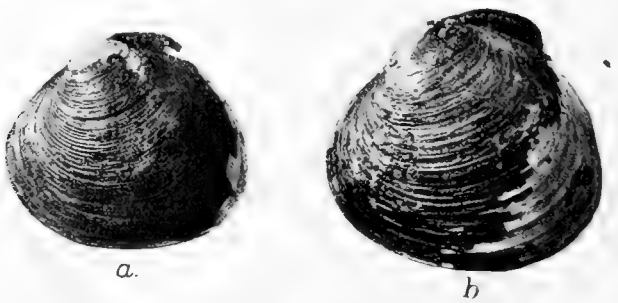
Batissa similis, Prime.

1859. *Batissa similis*, Prime, *Ann. Lyceum Nat. Hist. Soc. New York* VII, p. 112.
1866. *Batissa similis*, *id.*, *ib.*, VIII, p. 229, fig. 60.
1869. *Batissa similis*, Prime, *Cat. Corbiculidae* in *Amer. Journ. Conch.* V, p. 140.

1879. *Batissa similis*, Clessin, *Cycladeen* in Martini-Chemn. *Conch.-Cab.*, p. 213, pl. xxxvi, fig. 3.
1908. *Batissa capillata*, Preston, *Rec. Ind. Mus.* II, p. 207, pl. xvi, fig. 39.
1915. *Batissa similis* and *B. capillata*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 208.

The specific identity of Preston's *B. capillata* with Prime's species has been remarked on in the introductory part. The following notes on the specimens in the Indian Museum may be of interest as supplementing Prime's description of the species.

The shell in this species varies from subtrigonal or obovate to ovate-orbicular; it is very inequilateral, with a short anterior side which regularly slopes down and is straight or only slightly concave; the posterior side is much longer and somewhat biangulate in its distal part. The umbones are very anteriorly placed, being recurved forwards and inwards but widely separated from one another; in most cases they are greatly eroded. *Hinge.*—There are only two laterals in each valve. The anterior lateral may be described as consisting of two parts, a distal curved part forming



Text-fig. 2.—Photographs of the left valves (× ½) of (*a*) *B. similis*, Prime; (*b*) *B. inflata*, Prime.

the upper boundary of the impression for the anterior adductor muscle and the proximal thicker nearly straight part in the hinge region The posterior lateral is blade-like, but slightly arched and rather longer than the anterior. Both the teeth are finely serrate along their upper inner margin. Of the three cardinals the anterior is most small and conical in the right valve, somewhat larger and knob-like in the left valve; the middle one of the right valve has the shape of the molar teeth of mammals but has only a single furrow along its free edge, in the left valve it is much thinner but larger; the posterior one is thinner than the other two but more elongate and somewhat curved and not so much compressed. The areas between the three teeth are deeply canaliculate.

Measurements (in millimetres).

Length	..	53	67	77	82	84	89
Height	..	48	59	66	72	73	74
Thickness	..	27	34	38	41	43	72

Distribution.—Prime's specimens were obtained in the Nicobars, while all those in the Indian Museum are from the Andamans. Some of these, as already noted, had provisionally been identified as *B. violacea*, Brug., but they do not belong to that species.

Batissa inflata, Prime.

1915. *Batissa inflata*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 208.

For previous references to this species Preston's volume, cited above, may be consulted.

In the Indian Museum there is a specimen from the Andaman Islands which I assign to this species. It differs from the shells of *B. similis* in the shell being more oblique and, as the name indicates, inflated, the umbones more anteriorly placed and greatly recurved forwards, the anterior margin shorter and more slanting, the posterior margin more curved and not biangulate, the podium more marked and the ventral border less arched. The hinge is much more arched but all the teeth are comparatively smaller, broader and coarser, the laterals are more serrate and the cardinals sharper.

The single specimen from the Andaman Islands measures 76 mm. × 68 mm. × 45 mm.; it is smaller than Prime's type-specimen which was collected in the Nicobar group.

EXPLANATION OF PLATE XX.

INDIAN SPECIES OF *CYRENA*.

All the figures are direct photographs of the right valves of specimens in the Indian Museum, reduced to ½ the natural size.

Cyrena bengalensis, Lamarck.

FIG. 1.—Medium sized shell from the Sunderbans in the Gangetic Delta.

,, 2.—Adult shell from the Salt Lakes near Calcutta.

Cyrena siamica, Prime.

FIG. 3.—Medium sized shell from Rangoon, Burma.

,, 4. ,, ,, ,, ,, the Nicobar Islands.

,, 5. ,, ,, ,, ,, Cochin-China.

Cyrena impressa, Deshayes.

FIG. 6.—Medium sized shell from Ratnagiri, near Bombay.

,, 7.—Adult shell from the same locality.

Cyrena proxima, Prime.

FIG. 8.—Medium sized shell from the Mergui Archipelago.

,, 9.—A smaller shell from the same locality.

Cyrena tennentii, Hanley.

FIG. 10.—A full-grown shell from Ceylon.

Cyrena ceylonica (Chemnitz).

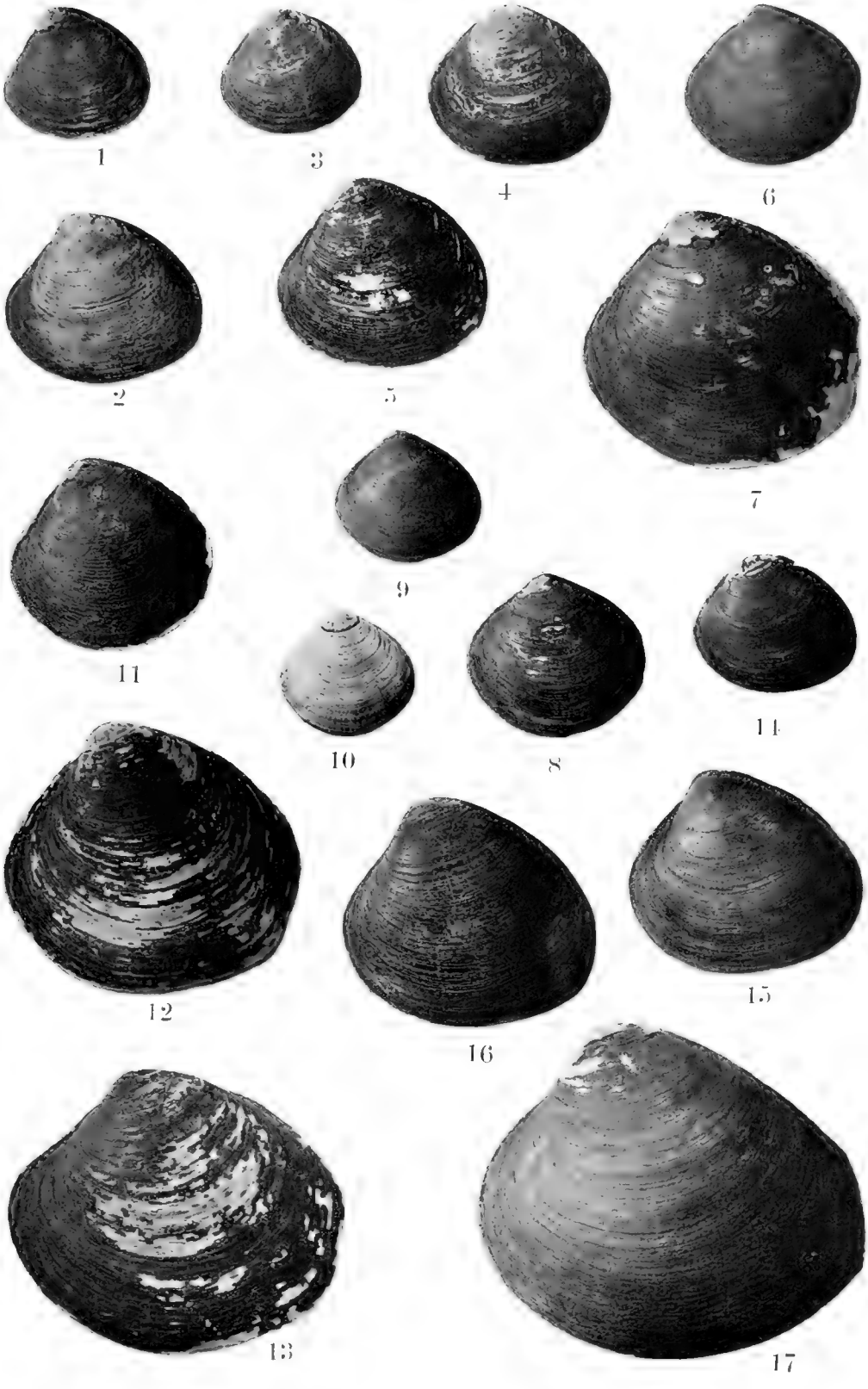
FIGS. 11—13.—Shells of different sizes, all from Ceylon.

Cyrena galatheae, Mörch.

FIG. 14. A young shell from the Andaman Islands.

FIGS. 15, 16.—Medium and large sized shells from the Havelock Island in the Andaman group.

FIG. 17.—A full-grown specimen from the Trinkat Island in the Nicobar group.



S. C. Mondul, photo

INDIAN SPECIES OF *CYRENA*.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

XVII. REMARKS ON THE INDIAN SPECIES OF *DENDROPHIS* AND *DENDRELAPHIS*.

By Colonel F. Wall, *C.M.G., I.M.S.*

There has been so much confusion in the past over the identification of many of the species of *Dendrophis* and *Dendrelaphis* that I appealed to Dr. Annandale lately to allow me to examine all the specimens of these genera in the Indian Museum, and to Mr. Spence to send me all the available specimens in the Bombay Natural History Society's collection.

When the Fauna of British India, Reptilia and Batrachia, appeared in 1890 the snake now known as *Dendrelaphis tristis* was not recognised as a separate species but included under the species *Dendrophis pictus*. Later when the second volume of Boulenger's Catalogue appeared in 1893 a clear distinction was made between the two, but the available specimens in the Indian Museum and Bombay collections had not been re-examined until I did so recently. As a result of my examination of this material I have acquired a great deal of information, and been able to correct the mistakes of earlier herpetologists. Among specimens labelled *pictus* in the Indian Museum I discovered many specimens of *Dendrophis gorei* described by me (*Bombay N. H. Journ.* 1910, p. 829), and also of *Dendrophis proarchus* described by me (*Bombay N. H. Journ.* 1910, p. 827).

In addition to the information derived from the above collections I have revised all my own notes, and incorporated my observations during the last 26 years, and I hope in the succeeding remarks to bring the subject so far as the Indian species are concerned up to date, and make the identification of these easily confused species easier for other workers in this field.

Boulenger (*Cat. Snakes, Brit. Mus.*, Vol. II, 1893, pp. 77 and 87) separates the two genera on the posterior maxillary teeth. In *Dendrophis* the last 3 or 4 are distinctly enlarged, and compressed. In *Dendrelaphis* the posterior maxillary teeth though slightly more trenchant are not enlarged, but if anything rather shorter than the preceding teeth in the series. I have made a very critical comparison of all my skulls bone for bone, and can find no characteristic other than the posterior maxillary teeth that distinguishes the two genera.

Genus **Dendrophis**.

Dendrophis caudolineolatus Gunther.

Gunther's Dendrophis (or Bronze Back).

Dendrophis caudolineolatus, Boulenger, *Cat.*, Vol. II, p. 85; Ferguson, *Bomb. N.H.J.*, 1895, p. 72; Sarasin, *Zool. Jahr., Jena*, 1910, p. 128.

Dendrophis caudolineatus, Willey, *Spol. Zeylan.*, 1903, p. 86; *l.c.*, 1906 p. 233.

Colour.—Dorsally bronze. No buff anterior vertebral stripe. A series of blackish, equidistant, oblique, lateral stripes anteriorly. No buff flank stripe or black lines. Ventrally greenish, lighter anteriorly. Tail with two black lines on each side, the lower on the edges of the subcaudals and ultimate row of supracaudals. Head bronze above. No buff interparietal spot. A well defined black postocular stripe.

One erythritic specimen has passed through my hands. It was a uniform chocolate colour dorsally, and ventrally unrelieved by any markings. The upper lip, chin and throat were a dirty yellow.

Length.—My largest measured 876 mm. (2 feet 10½ inches). A juvenile specimen apparently recently hatched measured 305 mm. (12 inches).

Food.—I have found a frog in the stomach.

Breeding.—A gravid female was killed in the month of May on Hopewell Estate, Balangoda, measuring 870 mm. (2 feet 10¼ inches). It contained three very elongate eggs measuring 41×8 mm. ($1\frac{5}{8}\times\frac{3}{4}$ of an inch)

Lepidosis.—The scales are in 13 rows to behind midbody, and reduce to 9 before the vent. Ventrals, 149 to 164. Anal, divided. Subcaudals 119 to 128. Loreal, one. Temporals, 1+2+2 or 2+2+2. Supralabials, 8 (rarely 9), the 4th and 5th (5th and 6th when there are 9) touching the eye.

Dentition.—From one skull in my collection. Maxillary, 28 coryphodont. Palatine, 18 to 21. Pterygoid, 32 to 34. Mandibular, 27 to 30.

Distribution.—Ceylon; S. India.

Ceylon. Confined to the hills. Apparently uncommon and local. Sab'wa Prov. Balangoda, Udugama, (Haly); Hopewell Estate, Balangoda (F. W.); Illagalla (Haly).

S. India. Ramnad (Ind. Mus.), Travancore (Ferguson).

Note.—I have examined five specimens.

Dendrophis effrenis Werner.

Werner's bronze-back.

D. effrenis, Werner, *Rept. Nat. Hist. Mus. Hamburg*, 1909, p. 221.

Colour.—As in the last species.

Length.—884 mm. (2 feet 11 inches).

Lepidosis.—The scales are in 13 rows at midbody. Ventrals, 175. Subcaudals, 129. Loreal, none.

Distribution.—Ceylon. Said to be from Colombo.

Note.—May prove to be an aberrant example of *caudolineolatus*. In one specimen seen by me I have noted that the praefrontal is confluent with the loreal on one side.

Dendrophis gorei Wall.

Gore's Dendrophis (or Bronze Back).

Dendrophis pictus, Sclater, *List. Sn. Ind. Mus.*, 1891, p. 34 (part). Nos. 3945, 4042, 5703, 7705, 7707 and 7736.

Dendrophis gorei, Annandale, *Rec. Ind. Mus.*, 1912, pp. 37, 48 and 53 (part). (No. 16871 from Kobo); Wall, *Bomb. N.H.J.*, 1910, p. 829; *l.c.*, 1913, p. 639.

Colour.—Very like *D. pictus* variety *cyanochloris*. Dorsally bronze, blue-grey when the epidermis is shed, the bases and overlapped parts of the scales black, the latter enclosing turquoise-blue patches. No buff anterior vertebral stripe. A series of black equidistant, lateral, anterior bars. An ill-defined buff flank stripe ending at the vent, with no black lines above or below. No caudal stripes. Ventrally greenish or greyish. Head bronze above. No buff interparietal spot. No black-bordered, anterior supralabials. Loreal shield entirely or partially black. A well-defined black postocular stripe occupying the full depth of the temporal region.

Lepidosis.—Scales in 13 rows to behind midbody reducing to 11 or 9 before the vent. Ventrals 187 to 199. Anal, divided (entire in a specimen from Tounggyi, S. Shan States). Subcaudals, 139 to 153. Loreal as long as the nasals, its depth about two-fifths its length. Temporals, 1+1+2. Supralabials, 8 (9 in one example), usually the 2nd and 3rd touching the loreal, and 4th and 5th touching the eye.

Dentition.—From one skull in my collection. Maxillary, 24 to 25 coryphodont. Palatine, 13? to 15. Pterygoid, 21. Mandibular, 24? to 25.

Distribution.—Eastern Himalayas; Assam; Burma.

E. Himalayas. Darjeeling District (Nos. 7703, 7705, 7736).

Assam. Kobo, Abor Expedition (No. 16871, Ind. Mus.); near Dibrugarh (F. W.); Sibsagar (No. 4042, Ind. Mus.); Garo Hills (No. 3945, Ind. Mus.); Naga Hills, Jaipur (F. W.); Samaguting (No. 7707, Ind. Mus.).

Burma. S. Shan States (Tounggyi, Bombay colln.).

Dendrophis pictus (Gmelin).

Gmelin's Dendrophis (or Bronze Back).

Dendrophis pictus, Annandale, *J. A. S. Beng.*, 1905, pp. 174 and 175; Blyth, *Andaman Islanders*, pp. 305 and 306; Boulenger, *Cat.*, Vol. II, 1893, p. 78; Sarasin, *Zool. Jahr., Jena*, 1910, p. 131; Sclater, *List Sn. Ind. Mus.*, 1891, p. 34 (part). (Nos. 4074, 4483, 4484, 4485, 4486, 4487, 4489, 4490, 4491, 4492, 4493, 4494, 7682, 7683, 7686, 7687, 7691, 7692, 7696, 7698, 7700, 7701, 7704, 7706, 7709, 7710, 7711, 7712, 7714, 7718, 7734, 7735, 7886, 8614, 8615, 8894, 8897, 8898, 12542); Wall and Evans, *Bomb. N.H.J.*, 1900, p. 345; *l.c.*, 1901, p. 615; Wall *Bomb. N.H.J.*, 1909, p. 347; *l.c.*, 1910, pp. 787 and 827; ? *l.c.*, 1918, p. 509.

Dendrophis gorei, Annandale, *Rec. Ind. Mus.*, 1912, pp. 37, 48 and 53 (part), (Nos. 16836 and 16993).

Specimens of *pictus* present three distinct colour varieties.

Variety A. *typicus*.—Dorsally bronze. The bases of all scales black and the lateral borders of the vertebrals and lower borders of the costals black, enclosing a turquoise-blue patch. Ventrally uniform buff, greyish, or greenish-buff merging to buff anteriorly. No buff vertebral stripe anteriorly. A series of more or less distinct, equidistant, lateral, black, oblique bars anteriorly. A buff flank stripe with a well-defined black line below on the edges of the ventrals and ultimate row of scales. Sometimes a thinner black line above the buff on the upper half of the penultimate row. Tail with no black lines. Head bronze, the lore dusky not black. No anterior labials with black posterior borders though these may be dusky. A deep well-defined, black postocular stripe from the edge of the parietals to the edge of the supralabials. No buff interparietal spot.

In all the five South Indian specimens I have seen, the buff flank stripe is but faintly indicated or absent, and there are no black lines above or below this.

Food.—I have no records on this point.

Breeding.—I have seen no gravid specimen.

Length.—My largest specimen measured about 915 mm. (3 feet). I have seen juvenile examples apparently recently hatched measuring 298 and 330 mm. ($11\frac{3}{4}$ and $12\frac{1}{2}$ inches).

Lepidosis.—The scales are in 15 rows to behind midbody and reduce to 11 or 9 before the vent. Ventrals, 173 to 194. Anal, divided. Subcaudals, 131 to 160. The loreal is rather shorter than the nasals, and its depth about two-fifths its length. Temporals, normally 2+2+2. Supralabials, usually 9, the 2nd, 3rd and 4th touching the loreal, and the 4th, 5th and 6th the eye.

Dentition.—From one skull in my collection. Maxillary, 25. Palatine, 14. Pterygoid, 28. Mandibular, 22.

Distribution.—Hills of S. India; Bengal; Assam; Burma; Nicobars.

S. India. Uncommon, Ponmudi, Travancore (F. W.); Castle Rock, Mercara, Coorg, Thana (Bomb. N.H. colln.).

Bengal. Calcutta (No. 16661. Ind. Mus.).

Assam. Nasira (No. 7701, Ind. Mus.); Samaguting, Naga Hills (No. 7709, Ind. Mus.); Cachar (No. 14736, Ind. Mus.); Chittagong (No. 7886, Ind. Mus.); No loc. (No. 7686. Ind. Mus.).

Burma. Bhamo (No. 7696, Ind. Mus.); Upper Burma (No. 7698, Ind. Mus.); Tenasserim (Nos. 4074, 8614 and 8615 Ind. Mus.); S. Shan States (Taounggyi, No. 142-6, Bombay colln.) Common in Lower Burma (F. W.).

Nicobars. (No. 8894, Ind. Mus.); No loc. (No. 14575, Ind. Mus.).

Note.—No. 7698, Ind. Mus., from Upper Burma with 154 ventrals, anal divided, and 118 subcaudals (tail complete) and the praeocular touching the frontal on both sides, though coloured as above, suggests a distinct species.

Variety B. *cyanochloris.*—Differs from A in the ground colour which is blue-green, sometimes of a peculiarly vivid hue. The scales are more conspicuously outlined with black. There is no light flank stripe or a very obscure and ill-defined one, with no black lines above or below. The belly is eau-de-Nil or yellowish-green between the ventral keels.

Length.—I have examined two juvenile erythritic specimens, apparently hatchlings from the Nicobars, captured on the 27th of October, 1880, that measured 254 and 263 mm. (10 and 10⅜ inches). The largest example measured by me was 1220 mm. (4 feet).

Food.—A gecko provided the meal on one occasion, a frog on another.

Breeding.—One gravid female has passed through my hands killed in July. It measured 1087 mm. (3 feet 6¾ inches).

Lepidosis.—As in A. The ventrals, 175 to 207. Subcaudals, 129 to 153.

Dentition.—From five skulls in my collection. Maxillary, 20 to 21, coryphodont. Palatine, 13 to 14. Pterygoid, 18 to 26. Mandibular, 20 to 23.

Distribution.—Eastern Himalayas; Assam; Burma; Nicobars.

Eastern Himalayas. Fairly common (F. W.), Darjiling District. (Nos. 7704, 7734 and 7735, Ind. Mus.).

Assam. Abor Expedition (Nos. 16836 and 16993, Ind. Mus.); Jaipur (F. W.); Sibsagar (No. 7718, Ind. Mus.); Garo Hills (Tura, Nos. 18541 and 18542, Ind. Mus.); Khasi Hills (Cherrapunji, Nos. 7700 and 14883, Ind. Mus.); Naga Hills (Samaguting, Nos. 7706 and 7710, Ind. Mus.).

Burma, Sima (No. 142-15, Bombay coll.); Thandung Hills (No. 142-16, Bombay coll.).

Nicobars (Nos. 7711, 7712, 8886, 12542, 13516, 13517 and 17568, Ind. Mus.).

Note.—I have seen about thirty examples, four of which were erythritic specimens. These latter are brown dorsally and ventrally. The lore, the postocular stripe, the oblique anterior lateral bars and the edges of the scales are darker brown instead of black. Nos. 8897 and 8898 in the Indian Museum both apparently hatchlings from the Nicobars are examples. A third specimen of mine is also from the Nicobars. An adult in the Indian Museum with no number and no recorded locality is another example. In this the hue is cigar-brown dorsally and ventrally, rather lighter in hue between the ventral keels. Like the juvenile examples a still darker brown replaces the black marks of the usual blue-green specimens.

Variety C. *andamanensis.*—In this the prevailing hue is much like the last, being a bright blue-green. The scales are still more conspicuously outlined with black. The posterior two-fifths of the vertebrals are black. Oblique black lateral bars are more or less in evidence. There is no light flank stripe, and no black lines on the flanks, or on the tail. The belly is yellowish-green.

The loreal shield is black. The postocular black stripe is shallow and ill-defined above, and runs along the lower temporals, instead of occupying the whole depth of the temporal region.

Length.—The largest measurement in my notes is 1010 mm. (3 feet $3\frac{3}{4}$ inches).

Food.—I have taken a terrestrial frog from the stomach of one.

Breeding.—Two gravid females contained respectively four and eight eggs. These in one instance were remarkably elongate, measuring 38×9 mm. ($1\frac{1}{2} \times \frac{3}{8}$ of an inch). The smallest example was 1010 mm. (3 feet $3\frac{3}{4}$ inches). No dates were on record in either case.

Lepidosis.—As in *typicus*, except that the loreal is as long as the nasals, and its depth one-third, or less than one-third its length. Usually only the 5th and 6th supralabials touch the eye. Ventrals, 182 to 194. Subcaudals, 126 to 148.

Dentition.—From three skulls in my collection. Maxillary, 21 to 23, coryphodont. Palatine, 13 to 14. Pterygoid, 26 to 28. Mandibular, 23 to 25.

Distribution.—This appears to be quite peculiar to the Andamans. I have examined at least 25 specimens.

Note.—I have seen one melanotic specimen (No. 16396, Ind. Mus.). This is uniform bluish-black dorsally, a still deeper bluish-black replacing the black of normal specimens, i.e. on the lore, the postocular stripe, the oblique lateral anterior bars, and the edges of the scales. Ventrally it is uniform bluish-black merging to yellow on the throat and chin.

I acquired an erythritic example from the Indian Museum, No. 14498 from the Andamans. This was cigar-brown. The lore, postocular stripe, oblique lateral anterior bars, and the edges of the scales, and the posterior two-fifths of the vertebrals darker brown. The skull agrees in its dentition with the normal blue-green specimens, and is included among the three skulls already referred to.

Dendrophis grandoculis Boulenger.

Beddome's Dendrophis (or Bronze Back).

D. grandoculis, Boulenger, *Cat.*, Vol. II, 1893, p. 84; Ferguson, *Bomb. N.H.J.*, 1895, p 72; Sarasin, *Zool. Jahr., Jena*, 1910, p. 138.

Colour.—Dorsally brown (chocolate in a juvenile specimen 330 mm. in length). A series of lighter, oblique, lateral stripes forming saggitate marks with those of the opposite side, the points directed forwards. No light anterior vertebral stripe. No light flank stripe, and no dark flank lines. Ventrally light brown, the shade deepening posteriorly and merging to buff on the throat and chin. Three more or less distinct caudal stripes, the median along the middle of the subcaudals. Head brown. No light interparietal spot. No anterior supralabials with dark borders. No dark postocular stripe.

Lepidosis.—The scales are in 15 rows to behind midbody, reducing to 11 or 9 before the vent. Ventrals, 167 to 188. Anal,

divided. Subcaudals, 117 to 124. Loreal, rather shorter than the nasals, its depth half to less than half its length. Temporals, 2+2+2. Supralabials 9, the 2nd, 3rd and 4th touching the loreal, the 4th, 5th and 6th touching the eye.

Dentition.—Maxillary 29 ?, coryphodont. I have no skull.

Distribution.—Western Ghats, south of the Goa Gap; Travancore and Tinnevelly (Brit. Mus.); Nilgiris (Kollengode, Bombay colln.); Wynad (Brit. Mus.).

Dendrophis proarchus Wall.

Wall's Dendrophis (or Bronze Back).

Dendrophis pictus, Sclater, *List Sn. Ind. Mus.*, 1891, p. 34 (part) (Nos. 3998, 4046, 6909, 7680, 7713, 7717, 11368); Wall, *Bomb. N.H.J.*, 1907 p. 189.

D. proarchos, Wall, *Bomb. N.H.J.*, 1910, pp. 827 and 898.

Colour.—Very like variety *typicus* of *pictus*. Dorsally bronze, the bases and the overlapped edges of the scales black, the latter enclosing turquoise-blue patches. No buff anterior vertebral stripe. Blackish, equidistant, anterior, lateral bars more or less distinct. A conspicuous buff flank stripe ending at the vent with a thick black line below on the edges of the ventrals and ultimate row. A more or less distinct finer black line above on the upper half of the penultimate row. No caudal stripes. Ventrally greenish-grey or yellowish, lighter anteriorly. Head with no interparietal buff spot. The lore is dusky, not black, and none of the anterior supralabials have black borders. A well-defined, black, postocular stripe occupying the full depth of the temporal region.

There is a melanotic specimen in the Bombay collection from Tura, Garo Hills. This is deep blackish dorsally, with a narrow ill-defined lightish flank stripe posteriorly. Ventrally uniform bluish-clay coloured, merging to buff on throat and chin. Head blackish except the 5th and 6th supralabials which are buff. This strikingly resembles the melanotic specimens of *pictus* and *tristis* herein referred to.

Food.—I have found a gecko in one, and a tree-frog in another.

Breeding.—I have found seven eggs in two gravid females and eight in another. The eggs are very elongate as in other species of this genus. In one they measured 41×12 mm. ($1\frac{9}{32}\times\frac{1}{2}$ an inch). Specimens in which the eggs appeared fit for discharge were killed in May and June in Assam. The smallest prospective dam measured 1137 mm. (3 feet $8\frac{3}{4}$ inches).

Length.—My largest specimen measured 1296 mm. (4 feet 3 inches).

Lepidosis.—The costals are in 15 rows to behind midbody, and reduce to 9 before the vent. Ventrals, 181 to 196. Anal entire. Subcaudals, 141 to 157. The loreal is as long as the nasals, and its depth about two-fifths its length. Temporals, normally 2+2+2. Supralabials 9, the 2nd, 3rd and 4th touching the loreal, the 4th, 5th and 6th the eye.

Dentition.—From four skulls in my collection. Maxillary, 26 to 28, coryphodont. Palatine, 15 to 18. Pterygoid, 24 to 29. Mandibular, 25 to 29.

Distribution.—S. India; Bengal; Eastern Himalayas; Assam; Burma.

S. India. Upper Godavery District (No. 6909, Ind. Mus.).

Bengal. Jalpaiguri District (F. W.).

Eastern Himalayas. Darjiling District (F. W.).

Assam. As far north as Sadiya (F. W.); Sibsagar (No. 4046, Ind. Mus.); Narainpur (No. 3998, Ind. Mus.); N. Cachar (No. 11368, Ind. Mus.); Silchar (F. W.); Garo Hills (No. 7713, Ind. Mus.); Tura (Bombay coll.); Naga Hills (No. 7717, Ind. Mus.); Chittagong (F. W.).

Burma. Ramri Island, Arrakan (No. 7680, Ind. Mus.); Upper Burma (F. W.).

Dendrophis bifrenalis Boulenger.

Boulenger's Dendrophis (or Bronze Back).

Dendrophis bifrenalis, Abercromby, *Spol. Zeylan.*, 1911, pp. 205 and 207; Boulenger, *Cat.*, Vol. II, 1893, p. 80; Ferguson, *Bomb. N.H.J.*, 1895, p. 72; Sarasin, *Zool. Jahr., Jena* 1910, p. 128; Wall, *Bomb. N.H.J.*, 1913, p. 639; Werner, *Rept. Nat. Hist. Mus. Hamburg*, 1909, p. 246; Willey, *Spol. Zeylan.*, 1904, p. 116.

Colour.—Dorsally bronze, the bases and the edges of the scales black. The lower borders of the vertebrals and costals enclose a turquoise-blue patch. No buff anterior vertebral stripe. Usually a series of more or less distinct black, lateral, anterior, oblique bars. A light flank stripe sometimes faintly indicated with no black lines above or below, more usually absent. Ventrally above the keels dark olive, between the keels buff or greenish-yellow merging to buff anteriorly. No black lines on the tail. Head bronze above. No buff interparietal spot. Lore dusky sometimes black. A well-defined black posterior stripe. No anterior supralabials with black posterior edges.

Food.—I have twice found an arboreal frog in the stomach.

Breeding.—A Travancore specimen contained five large eggs, but the date of its capture is not on record.

Length.—Boulenger gives 1030 mm. (3 feet 4 inches). I have seen nothing larger.

Lepidosis.—The scales are in 15 rows to behind midbody, reducing to 11 or 9 before the vent. Ventrals, 154 to 176. Anal, divided. Subcaudals, 144 to 165. Loreals, two (1+1), taken together longer than the nasals. Temporals 1+1+2 or 2+2+2. Supralabials 9, the 2nd, 3rd and 4th touching the loreals, the 5th and 6th the eye.

Dentition.—From three skulls in my collection, one from Travancore and two from Ceylon. Maxillary, 22 to 25, coryphodont. Palatine, 12 to 14. Pterygoid, 21 to 27 (both extremes from Galle.) Mandibular, 23 to 27.

Distribution.—S. India, Ceylon.

S. India. Trivandrum (F. W.); Travancore (No. 13504, Ind. Mus.).

Ceylon. North Prov. (Vavuniya, Mullaitivu, Colombo Mus.); Sab'wa Prov. (Yatiyantota, Colombo Mus.); South Prov. (Galle, F. W.).

Note.—I have seen over twenty-five specimens.

Genus **Dendrelaphis.**

Dendrelaphis biloreatus Wall.

Wall, *Bomb. N.H.J.*, 1907, p. 273, *l.c.*, 1910, p. 830.

Colour.—Dorsally bronze, the bases and overlapped portions of the scales black, the lower borders enclosing a turquoise-blue patch. No buff anterior vertebral stripe. A buff flank stripe on the lower half of the penultimate, and the whole of the ultimate row, ending at the vent. Head bronze above. A black loreal stripe. A deep postocular stripe. No buff interparietal spot. Lips buff, the anterior labials are edged with black posteriorly.

Length.—699 mm. (2 feet $3\frac{1}{2}$ inches).

Lepidosis.—Costals in 13 rows to behind midbody, reducing to 9 before the vent. Ventrals, 192. Anal, divided. Subcaudals, 147.

Distribution.—Assam, Sadiya.

Dendrelaphis subocularis (Boulenger).

Fea's Dendrelaphis (or Bronze Back).

Dendrelaphis subocularis, Boulenger, *Cat.*, Vol. II, p. 89; Malcolm-Smith, *Bomb. N.H.J.*, 1915, p. 785.
Dendrophis subocularis, Sclater, *List Sn. Ind. Mus.*, 1891, p. 35.

Colour.—Extremely like *Dendrelaphis tristis.* Dorsally bronze, the bases and overlapped portions of the scales black. A buff anterior vertebral stripe. A series of more or less distinct blackish equidistant, anterior, lateral bars. A buff flank stripe to the vent on the upper half of the ultimate and lower half of the penultimate rows. No black lines above or below the flank stripe. No caudal lines or stripes. Belly yellowish or greenish-yellow. Head bronze above. No buff interparietal spot. Loreal more or less black. The first four supralabials with narrow black posterior borders. A black postocular stripe occupying the full depth of the temporal region.

Length.—820 mm. (2 feet $8\frac{1}{4}$ inches).

Lepidosis.—The scales are in 15 rows to behind midbody, reducing to 11 or 9 before the vent. Ventrals, 158 to 188. Anal, divided. Subcaudals, 74 to 104. Loreal, rather shorter than the nasals, its depth about two-fifths its length. Temporals, 2+2+2. Supralabials 8, the 2nd and 3rd touching the loreal, 5th (apparently a confluence of two shields) touching the eye.

Dentition.—Maxillary 18 ?, isodont or subisodont, not coryphodont. I have no skull.

Distribution.—Burma; Siam; Indo-China.

Burma. Bhamo (Brit. Mus., No. 7697, Ind. Mus.).

Siam. Bangkok, and Fat Bua Kao (Bombay colln.); Deu Chai, Sriracha Koh Lam and Bangtophan (Malcolm-Smith).

Indo-China. Pavie Mission.

Dendrelaphis tristis (Daudin).

Seba's Dendrelaphis (or Bronze Back).

Dendrophis pictus, Abercromby, *Spol. Zeylan.*, Vol. IX, p. 146; *Sn. of Ceylon*, 1910, pp. 45, 48 and 75; Annandale, *Mem. A.S. Beng.*, Vol. I, p. 194; Boulenger, *Cat.*, Vol. II, 1893, p. 337 (part); D'Abreu, *Bomb. N.H.J.*, 1917, p. 306; Ferguson, *Bomb. N.H.J.*, 1895, p. 73; Green, *Spol. Zeylan.*, 1906, p. 220; Sclater, *List Sn. Ind. Mus.*, 1891, p. 34 (part), (Nos. 7684, 7685, 7715, 7716, 7720, 7721 and 12952); Wall, *Bomb. N.H.J.*, 1905, p. 301; Willey, *Spol. Zeylan.*, Vol. I, p. 117; *l.c.*, 1906, p. 233.

Dendrelaphis tristis, Boulenger, *Cat.*, Vol. II, 1893, p. 88; Luard, *Bomb. N.H.J.*, 1917, p. 306, Sarasin, *Zool. Jahr., Jena.* 1910, p. 131; Wall, *Bomb. N.H.J.*, 1909, pp. 347 and 757; *l.c.*, 1910, pp. 35 and 776; *l.c.*, 1919, p. 567.

Colour.—Dorsally bronze, the bases and overlapped portions of the scales narrowly edged with black. The lower black borders enclosing patches of turquoise-blue. A buff anterior vertebral stripe. More or less distinct, black, paired, lateral, anterior bars. A buff flank stripe ending at the vent with a black line above on the upper half of the penultimate row of scales. Sometimes an indistinct indication of a black line below the flank stripe. No caudal lines or stripes. Ventrally greyish, greenish, or yellowish, lighter anteriorly. Head bronze above. A small round buff spot in the middle of the interparietal suture, tending to effacement in some old specimens. Lore dusky not black. The 2nd, 3rd and 4th (sometimes 1st also) supralabials with thin posterior black borders. A thin black postocular stripe just above the supralabials, ill-defined above.

A specimen in the Bombay collection (No. 146-8) from Nilambur is melanotic. It is a deep bluish-black dorsally with an ill-defined light flank stripe between the ultimate and penultimate rows. Ventrally bluish-clay-coloured, merging to buff on the throat and chin.

Food.—In its natural haunts it feeds upon lizards of the families Agamidae, Geckonidae, and Scincidae, and frogs of both arboreal and terrestrial genera. It has been seen to attack a snake of the genus *Typhlops*. Young specimens, I am told, by Mr. Green, feed on grasshoppers, and Dr. Annandale told me one of his assistants once saw one eating a butterfly. In captivity in the Madras Museum it takes frogs and toads with avidity.

Breeding.—From 4 to 10 eggs are produced at a time. These are unusually elongate. Eggs deposited in Mr. Green's vivarium in Peradeniya, Ceylon, measured 28 × 9 mm. ($1\frac{1}{8} \times \frac{3}{8}$ of an inch). I have found them even larger before deposition, one measuring

32 × 11 mm. ($1\frac{1}{4}$ × $\frac{7}{16}$ of an inch). I have had a gravid female with the ovarian follicles impregnated in September, and others in which the eggs were nearly mature in December and February. Mr. Green's eggs were deposited in January. Abercromby says the period of gestation is from 4 to 5 months, and the period of incubation from 4 to 6 months. My smallest gravid female was 1028 mm. (3 feet $4\frac{1}{2}$ inches).

Length.—This varies from about 266 mm. ($10\frac{1}{2}$ inches) at the time of hatching to 1320 mm. (4 feet 4 inches).

Lepidosis.—The scales are in 15 rows to behind midbody, reducing to 11 or 9 before the vent. Ventrals, 163 to 197 (163 to 187 in S. Indian examples, 190 to 197 in Bengal, Himalayan, and Burma examples). Anal, divided. Subcaudals, 120 to 140 (112 to 146 in S. Indian examples, 128 to 131 in Bengal, Himalayan and Burma examples). *Loreal*, shorter than the nasals, its depth about two-fifths its length. Temporals, 2+2+2. Supralabials 9, the 2nd and 3rd touching the loreal, and the 5th and 6th the eye.

Dentition.—From eleven skulls in my collection. Maxillary, 17 to 22, isodont or scaphiodont. Palatine usually 11 to 13 (14 in a Nilgiri specimen). Pterygoid usually 19 to 26 (28 to 29 in a Nilgiri specimen, 29 to 30 in a Ceylon specimen). Mandibular usually 20 to 24 (24 to 25 in a Ceylon specimen, 24 to 26 in a Nilgiri specimen).

Distribution.—Penisular India; Eastern Himalayas; Burma.

Peninsular India. As far north as Sind (Brit. Mus.).

Bengal. Jalpaiguri Dist. (Kalna. F. W.).

Eastern Himalayas. Darjiling Dist. not uncommon (F. W.). (Brit. Mus., No. 18666, Ind. Mus., Nos. 146-10 and 142-8, Bombay colln.).

Burma. Mergui (Nos. 7684 and 7685, Ind. Mus.).

Dendrelaphis caudolineatus (Gray).

Gray's Dendrelaphis (or Bronze Back).

Note.—The occurrence of this species in India rests on the authority of Beddome. Two specimens in the British Museum are labelled. "Wynad" donor Colonel Beddome. I discredit this locality, as many of Beddome's localities are open to the strongest doubts.

SYNOPSIS OF DENTITION.

	Max.	Pal.	Ptergd.	Mand.
pictus A	25	14	28	22
,, B	20—21	11—14	18—26	20—23
,, C	21—23	13—14	26—29	23—24
gorei	24—25	13—15	21	24?—25
proarchus	26—28	15—18	25—29	25—29
bifrenalis	22—25	12—14	21—27	24—27
caudolineolatus	28—29?	18—21	31—34	27—30

		Max.	Pal.	Ptergd.	Mand.
tristis	Ceylon	21	13	29—30	24—25
,,	S. India	19—22	11—14	21—29	21—26
,,	N. India	17—21	11—13	19—24	20—23

ERRATUM.

Line 12 from top of page 164, *for* "Stomata" *read* "Stigmata."

XVIII. NOTES ON A SMALL COLLECTION OF PENTASTOMIDS FROM THE INDIAN MUSEUM, CALCUTTA.

By Mary L. Hett, *B.Sc., Professor of Biology, Lady Hardinge Medical College, Delhi.*

The majority of the Pentastomids in this collection from the Indian Museum have already been described by other observers. Several, however, were unnamed specimens which could be referred to four different species; namely: *Porocephalus pattoni*, Stephens, *Porocephalus moniliformis*, Diesing, *Porocephalus kachugensis*, Shipley, and *Raillietiella bifurcata* var. *orientalis*, Hett. A few points of interest in each of these are worth noting.

Porocephalus moniliformis, Diesing.

(*a*) One specimen from the stomach of a python. This is of interest owing to the fact that adult *Porocephalus* are found as a rule in the air-passages or body-cavity of their host. Their occurrence in the stomach and intestine has been recorded in a few instances, but this situation is unusual.

(*b*) A larval specimen encysted on the stomach of *Tragulus javanicus*. It may be noted that *T. javanicus* is a new host for this species.

Porocephalus pattoni, Stephens.

Adult.

(*a*) Two ♀, one ♂ from the lung of *Zamenis* sp.

(*b*) Two ♀ from the coelom of *Z. mucosus*.

Larval forms.

(*c*) Encysted specimens from the mesentery of the rat-snake.

(*d*) ,, ,, on the stomach wall of *Bungarus fasciatus*.

In (*c*) the specimens were too young to be identified with absolute certainty, but I have little doubt that they belong to *P. pattoni*. It may be noted with reference to (*d*) that *Bungarus fasciatus* is a new host for *P. pattoni*.

The occurrence of the encysted forms of this species in snakes (the final host) is also interesting in that it lends support to the view that in at least some species of *Porocephalus* the life-history is normally carried out in one host.

Raillietiella bifurcata var. orientalis, Hett.

A number of specimens from the lungs, intestine and coelom of the common cobra (*Naia tripudians*); also from the coelom of

the rat-snake, together with an encysted specimen from the body-cavity of the cobra. Here again the presence of encysted specimens in the snake points to a single host.

Porocephalus kachugensis, Shipley.

From the liver of *Batagur baska*.

I have made a careful examination of these specimens, and, by the courtesy of the authorities of the Indian Museum, Calcutta, I have also had an opportunity of examining the type specimens from *Kachuga lineata*. I am therefore able to add the following particulars to the original description.

1. The mouth is rounded and slightly narrowed anteriorly.

2. Stomata are numerous and scattered irregularly over the whole surface of the body.

3. One specimen (presumably a male) had an anterior genital aperture.

4. The annulations, according to Shipley, were confined to the ventral surface, but I find that, though partially obliterated, they are in many places visible the whole way round the body. They are more conspicuous on the ventral surface owing to the presence in that region of the fine chitinous rods mentioned by Shipley, but the whole body is clearly annulated as in the majority of Pentastomids.

I am inclined to think that this is the larval form of *Porocephalus megacephalus*, Baird, with which it agrees in shape and number of rings. In his species the annulations were faintly marked on the dorsal surface, and the ventral surface was flattened and wrinkled. Length 20—25 mm., breadth of head 8—10 mm., body diminishing rapidly in size towards the tail. In *B. kachugensis* the length of body is from 9—12 mm. and breadth of cephalothorax about 4 mm. These proportions resemble those of *P. megacephalus*, the difference in size being easily explained by difference in age. In *P. kachugensis* the hooks are markedly double, while those of *P. megacephalus* are single, but larval forms frequently have double hooks which are shed at metamorphosis and replaced by single ones in the adult.

The host of *P. megacephalus* is the Soonderbund crocodile, *Crocodilus palustris*, while *P. kachugensis* has been found in the mud-turtles *Kachuga lineata* and *Batagur baska*, all from the same zoo-geographical region.

Baird described the male *P. megacephalus* as larger than the female, and as possessing a posterior genital aperture. I have examined Baird's specimens in the British Museum, and have little doubt that his statements were based on a misconception of the true relations of the organs. *P. kachugensis* certainly has an anterior genital aperture in the male.

XIX. FISH AND FISHERIES OF MANIPUR WITH SOME OBSERVATIONS ON THOSE OF THE NAGA HILLS.

By SUNDER LAL HORA, *M.Sc., Officiating Assistant Superintendent, Zoological Survey of India.*

(Plates IX—XII.)

CONTENTS.

The collection dealt with in this paper was made by the Zoological Survey Party which visited Manipur in February and March, 1920, and also to a large extent by myself. My best thanks are due to Sardar Dogar Singh, the State Overseer at the time of our visit, who after the departure of Dr. Annandale and other members of the party gave me material assistance in the collection of specimens and in arrangements for touring. He accompanied me to most of the places in the valley and helped me in various other ways. I am also indebted to Mr. A. C. Eleazar for giving me photographic prints from his valuable collection of negatives. Some of these are reproduced here as illustrations. To the Political Agent, Mr. C. W. R. Cosgrave, I am indebted for the services of a man who gave me great assistance in collecting.

My sincere thanks are due to Drs. Annandale and Kemp, to

the former for the great help and valuable suggestions that he gave to me throughout the preparation of this paper, and to the latter for going through the manuscript with me. Dr. Annandale's Monograph[1] on the Fish and Fisheries of the Inlé Lake has served me as a model in writing up the results of my investigations. The illustrations were executed under my supervision by the artists of the Zoological Survey with their usual skill and I must express my indebtedness to them for this work.

INTRODUCTION.

Only a few species of fish have hitherto been recorded from the Manipur Valley and the hills in its immediate vicinity. Day, in his volumes in the *Fauna of British India* records only three from the Naga Hills, *Erethistes hara*, *E. elongata* and *Danio aequipinnatus*. Specimens of other species have, however, been collected in small numbers from time to time in the streams of these mountains. Over half a century ago a small collection was made by Col. H. H. Godwin-Austen, but so far as my knowledge goes no account of it has been published. More recently, in 1910, the Rev. Mr. Pettigrew sent to the Indian Museum a small collection of fish from the hill streams of Northern Manipur. The species in this collection, as Dr. Annandale informs me, were all obtained in the hill country, probably from the neighbourhood of Ukhrul which is situated at an altitude of 6,000 ft. Two new species found by Mr. Pettigrew, *Nemachilus manipurensis* and *Danio naganensis*, were described by Dr. B. L. Chaudhuri,[2] while notes on some of the other species are incorporated here.

The list of the species given below is based on the information obtained from all these sources and from our own collection, which is of course much the largest. Under the name Naga Hills I include all the country inhabited by Naga tribes and not merely the district to which the name is officially applied.

LIST OF FISHES OBTAINED FROM MANIPUR AND THE NAGA HILLS.

Loktak Lake.

Clarias batrachus (Linn.).
Callichrous bimaculatus, Bloch.
Macrones bleekeri, Day.
Labeo calbasu (Ham. Buch.).
Labeo pangusia (Ham. Buch.).
Barbus sarana caudimarginatus, Blyth.
Rohtee belangeri (C. and V.).
Lepidocephalichthys irrorata, sp. n.
Ambassis ranga (Ham. Buch.).
Ophiocephalus harcourt-butleri, Annand.
Barbus conchonius (Ham. Buch.).
Barbus ticto (Ham. Buch.).

[1] Annandale, *Rec. Ind. Mus.*, XIV, pp. 33—64, pls. i—viii (1918).

[2] Chaudhuri, *Rec. Ind. Mus.*, VII, p. 443, pl. xl, figs. 4, 4*a*, 4*b* and pl. xli, figs. 1, 1*a*, 1*b*; p. 441, pl. xl, figs. 1, 1*a*, 1*b* (1912).

Sluggish Streams in the Manipur Valley.

Clarias batrachus (Linn.).
Wallago attu (Schn.).
Callichrous bimaculatus, Bloch.
Marcrones bleekeri, Day.
Macrones (*Macronoides*) *affinis* (Blyth).
Glyptothorax[1] *dorsalis*, Vinciguerra.
Glyptothorax minutus, sp. n.
Gagata cenia (Ham. Buch.).
Garra nasutus (McClelland).
Labeo calbasu (Ham. Buch.).
Labeo angra (Ham. Buch.).
Labeo pangusia (Ham. Buch.).
Crossochilus latia (Ham. Buch.).
Barbus ticto (Ham. Buch.)
Barbus conchonius (Ham. Buch.).
Barbus sarana caudimarginatus, Blyth.
Rohtee belangeri (C. and V.).
Rohtee alfrediana (C. and V.).
Barilius barila (Ham. Buch.).
Danio (*Brachydanio*) *acuticephala*, sp. n.
Botia berdmorei (Blyth).
Botia histrionica, Blyth
Lepidocephalichthys berdmorei (Blyth).
Lepidocephalichthys irrorata, sp. n.
Acanthophthalmus pangia (Ham. Buch.).
Nemachilus zonalternans (Blyth).
Ambassis ranga (Ham. Buch.).
Mastacembelus manipurensis, sp. n.
Ophiocephalus harcourt-butleri, Annand.

Streams with Rocky Bed in the Southern Watershed of the Naga Hills.

Garra rupiculus (McClelland).
Garra abhoyai, sp. n.
Crossochilus latia (Ham. Buch.).
Barbus hexastichus, McClelland.
Barbus conchonius (Ham. Buch.).
Barbus oatesii, Boulenger.
Barilius barila (Ham. Buch.).
Barilius dogarsinghi, sp. n.
Danio æquipinnatus (McClelland).
Danio naganensis, Chaudhuri.
Danio (*Brachydanio*) *acuticephala*, sp. n.
Lepidocephalichthys berdmorei (Blyth).
Acanthophthalmus pangia (Ham. Buch.).
Nemachilus manipurensis, Chaudhuri.
Nemachilus zonalternans (Blyth).
Nemachilus sikmaiensis, sp. n.
Nemachilus kangjupkhulensis, sp. n.
Nemachilus prashadi, sp. n.

Streams with Rocky Beds in the Northern Watershed of the Naga Hills.

Erethistes hara (Ham. Buch.).
Erethistes elongata, Day.
Psilorhynchus, sp., Hora.
Garra naganensis, sp. n.
Barbus clavatus, McClelland.
Barbus tor (Ham. Buch.).
Barilius barila (Ham. Buch.).
Danio dangila (Ham. Buch.).
Danio aequipinnatus (McClelland).
Lepidocephalichthys guntea (Ham. Buch.).

[1] In a paper to be published shortly I give reasons for adopting this name in preference to *Glyptosternum*.

Barbus hexastichus, McClelland.
Rasbora rasbora (Ham. Buch.).
Barilius bendelisis var. *chedra* (Ham. Buch.).
Nemachilus botia (Ham. Buch.).
Badis badis (Ham. Buch.).
Rhynchobdella dhanashorii, sp. n.
Ophiocephalus punctatus, Bloch.

I will now discuss separately the fishes of the four areas enumerated above.

The fish-fauna of the Loktak Lake is, unlike that of the Inlé Lake,[1] not at all specialized. Of the dozen species obtained from it none are endemic, and all these have also been found in the streams of the valley. The only new species from the lake is a small loach of the genus *Lepidocephalichthys* which was equally abundant all over the valley. The major part of our collection was made in the sluggish streams of the flat country. Here four new species were discovered, one of the genus *Lepidocephalichthys* also found in the Loktak Lake, and others belonging to the genera *Mastacembelus*, *Danio* and *Glyptothorax*. Except the *Mastacembelus*, which may grow to a foot or more in length, the new forms are all very small and apt to be overlooked while collecting. Of the remaining species *Barbus phutunio* is said to have been introduced in the Residency ponds from outside the valley. We obtained a large series of specimens but only from these ponds. The eel (*Monopterus albus*) was found buried in mud at the edge of the lake and in rice-fields and was not obtained from any of the streams.

Most of the new species I collected are from the hill streams of the southern watershed which flow into the Manipur Valley from the adjacent Naga Hills. Their restricted distribution is not surprising since they are only found in localised areas in these streams. The new forms chiefly belong to two genera, *Nemachilus* and *Barilius*.

Of the species listed under the heading "Northern watershed, Naga Hills," *Ophiocephalus punctatus*, *Rasbora rasbora*, *Badis badis* and *Rhynchobdella dhanashorii* were netted by me at Dimapur in the plains just north of the Naga Hills. The discovery of a species of *Rhynchobdella* so far inland is interesting. A parallel instance may be given of a marine genus *Moringua*, which has been recorded from the Abor country by Dr. B. L. Chaudhuri.[2] Most of the species obtained in the Naga Hills were collected in the Mithapani and Senapati Streams near Kairong on the main northern watershed of the range. The rest were captured in small streams at various points on the road between the Manipur Valley and Dimapur.

As a result of our investigations 56 species are now known to inhabit the Manipur Valley and the Naga Hills. Of these 27 belong to the family Cyprinidae, 12 to the Cobitidae and 10 to the Siluridae. The remaining seven species are distributed among the families Symbranchidae, Mastacembelidae, Ophiocephalidae,

[1] *Rec. Ind. Mus.*, XIV, pp. 33—64 (1918).
[2] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 255 (1913).

Nandidae and Percidae. The large number of species and individuals of the first three families, and especially of the family Cyprinidae is a noteworthy feature of the fish-fauna of these regions. Moreover, the members of these families that live in hill streams show certain adaptive characters which are dealt with in detail under a separate heading.

THE PHYSICAL AND OTHER CONDITIONS AS THEY AFFECT THE FISH.

In the general introduction to the fauna of the Manipur Valley, Dr. N. Annandale has given an account of the Loktak Lake. I need here only mention a few of the features that seem to have a special bearing on the fish-fauna.

Dr. Annandale has referred to the luxuriance of vegetation in the lake and has pointed out that it is blocked up to the surface by a thick growth of *Potamogeton*, *Hydrilla* and *Trapa*. From the fact that no specimen of fish, more than a few inches in length, was found in the lake, it is evident that this thick vegetation, while providing food and shelter for the fish, is inimical to the existence of big species, probably because it would retard their progress and make them an easy prey to water-birds, otters, etc. Cover plays a great part in the life of fish and the readiness with which they seek it in the lake is fully illustrated by the devices employed by the Manipuris in capturing them.

Except the snake-headed fish (*Ophiocephalus harcourt-butleri*) and three species of Siluridae, all the fish generally feed on aquatic weeds, on small worms or insect larvae in the mud. Surface-feeding fish (*Nga-wa*) though abundant in the streams of the valley are totally absent from the lake.

The destruction of fish brought about by man's agency is enormous and in fishing Manipuris do not spare the small forms, which only inhabit the lake. After man the most active agents of destruction are certain species of birds. The stomachs of a few cormorants shot near Potsengbaum were found to be full of specimens of *Lepidocephalichthys berdmorei* and *Monopterus albus*. Large numbers of these birds were often observed sitting on floating islands and feeding on the fishes in the lake. The ducks and geese for which this lake is famous among sportsmen do not appear to do much harm, judging from the contents of their stomachs, unless it be by destroying spawn.

On dissection several species of fish were found to be infected with round worms, but the degree of parasitisation was not very high.

The fish of the sluggish streams in the Manipur Valley comprise all those that live in the lake and include some of those the proper habitat of which is the mountain torrents. It is not surprising to find species of *Glyptothorax*, *Garra*, *Nemachilus* and other highly specialized genera in muddy streams when it is realised that within a short distance a mountain torrent may become a

sluggish stream in almost level country. During my tour I was able to make collections from the same stream at different places where the bed was sometimes rocky and sometimes muddy. For example I made a collection in the Thaubal stream near Yaribuk where it is muddy and sluggish and in the same stream about 1 mile from Phadai, where it flows rapidly over a rocky bed. Similarly in Sikmai Stream I made collections at two different places, one near Vabgai in the valley and the other near Palel some six miles from Kakching village, where the stream may be called a torrent. A comparison between the species obtained from the latter stream in the two places is instructive.

Muddy and sluggish, near Vabgai.	Flowing rapidly over a rocky bed, near Palel.
Acanthophthalmus pangia.	*Acanthophthalmus pangia.*
Crossochilus latia.	*Crossochilus latia.*
Macrones bleekeri.	*Garra rupiculus.*
Lepidocephalichthys berdmorei.	*Barilius barila.*
Lepidocephalichthys irrorata.	*Nemachilus zonalternans.*
	Nemachilus sikmaiensis.
	Nemachilus prashadi.

It will be observed that examples of *Garra* and *Nemachilus*, the only genera that exhibit adaptations to life in hill-streams, are found at Palel where the water flows rapidly over a rocky bottom, while those of *Lepidocephalichthys* and *Macrones* that prefer a muddy bottom are only found near Vabgai where the stream is sluggish and muddy. The remaining two species, belonging to *Acanthophthalmus* and *Crossochilus*, are capable of existence under both conditions.

The greatest specialization is found, however, among those fish that actually live in rapid waters. In the species of the genus *Barilius*, the paired fins are greatly expanded and some of their outer rays have become very strong. In older specimens definite muscle-pads are developed on either side of the chest in front of the bases of the pectoral fins. In loaches the mouth is specialized to form a sucker, and by the help of its thick lips the fish are enabled to stick to stones and withstand rapid currents. In *N. sikmaiensis* the mouth is not specialized, but this is compensated for by the higher specialization of the paired fins which are greatly expanded and are provided with muscles on their ventral aspect. The disc of *Garra* and the chest-muscles of *Glyptothorax* are examples of extreme modifications due to adaptation to a particular environment.

GEOGRAPHICAL RELATIONS.

The fish dealt with in this paper belong to two watersheds. The line separating these is a ridge some three miles from Kairong,

between it and Kanglatombi among the Naga Hills. The Imphal River, the chief river of the valley, rises near Kanglatombi and flowing southwards through the valley ultimately joins the Chindwin, a tributary of the Irrawadi. The streams of the northern watershed on the other hand form part of the Brahmaputra System.

Seventeen species of fish belonging to six families and 12 genera are represented from the northern watershed. All the families are widely distributed in the waters of the Oriental and Ethiopian Regions.

Of the 12 genera, 11 are distributed in the freshwaters of the adjacent country, while the genus *Rhynchobdella*, which has hitherto only been found in the deltas of all the large rivers of India and Burma, is now for the first time recorded from far inland.

Of the 17 species, 4 are only known from the Naga Hills. Of the rest, 9 are distributed all over India and Burma and the remaining 4 do not extend to Burma but occur along the base of the Himalayas. *Barbus clavatus*, which is redescribed in this paper, has so far been known from a single specimen obtained from a river at the base of the Sikkim mountains.

On the whole the fauna of the northern watershed, so far as the fish are concerned, is chiefly Assamese and only differs from that of the Brahmaputra Valley in so far as it contains hill-stream species.

Forty-two species of fish collected from the southern watershed belong to six families and 21 genera. All the families are widely distributed in the Oriental and Ethiopean Regions. Of the 21 genera, 20 are widely distributed in India and Burma, while the genus *Monopterus* is confined to south-eastern Asia and has not so far been recorded from the Assam Valley. Of the 42 species, 18 are widely distributed in India and Burma; 11 are known only from Manipur; the remainder with the exception of 3 are exclusively Burmese. Of these 7 were recorded and described from the Sitang River by Blyth,[1] two have been described from the S. Shan States (one by Boulenger[2] and the other by Annandale[3]), and the remaining species by Vinciguerra[4] from Meetan. The only Assamese species are *Garra rupiculus*, which was described from the Mishmi Hills north-east of the Brahmaputra Valley, and *Garra nasutus* of the Khasi and the Mishmi Hills. Annandale,[5] while dealing with the Batrachians of the Abor country, adduced evidence to show that the fauna of the Khasi, Mishmi and other adjacent hill tracts is similar and differs from that found on the other side of the Brahmaputra River. My results confirm the above statement.

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[1] Blyth, *Journ. As. Soc. Bengal*, XXIX, pp. 138—174 (1860) [(1889).

[2] Boulenger, *Ann. Mag. Nat. Hist.*, (6) XII, p. 201 (1893).

[3] Annandale, *Rec. Ind. Mus.*, XIV, p. 54, text-fig. 2, pl. 2, fig. 7; pl. iv, figs. 16, 17 (1918).

[4] Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, XXIX, p. 246, pl. vii, fig. 4

[5] Annandale, *Rec. Ind. Mus.*, VIII, p. 36 (1912).

Barbus phutunio, a widely distributed Indian species, is said to have been introduced into ponds in the Residency gardens at Imphal, in which alone it was found, as an ornamental fish.

Thus we see that the two important elements of the fish-fauna of the S. watershed are the endemic Manipur element and the Burmese element. The endemic element is chiefly confined to the hill-streams and strictly speaking is an isolated one. Some of the species (for example *Botia histrionica*, *Botia berdmorei*, *Macrones affinis*, *Nemachilus zonalternans*, *Lepidocephalichthys berdmorei*), which have so far been known only from a small number of specimens obtained in Burma, are among the commonest species of the Manipur Valley and are represented by large series in our collection.

LOCAL NAMES OF FISH AND THEIR ECONOMIC VALUE, ETC.

Nga is the ordinary word both in Burma and Manipur for fish; but it is never omitted by Manipuris, except in a few cases, when referring to a particular species. Even the large water-bug (*Belostoma indicum*), which Manipuris eat, is called *Nga-Ki-Hum*. Those fish that do not occur in the valley, but are found in the northern watershed, are called comprehensively *Ching-Nga* or "mountain-fish." For most of these species I could obtain no Manipuri name.

Most of the local names were checked in the field by calling them out to a party of fishermen and getting the corresponding fish. The meanings of the names were for the most part given to me by Tumba Singh, whose services were lent to us by the Political Agent. They were also confirmed by other persons, who knew the Manipuri language very well.

There was some difficulty in writing the local names in roman characters, because it was rather difficult to follow their sound, which is partly nasal. However, I was able to get a complete list of the Manipuri fishes in Hindi characters, which I can read myself, and the spellings of the various names may thus be regarded as fairly reliable.

The Manipuris are a very intelligent and observant people and in giving names to the various species have had some regard either for its habit, colouration or resemblance to other animals (*e.g. sarinkhoibi*=otter mouthed). Thus all the species of Barilius are called *Nga-wa*, "air-fish," and all *Nemachilus* with vertical bands *Nga-tup*, "segmented-fish," and any striped fish *Nga-rang*, "striped-fish."

During my visit to Manipur I obtained a considerable amount of information regarding the local names of fish, their value as food and the method by which they are captured and cooked. In the table below I have given the names of all species from the area with which this paper deals, though in a few cases I have not been able to discover the local names or their meanings.

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
	Family SYMBRANCHIDAE.			
1	*Monopterus albus* (Zuiew).	*Nga puram.*	No explanation was given by the Manipuris. Kaboi Nagas call it *kha-roi*, snake-fish	Manipuris do not eat this fish, because, as they informed me, this name comes after those of all other eatable fish in their holy book, the Puranas. Nagas catch it by a two pronged spear and smoke it without salting.
	Family SILURIDAE.			
2	*Clarias batrachus* (Linn.).	*Nga-kara* ..	"Burnt black fish" The name refers to its black colour.	Fairly good eating. This is captured in large numbers in swamps by cutting the grass and scooping out the water.
3	*Wallago attu* (Schn.).	*Sareng* ..	"Big fish"	Good eating The biggest fish sold in the market.
4	*Callichrous bimaculatus* (Bloch).	*Nga tin.* ..	*tin* "to spit" or "a bow." The dorsal profile in this fish is like a bow; also, according to the Manipuris, the fish spits when taken out of water.	Fairly good eating. During the rainy season, its roe is ground and fried and is used in making a kind of flat cake.
5	*Macrones bleekeri*, Day.	*Nga-chep* ..	*chep* implies the habit of the fish when taken out of water. It shuts and opens its mouth constantly.	Fairly good eating. It is said to have few bones.
6	*Macrones* (*Macronoides*) *affinis* (Blyth).	*Nga-rang* ..	"Striped fish." The name is derived from *arangbah*. This adjective is used for other things also.	Good eating.
7	*Glyptothorax dorsalis* (Vinciguerra)	*Nga-pang.*	*pang* from *pangwa* "innocent." This implies the habit of the fish which does not dart away when disturbed but remains quietly in the same place and is easily caught.	It is said to be full of fat and oil.
8	*Glyptothorax minutus*, sp. nov			
9	*Gagata cenia* (Ham. Buch.).	*Nga-rang* ..	[See No. 6 above] ..	The Manipuris do not distinguish this species from *M. affinis*.
10	*Erethistes hara* (Ham. Buch.).	....	....	These species are not represented in our collection. They are known to occur in the Naga Hills.
11	*Erethistes elongata*, Day.			
	Family CYPRINIDAE.			
12	*Psilorhynchus* sp., Hora.	....	....	....
13	*Garra nasutus*, McClelland.	*Nga-mu-sangum.*	*mu* "black"; *sangum* "an umbrella" or "a mushroom" in reference to the mental disc. According to others *sangum* is an insect	Fairly good eating, said to be rich in oil.

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
			which lives in grass and by its bite produces a swelling.	
14	*Garra naganensis*, sp. nov.	....	....	....
15	*Garra abhoyai*, sp. nov.	....	....	....
16	*Garra rupiculus*, McClelland.	*Nug-nga* ..	"Stone fish" ..	Nagas eat it.
17	*Labeo calbasu* (Ham. Buch.).	*Paing-ba* or *Pemba*.	A fish with a red streak below the cheek and with red iris. *Pemba* denotes red.	Good eating but bony.
18	*Labeo angra* (Ham Buch.).	*Kha-bag*.	*kha*-mouth; *bag* denotes the fleshy appendages which surround the mouth.	Good eating. They are chiefly used for extraction of oil in which other fish and vegetables are fried.
19	*Labeo pangusia* (Ham. Buch.).	do.		
20	*Crossochilus latia* (Ham. Buch.).	*Nga-rohi* or *nga rohi mapi*.	*rohi* "round," in reference to the cylindrical form of the fish. The young are called *nga-rohi* and the adults *nga-rohimapi* the mother of *nga-rohi*.	The young are bitter in taste while the adults are slightly bitter but not bony,
21	*Barbus sarana caudimarginatus*, Blyth.	*Nga-noi* ..	*noi* "fat;" the young of this fish are called *nga-hau* at Wangjing village.	Full of bones; though its flesh is said to have good flavour.
22	*Barbus oatesii*, Boulenger.	....	.. .	....
23	*Barbus clavatus*, McClelland.	*Samehet* ..	"Comb fish," in reference to the denticulations along the dorsal spine.	The fish was obtained at Kairong and only the Naga name is given here.
24	*Barbus tor* (Ham. Buch.)	....	....	....
25	*Barbus hexastichus*, McClelland.	*Huru* ..	"Restless fish," makes *hur-hur* agitation or trembling in the water.	Few people eat it fresh. It is generally dried in big trays and then ground into powder, which is used as a condiment like pepper with vegetables.
26	*Barbus ticto* (Ham. Buch.)	*Nga-kha* ..	*khaiba* "bitter." The Manipuris compared the taste of these fishes to that of a tobacco leaf.	
27	*Barbus conchonius* (Ham Buch.).	do. ..	....	....
28	*Barbus phutunio* (Ham. Buch.)	do. ..	....	....
29	*Rasbora rasbora* (Ham. Buch.).	....	....	....
30	*Rohtee belangeri* (C. and V.).	*Tharak* ..	"Flat and thin" ..	[See No. 17 above].
31	*Rohtee alfrediana* (C. and V.).	*Nga-shiksha*	"Compressed fish" ..	Fairly good eating.
32	*Barilius bendelisis* var. *chedra* (Ham. Buch.).	*Nga-wa*.	*wa* "air;" in reference to the surface feeding habits of the fish. At Kairong some Manipuris called it *nga-ra* on account of the blue bands on the sides of the body.	The intestine, which is also eaten, is said to be bitter. The fish is, however, good eating.
33	*Barilius barila* (Ham. Buch.).			
34	*Barilius dogarsinghi*, sp. nov.	do.		

Serial No.	Scientific name.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
35	*Danio dangila* (Ham Buch.).	....	....	....
36	*Danio acquipinnatus* (McClelland).	....	....	....
37	*Danio* (*Brachydanio*) *acuticephala*, sp. nov.	....	....	....
38	*Danio naganensis*, Chaudhuri.	....	....	....
	Family COBITIDAE.			
39	*Botia berdmorei* (Blyth).	*Sarin Khoibi*	"Otter-mouthed fish."	Very good eating.
40	*Botia histrionica*, Blyth	*Nga-rang.*	"Striped fish" in reference to its black and white colour.	do.
41	*Lepidocephalichthys guntio* (Ham. Buch.)	....	....	....
42	*Lepidocephalichthys berdmorei* (Blyth)	*Nga kshrou* or *Nga-ki-jarau*	*kshrou* "loose mud." The fish lives in loose mud hence the name. The second name signifies its slimy skin like that of a leech *jarau*.	It is generally smoked, but people occasionally eat it fresh.
43	*Lepidocephalichthys irrorata*, sp. nov.	*Nga-nap* ..	*nap* denotes the action of pressing a thing between the fingers hence "a compressed fish."	Manipuris do not like it fresh and generally smoke it.
44	*Acanthophthalmus pangia* (Ham. Buch.).	*Nga-sang* ..	*sang* "thin and long" ..	[See Nos. 25—28 above.]
45	*Nemachilus botia* (Ham. Buch.).	....	....	....
46	*Nemachilus zonalternans* (Blyth).	*Nga-rem* ..	....	....
47	*Nemachilus manipurensis*, Chaudhuri.	*Nga-sarva*	....	....
48	*Nemachilus kangjupkhulensis*, sp. nov.	*Laingoi-phumba* or *Sarin*	*phumba* "sand," the fish lives in sand and hence the name.	....
49	*Nemachilus sikmaiensis*, sp. nov.	*Nga-tup*	*tup* "segmented," in reference to the vertical band on the sides.	[See No. 42 above.]
50	*Nemachilus prashadi*, sp. nov.	do.		
	Family PERCIDAE.			
51	*Ambassis ranga* (Ham. Buch.).	*Nga-mahi* ..	"Silvery fish" in reference to the colour of the abdomen.	Bony, not bitter.
	Family NANDIDAE.			
52	*Badis badis* (Ham. Buch.).	*Pona* ..	"Deep-black" ..	....
	Family MASTACEMBELIDAE.			
53	*Rhynchobdella dhanashorii*, sp. nov.	....	....	....
54	*Mastacembelus manipurensis*, sp. nov.	*Nga-rin* ..	"Snake-fish" ..	Fairly good eating. It is generally smoked.

Serial No.	Scientific names.	Local name.	Meaning of the local name.	Economic value of the species and other particulars.
	Family Ophiocephalidae.			
55	*Ophiocephalus harcourt-butleri*, Annandale.	*Nga-mu* ..	"Black fish" ..	Fairly good eating, very common in swamps, especially near the Loktak Lake.
56	*Ophiocephalus punctatus*, Bloch.	....	....	....

Besides those fish given in the table above, there are others that visit the valley only during the rains. For convenience of reference I give their vernacular names, but as they are not represented in our collection I am unable to give their scientific equivalents.

Nga-mu-poram.—Imported for sale in a dried condition from Silchar.

Sna-nga=gold fish.

Nga-cha-hu or *Nga-chau.*—This fish is dreaded by local fishermen, because even a mild injury inflicted by its spine causes the swelling of all lymphatic glands, while a deep wound results in fever which may last for two to three days. It is said to be good eating

Nga-khro-bi.—This literally means "a fish with its mouth on the under surface." It is said to have a large upper lip.

Muglang.—This fish, like *nga-noi*, has a red operculum, caudal fin, belly, and streak of the same colour along the dorsal surface. Manipuri cartmen gave me this name for *Rasbora rasbora* at Dimapur, but I had no opportunity of verifying their statements from any other sources.

Nga-thi=ugly fish.

Nga-pa-hi.—The fish is said to hop like a sparrow.

Nga-hi=boat fish, in reference to its form like the Manipuri dugout.

Nga-len.—From *lenghba*=one that does not move. A remarkable account of the method of capture was given to me. The Mohammedan fishermen who alone capture and eat this fish dive and search for it under water. On discovering a fish, they come out and take a rope with them and dive again to the same place. They tie the rope round the tail of the fish being always careful not to touch its belly as this immediately disturbs it. The rope is now taken on shore and two or three people drag the fish out. It is said to be the most powerful fish in the valley.

For the following names I have no explanation:—*Nga-san*; *Nga-ril*; *Nga-chik*; *Nga-na-hi*; ; *Nga-nal*; *Nga-tin-charo*; *Nga-rel.*

The Manipuris do not take any other animal diet but fish, and practically all species found in the valley, except the *Nga-puram* and the *Nga-len*, to which they have a religious objection, are eaten. All are said to be more or less "bitter," when compared with the dried fish imported in large quantities from Sylhet, Cachar and from various other places. Below I have arranged the fish according to their food value as determined by Manipuris.

Good eating.—*Khabag*; *Sarin-khoi-bi*; *Sáreng*; *Nga-chep*; *Nga-rang*; *Nga-pang*; *Nga-chau*; *Nga-wa*.

Fairly good.—*Nga-rin*; *Nga-mu*; *Nga-kara*; *Nga-tin*; *Nga-mu-sangum*.

Fairly good but bony.—*Nga-tol*; *Nga-rohi-mapi*

Very bitter.—*Haru*; *Nga-kha*; *Nga-sang*; *Nga-rohi*.

Smoked before eating.—*Nga-kshrou*; *Nga-nap*; *Nga-rin*; *Nga-tup*.

The fish sold fresh in the markets are:—*Nga-mu*; *Nga-kara*; *Nga-tin*; *Nga-chep*; *Sareng*.

Of these the first two are very common and are sold in a living condition in the market. The rest of the species except *Sareng* are also brought to the market dried. The major part of the freshfish sold in Imphal comes from Waithu-pat and the dried fish are mostly from the Thanga Island.

SYSTEMATIC DESCRIPTION OF THE COLLECTION FROM THE MANIPUR VALLEY AND THE NAGA HILLS.

Order SYMBRANCHOIDEA.

Family SYMBRANCHIDAE.

Monopterus albus (Zuiew).

1916. *Monopterus albus*, Weber and Beaufort, *Fishes Indo-Austr. Arch.*, III, p. 413, figs. 210, 211.

1918. *Monopterus albus*, Annandale, *Rec. Ind. Mus.*, XIV, p. 42.

Monopterus albus is found all over southern Asia east of the Bay of Bengal; its range extends to northern China and Japan.

The fish is only found buried in mud at the edge of the Loktak Lake. Some specimens were also found in the rice-fields in partially dried ponds. It is eaten by Nagas but not by Manipuris, who have certain religious scruples regarding the species. The Nagas, like the Inthas in the Inlé Lake, capture the fish with a two-pronged spear.

Cormorants, judging from the contents of their stomachs, seem to feed largely on this species.

Order OSTARIOPHYSI

Family SILURIDAE.

Clarias batrachus (Linn.).

1913. *Clarias batrachus*, Weber and Beaufort, *Fishes Indo-Austr. Arch.*, II, p. 190, fig. 74 (p. 187).
1918. *Clarias batrachus*, Annandale, *op. cit.*, p. 43.

This species is common everywhere in the valley, especially in and about the Loktak Lake. In the market it is usually sold in a living condition. Though the fish is very common in the swampy portion of the lake, it is also fairly abundant among the weeds further inwards. It does not grow to a very large size in the valley.

Adults are black in colour, but not quite so dark as young individuals. There are minute white spots forming distinct rows all over the body. The pectoral spine is roughened externally and finely serrated along its posterior border.

All the specimens in our collection are from the Loktak Lake.

Wallago attu (Schn.).

1889. *Wallago atiu*, Day, *Faun. Brit. Ind. Fish.*, I, p 126 fig. 54.
1889. *Wallago attu*, Vinciguerra, *Ann. Mus. Stor. Nat. Genova*, (2) IX, p. 199.

This was the biggest fish brought to the Manipur market at the time of our visit. Waithu-pat, a lake on either side of the Burma Road some 10 miles from Imphal, is particulary noted for this species.

It is found throughout India, Burma and Ceylon.

Callichrous bimaculatus (Bloch).

1889. *Callichrous bimaculatus*, Day, *op. cit.*, p. 131, fig. 57.
1889. *Callichrous bimaculatus*, Vinciguerra, *op. cit.*, p. 201.
1919. *Ompok bimaculatus*, Jordon and Starks, *Ann. Carnegie Mus.*, XI, p. 434.

Young specimens of this species are very difficult to distinguish from those of *C. macrophthalmus* (Blyth). In the identification of the Manipur specimens I have followed Vinciguerra, though an examination of the collection in the Indian Museum has shown that much reliance cannot be placed on the character of the vomerine teeth.

The specimens in the collection were obtained from Imphal and Khurda streams and from the Loktak Lake. There is a great variation in colour even in specimens from the same locality Some are silvery-white all over the body with a black blotch on either side above the pectorals ; while in others the body is densely covered with minute black spots on a dull-white background, and the mark above the pectorals is not distinct.

In the valley *C. bimaculatus* does not reach a larger size than 9 to 10 inches.

Macrones[1] bleekeri, Day.

1889. *Macrones bleekeri*, Day, *op. cit.*, p. 162.
1889. *Macrones bleekeri*, Vinciguerra, *op. cit.*, p. 219.

The adipose fin of this species has a very great resemblance to that of *M. cavasius* and *M. leucophasis*. The difference between the three species may be expressed in a table as follows :—

M. cavasius (H.B.).	*M. leucophasis* (Blyth).	*M. bleekeri*, Day.
Maxillary barbels reach the caudal fin.	Maxillary barbels reach the anal fin.	Maxillary barbels reach the anal fin.
A black spot at the base of the first dorsal spine.	The head and fore part of the body bright silvery-white; no black spot at the base of the first dorsal spine.	Light longitudinal bands along the body; sometimes with a black shoulder spot. In the Burmese examples a black spot is also present at the base of the caudal fin.
Depth of body $5\frac{1}{2}$ times in the total length.	Depth of body $4\frac{1}{2}$ times in the total length.	Depth of body $5\frac{1}{2}$ times in the total length.
No interneural bone.	An interneural bone present.	No interneural bone.

The fish is very common all over the valley and is captured in large numbers in traps, both in the streams and the lakes.

The specimens from the Loktak Lake are darker in colour.

Subgenus Macronoides, nov.

This new subgenus is proposed for species which differ from typical *Macrones* in the possession of a distinct ventral mouth bordered by fringed lips; in having short barbels not exceeding the length of the head; in the mandibular pairs of barbels being disposed in a transverse row across the mandible and in the possession of a number of open pores on the ventral surface of the head just behind the mouth. In general facies the fish of this subgenus show a remarkable resemblance to those of the genus *Gagata*, from which, however, they are easily distinguished by the crescentic band of teeth and a free air-bladder in the abdominal cavity.

I assign the following species to the new subgenus :—*Macrones affinis* (Blyth),[2] *M. dayi* Vinciguerra[3] and *M. marianiensis* Chaudhuri.[4] I have examined the types of the first and the third; while Vinciguerra's description and figures of *M. dayi* leave no doubt as to its affinity with the other two.

[1] Jordan, *Proc. Acad. Nat. Sci. Phil.* LXX, p. 341, considers *Macrones* a synonym of *Aoria*; but in view of the familiarity of the name *Macrones*, I have retained it in this paper.
[2] Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 150 (1860).
[3] Vinciguerra, *op. cit.*, p. 230, pl. vii, fig. 3 (1889).
[4] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 253, pl. xi, figs. 1, 1*a*, *b* (1913).

The subgenus *Macronoides* is distributed in Burma, the Abor Hills and the Manipur Valley.

Macrones (Macronoides) affinis (Blyth).

1860. *Batasio affinis*, Blyth, *op. cit.*, p. 150.
1889. *Macrones blythii*, Day, *op. cit.*, p. 151.

The fishermen of Manipur do not make any distinction between this fish and *Gagata cenia*, both of which are called *nga-rang*. The body is dotted with black spots which are aggregated in certain regions to form 3 or 4 indistinct vertical bands. Both the adipose and the spiny dorsal are edged with black. The alimentary canal is simple and has only two coils in its entire length.

Reference may be made to the importance which has been attached to the number of serrations on the pectoral spine. I have, however, found on examining a large number of specimens that the number of serrations is variable not only in different individuals, but even in the spines of the two sides of the same specimen.

There are four specimens from Amambi stream near Karam Lakai, about 8 miles from Imphal on the Burma Road.

M. affinis is known from Burma and the Manipur Valley.

Glyptothorax dorsalis, Vinciguerra.

1889. *Glyptothorax dorsalis*, Vinciguerra, *op. cit.*, p. 246, pl. vii, fig. 4.

There are ten specimens of this species, five from the Imphal stream and the rest from Amambi stream, some eight miles from Imphal on the Burma road.

The maxillary barbels reach the posterior margin of the base of the pectoral fin; the upper surface of the head and body is tuberculated, the tubercles being arranged in longitudinal rows. The dorsal spine is roughened externally and is smooth along its inner border; that of the pectoral fin is flattened and has 11 denticulations internally.

Most of the female specimens are full of eggs.

The species is known from Burma and the Manipur Valley.

Glyptothorax minutus, sp. nov.

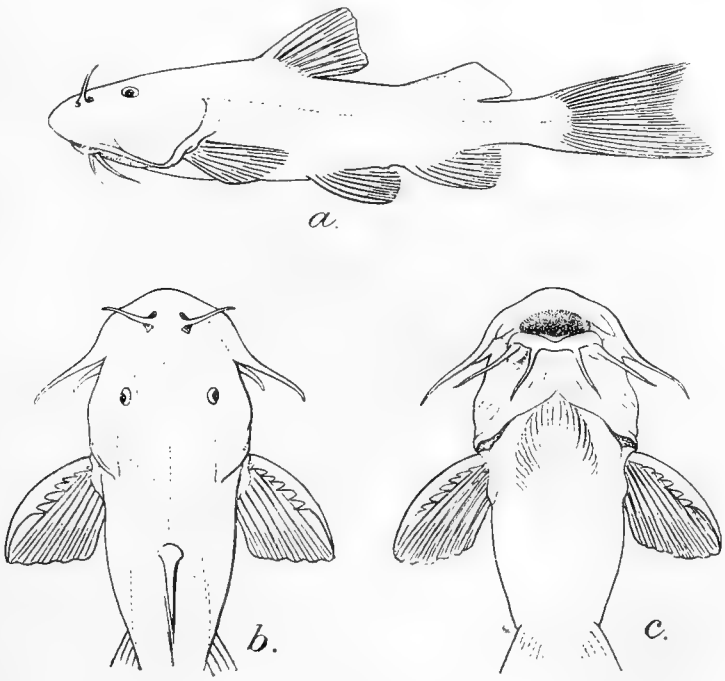
D. 1/6. A. 3/9.

The length of the caudal fin is contained 5—$5\frac{1}{4}$ times, the depth of the body $5\frac{1}{3}$—6 times and the length of the head $5\frac{1}{2}$—$5\frac{3}{4}$ times in the total length including the caudal fin. The head is $1\frac{1}{4}$ times as long as broad. The eyes are minute, situated in the beginning of the posterior half of the head, they are dorso-lateral in position and are not seen from the ventral surface. *Barbels.*—The maxillary pair reach the base of the pectoral, the nasals reach the eye, the inner mandibular reach the anterior

margin of the adhesive apparatus and the outer the gill membrane. *Fins.*[1]—The adipose fin is well developed; both the dorsal and the pectoral fins have loose folds of skin at their bases, the spine of the former is smooth while that of the latter is smooth externally and has six denticulations internally. The lower lobe of the caudal fin is slightly the longer.

The adhesive apparatus is **U**-shaped and is fairly well developed.

Colour.—The dorsal surface is dark, while the belly and the undersurface of the head are white; there are conspicuous black



Text-fig. 1.—*Glyptothorax minutus*, sp. nov.
(*a*) Lateral view of adult fish, × $2\frac{1}{2}$.
(*b*) Upper view of head of same, × 3.
(*c*) Lower view of head of same, × 3.

bands at the bases of all the median fins; the caudal is grey and the paired fins are colourless. A **V**-shaped whitish area is also present at the base of the dorsal fin.

Four specimens were obtained from the Imphal stream near Karong. Manipuris do not make any distinction between this species and the preceding one.

[1] In giving the formula of the fin rays, I have attached great importance to the number of branched rays both in the dorsal and the anal fins. In the descriptions of the new species I have omitted the number of fin-rays in the caudal fin, because it is very difficult to count the smaller rays on either side after the longest ray. I have included, however, the length of the caudal fin in the total length.

Originally I regarded these specimens as the young of *G. dorsalis*, but on dissection I found the females full of eggs. Besides the smaller size, the species is distinguished from *G. dorsalis* by differences in the proportions of the body, the colouration and by the number of denticulations on the pectoral spine.

The largest specimen is 36 mm. in length.

Unfortunately the specimens are lost; but the figures clearly show all the features.

Gagata cenia (Ham. Buch.).

1889. *Gagata cenia*, Day, *op. cit.*, p. 208, fig. 75.
1889. *Gagata cenia*, Vinciguerra, *op. cit.*, p. 249.

This species is always confused by Manipuris with *Macrones* (*Macronoides*) *affinis*.

All the specimens from Manipur are young; they were only found in the Imphal and the Amambi streams.

The species is widely distributed in the waters of the Ganges and the Irrawadi.

Family CYPRINIDAE.

Psilorhynchus sp., Hora.

Plate IX, figs. 6, 6*a*.

1920. *Psilorhynchus* sp., Hora, *Rec. Ind. Mus.*, XIX, p. 211.

A few young specimens were collected in a small hill-stream at Piphima, Naga Hills.

Garra (Ham. Buch.).

Three species of this genus were discovered in the Manipur Valley and the Naga Hills by the survey party and myself. Of these two are represented by a large series in our collection while the remaining one, which is new, is known from a single specimen. In Mr. Pettigrew's collection there are three specimens of this genus. They represent another undescribed form.

The discussion on these species is given in another paper in which I am publishing a revision of the genus *Garra*. The names that I propose to give to the new species are included in the list for the sake of completeness.

Labeo calbasu (Ham. Buch.).

1889. *Labeo Calbasu*, Day, *op. cit.*, p. 259, fig. 93.
1889. *Labeo calbasu*, Vinciguerra, *op. cit.*, p. 265.

Only one specimen, 28·5 cm. in length, was obtained; it was captured in Khurda stream near its origin from the Loktak Lake.

The fins are much elongated. The ventrals are longer than the pectorals and reach beyond the base of the anal, which in turn extends beyond the base of the caudal fin. The dorsal fin has a fairly long base.

The colour is black all over except the under surface of the head and chest, which is dirty white.

Labeo pangusia (Ham. Buch.).

1889. *Labeo pangusia*, Day, *op. cit.*, p. 266.
1913. *Labeo angra*, Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 249.

The specimens of *L. pangusia* from Manipur have a black blotch at the base of the caudal fin and are apt to be confused with those of *L. angra*. They can be distinguished from the latter species by the possession of definite barbels instead of the maxillary flaps inside the grooves, one on either side of the mouth, and in having a triangular black spot just above the fifth scale of the lateral line. The structure of the mouth and lips of the two species is also different.

Labeo pangusia is common in the streams of the valley and three specimens were collected from the Loktak Lake. The lake specimens are darker in colour.

Labeo angra (Ham. Buch.).

1889. *Labeo angra*, Day, *op. cit.*, p. 267.
1889. *Labeo angra*, Vinciguerra, *op. cit.*, p. 273.

The specimens of this species agree with Burmese examples in our collection. They possess a fleshy flap inside the groove instead of the maxillary barbels on each side of the mouth. There is a deep black blotch at the sides of the tail. In certain young individuals there is also an indication of a second blotch above the middle of the pectoral fin.

The specimens in the collection were found in the muddy streams of the Manipur Valley.

Crossochilus latia (Ham. Buch.).

1889. *Cirrhina latia*, Day, *op. cit.*, p. 279.
1889. *Crossochilus latius*, Vinciguerra, *op. cit.*, p. 280.
1918. *Cirrhina latia*, Annandale, *op. cit.*, p. 46.

This fish is found in abundance in the muddy streams of the valley, and does not exceed 7 inches in length.

The young specimens are slender in form and look somewhat different from the adults. Manipuris call the young *nga-rohi* and the adults *nga-rohi-mapi*, "the mother of *nga-rohi*."

This is one of the commonest species found in the streams of the Manipur Valley.

Barbus sarana caudimarginatus, Blyth.

1860. *Barbus caudimarginatus*, Blyth, *op. cit.*, p. 157.
1918. *Barbus sarana caudimarginatus*, Annandale, *op. cit.*, p. 46.

The species is fairly common in the Imphal River and its tributaries and is also found in the Loktak Lake. The lake specimens are, however, darker in colour.

Barbus oatesii, Boulenger.

1893. *Barbus oatesii*, Boulenger, *Ann. Mag. Nat. Hist.* (6) XII, p. 201.

Annandale[1] regarded this species as being synonymous with *Barbus sarana caudimarginatus*, Blyth, after comparing his specimens from the Inlé Lake with a cotype of Boulenger's *oatesii* and as a result of his examination of a series of specimens of *B. sarana* from India and Burma in the collection of the Indian Museum. In identifying my specimens I have referred to the same sources, and am convinced after a careful examination of the large series, that *B. oatesii* is a distinct species and that Annandale's own specimens undoubtedly belong to the true *B. sarana caudimarginatus*.

The most important difference between the two species is in the structure of the dorsal spine In *B. oatesii* it is strong and very strongly serrated, with 12 to 19 serrations on each margin of its posterior border. The serrations along the two margins of the spine are very close together and become longer and stronger from below upwards. In *B. sarana caudimarginatus* the spine is strong but finely serrated only in its upper half or two-thirds, the serrations are subequal. Along the posterior aspect, the spine is deeply grooved and the serrae are situated on its margins; their number is indefinite. The colour of the two species is also different. In both the forms, however, the opercular cleft has a black edge, which probably led to the confusion of the two species. In *B. oatesii*, as Boulenger observed, each scale is edged with black. This condition is not so well-marked in the cotype examined by Annandale, because the colour has become very faint on account of the specimen having been in spirit for over a quarter of a century. There can be no doubt regarding the colouration of the young specimens collected by me in Thaubal stream about a mile from Phaidai. Under a lens the black edge is seen to consist of minute black dots which are more closely aggregated along the anterior border of the scale.

The caudal fin is also different in the two species. In *B. oatesii* it is long and deeply notched, the lower lobe being broader and longer. In *B. sarana caudimarginatus* the caudal fin is relatively shorter in length, and is not so deeply notched. The two lobes are equal in length.

The proportions are also different in the two species.

In young specimens the length of the caudal fin, the depth of the body and the length of the head are almost equal and are contained $4\frac{1}{2}$—$4\frac{2}{3}$ times in the total length. The caudal fin is very brittle and is broken in most specimens. The following are the measurements of two complete young individuals:—

	A.	B.
Total length including caudal ..	53 mm.	57 mm.
Length of caudal	11 ,,	13 ,,
Depth of body	11 ,,	12·3 ,,
Length of head	12 ,,	12·7 ,,

[1] Annandale, *Rec. Ind. Mus.*, XIV, p. 46 (1918).

B. oatesii is now known from the S. Shan States and the Manipur Valley.

Barbus clavatus, McClelland.

Plate IX, fig. 1.

1845. *Barbus clavatus*, McClelland, *Calcutta Journ. Nat. Hist.*, V, p. 280, pl. xxi, fig. 2.
1868. *Barbus clavatus*, Günther, *Cat. Fish. Brit. Mus.*, VII, p. 97.
1878. *Barbus clavatus*, Day, *Fish. India*, II, p. 560.
1889. *Barbus clavatus*, Day, *op. cit.*, p. 300.

There has been some confusion between *Barbus chagunio* (Ham. Buch.), *B. spilopholus*, McClell. and *B. clavatus*, McClell. At first McClelland [1] considered *B. chagunio* to be "a variety of the spotted barbel, *B. spilopholus*," but later in describing *B. clavatus* he remarked that "the collection now before us, affords, however, a very distinct species, which I believe to be the *Cyprinus chagunio*, Buch." Günther regarded McClelland's two species as distinct, but placed *Cyprinus chagunio* with a query under the synonymy of *B. clavatus*. Day recognised *B. chagunio* as a distinct species and regarded *B. spilopholus* as its variety; he moreover considered *B. clavatus* as a distinct species. Chaudhuri [2] recognised *B. spilopholus* as a valid species, but had no material to decide about *B. clavatus* as it was then only known from McClelland's description which is unfortunately imperfect and meagre and some casual remarks in it are misleading; his figure of the species is also poor.

I take this opportunity to supply a short description and a figure of the species from a few well-preserved examples collected in Senapati stream near Kairong, Naga Hills, Assam.

D. 4/8. A. 3/5. P. 14—15. V. 8—9.

The length of the caudal fin equals the depth of the body which is contained 4—$4\frac{1}{2}$ times in the total length. The head is short and conical, its length being contained 5—$5\frac{3}{4}$ times in the total length; it is comparatively longer in young specimens than in the adult. The snout is shorter than the diameter of the eye, which is contained about 3 times in the length of the head. The caudal peduncle is $1\frac{3}{4}$—2 times as long as broad. *Fins.*—The origin of the dorsal is almost in the middle of the distance between the end of the snout and the base of the caudal fin, in some individuals it is nearer to the former. Its last spine is denticulated posteriorly and is almost as high as the depth of the body below it. The free margin of the fin is deeply concave. The caudal fin is very long and deeply forked, its rays are very brittle. *Scales.*—There are 40—42 scales along the lateral line, 7—8 rows of scales above it and $3\frac{1}{2}$—$4\frac{1}{2}$ below it to the base of the ventral fin. In an oblique line there are in all 11 rows between the bases of the dorsal and the ventral fins. There are 14

[1] McClelland, *Asiat. Resear.*, XIX, pp. 272 and 341 (1839).
[2] Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 250, pl. viii, figs. 1, 1*a*, *b* (1913).

scales in front of the dorsal. *Barbels.*—Both pairs of barbels are well developed Maxillary barbels are longer than the rostrals and are as long as the diameter of the eye.

The vent is much nearer the base of the caudal fin than the end of the snout.

The mouth is semicircular; its opening extends to the anterior border of the orbit. There are two rows of open pores on the under surface of the head. The snout is usually tuberculated, but in young individuals these tubercles are not developed.

The fish is blackish blue in the region above the lateral line, below it the sides and the ventral surface are dull white. The membranous portions of the skin between the rays of the dorsal fin are black in colour. The caudal along its superior and inferior margins is edged with black. The young specimens are brighter in colour and possess an obscure blotch at the base of the caudal fin. In some specimens the scales along the lateral line and of a few rows above and below it are covered by minute black spots, forming longitudinal bands along the side

Barbus clavatus is found in rivers at the foot of the Sikkim mountains on the northern frontier of Bengal and in the Naga Hills at Kairong.

Barbus hexastichus, McClelland

1889. *Barbus hexastichus*, Day, *op. cit.*, p. 308.
1889. *Barbus hexastichus*, Vinciguerra, *op. cit.*, p. 291.

Three grown up specimens were obtained at Kairong. They possess an indistinct black spot on either side of the tail. This character is best marked in the young fry collected at various places in small streams in the Naga Hills and also in Itok stream near Chanderkhong in the Manipur Valley.

Barbus tor (*s.l.*) (Ham. Buch.).

Only one specimen of this species was obtained from Senapati stream near Kairong, Naga Hills. The lips in the example are well developed and are provided with thick adipose growth

Barbus tor is a composite species and I hope to deal with its races and species in a separate paper when sufficient material from various localities is available.

Barbus conchonius (Ham. Buch.).

1889. *Barbus conchonius*, Day, *op. cit.*, p. 325.

Numerous specimens of this species were collected in lakes and streams all over the valley.

Barbus phutunio (Ham. Buch.).

1889. *Barbus phutunio*, Day, *op. cit.*, p. 327.

Numerous specimens of *Barbus phutunio* were collected from the Residency ponds, Imphal. The following description of the

colour of the living specimens was noted down by Dr. Annandale in the field-book :—" The dorsal surface brownish, deeply tinged with metallic green and dotted with black, sides metallic crimson, each scale edged with black ; ventral surface silvery ; pelvic, anal and caudal fins crimson ; dorsal and pectoral bright olivaceous green with the rays more or less infuscated and with black spots on the dorsal. Iris crimson, lower part of the cheek and operculum silvery white densely speckled with black."

S. Dogar Singh informed me that these fish were introduced into the Residency ponds from outside the Manipur Valley on account of their beautiful colouration.

Barbus ticto (Ham. Buch.).

1889. *Barbus ticto*, Day, *op. cit.*, p. 325.

This is the commonest fish in the valley and is daily captured in large quantities with baskets.

Rasbora rasbora (Ham. Buch.).

1889. *Rasbora buchanani*, Day, *op. cit.*, p. 337, fig. 107.

Only two specimens were captured from the Dhanashori stream, near Dimapur, Assam. In both specimens the scales have been rubbed off leaving the black edged membranes behind. The caudal fin is tipped with black as in the Burmese examples.

Rohtee, Sykes.

Some ichthyologists have adopted the generic name *Osteobrama*, Heckel, in preference to *Rohtee*, Sykes, probably owing to a confusion as to the dates of publication of the works of Heckel and Sykes. Günther in his "*Catalogue of the Fishes in the British Museum*," VII, p. 322, gives 1842 as the date of publication of the two works and selects *Osteobrama*, with Sykes' genus *Rohtee* as a synonym. Vinciguerra (*op. cit.*, p. 313) in adopting the same course writes as follows :—" Ho adottato il nome generico di *Osteobrama*, a preferenza di quello di *Rohtee*, perchè, mentre essi sono di data sincrona, poichè il lavoro di Heckel in cui il primo è proposto (Russegger's Reisen I, p. 1033) fu pubblicato nel 1842 data che porta anche quello di Sykes, in cui è stabilito il secondo (Trans. Zool. Soc. Lond. II, p. 364), quello ha sull'altro il vantaggio di non essere barbaro come esso." I do not agree with the authorities quoted above and find that Sykes' work was published on 27th February, 1841 ; while Heckel established *Osteobrama* in 1843. According to the rules of priority, therefore, *Rohtee* must have preference over *Osteobrama*. Vinciguerra's second argument for adopting *Osteobrama* is purely sentimental and therefore needs no consideration.

Another point deserving some consideration is, as to whether

Hamilton Buchanan's[1] eighth subgenus "*Cabdio*" of his *Cyprinus* should be revived in place of *Rohtee* or not, as it includes *Cyprinus* (*Cabdio*) *cotio* which is now regarded as a *Rohtee*. On a careful analysis of the subject, however, I find that *Cabdio* can not replace *Rohtee* because the forms assigned to *Cabdio* by Hamilton Buchanan include species which have subsequently been assigned to several genera and Sykes (1841) was the first to separate some species, in practice if not in theory, for in describing *Rohtee ogilbii* he observes as follows:—"The *Rohtee* has the appearance of *Clupanodon chanpole* of Dr. Hamilton; also of *Cyprinus devario* in the outline of the body; and were it proper to consider it a *Cyprinus*, which its armed back-fin renders impossible, it would be placed in Dr. Hamilton's eighth subgenus '*Cabdio*.'" Sykes in making the above remark ignored the fact that Hamilton Buchanan's *Cyprinus cotio* had a spine of this nature. Further, of the four species included under *Rohtee* by Sykes, two *viz. Rohtee pangut* and *Rohtee ticto* are now invariably referred to the genus *Barbus*, while of the other two belonging to *Rohtee* (s s) neither was known to Hamilton Buchanan. From the statements of the two authors it is clear, therefore, that *Cyprinus cotio* is congeneric with *Rohtee*, Sykes, which may stand for these and other similar species. I am highly indebted to Dr. N. Annandale and Dr. B. L. Chaudhuri for valuable suggestions on this point.

Rohtee alfrediana (C. and V.)

1889. *Osteobrama alfrediana*, Vinciguerra, *op. cit.*, p. 316.

The specimens of this species were collected in Khurda and Thaubal stream; the longest is 109 mm. in length. In young individuals the body is less deep and an indistinct black band is usually present behind the gill cover.

Rohtee belangeri (C. and V.).

1889. *Osteobrama belangeri*, Vinciguerra, *op. cit.*, p. 318.

This species is distinguished from the rest included in the genus *Rohtee* by the fact that the whole of the abdominal edge is sharp, whereas in others it is sharp behind the ventrals but flat and rounded in front of them. Moreover, the pharyngeal teeth in this species are armed with tubercles on their crowns; this character is shared by *R. ogilbii*.

It will not be out of place to make some observations on the nature of the pharyngeal teeth here. In a former paper by Annandale and myself[2] a reference was made to the occurrence of loose teeth in the muscles surrounding the pharyngeal bones. Having had the opportunity to dissect a large number of fish for these teeth, I find the loose teeth fairly common. In *R. belan-*

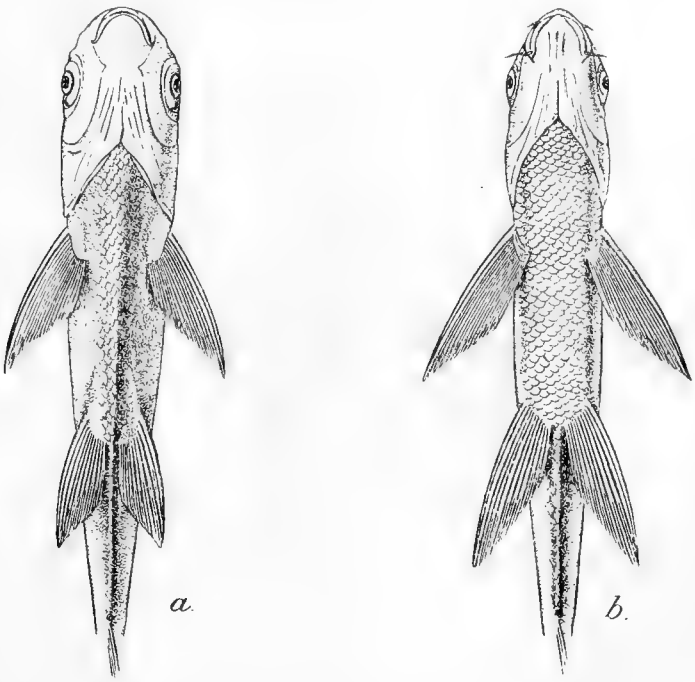
[1] Hamilton Buchanan, "*An account of the Fishes in the Ganges*," pp. 333 and 392 (1822).

[2] Annandale and Hora, *Rec. Ind. Mus.*, XVIII, p. 165 (1920).

geri their crown is crenulated like that of the fixed teeth and in all probability they represent the older teeth that have been cast off and their place being taken up by new ones. Dr. Annandale thinks it more probable that the free teeth are young and have not yet fused with the bone.

Two specimens of this species were obtained from the Manipur Valley, one in Loktak Lake and the other in the Khurda stream. The lake example is darker in colour.

This species occurs in Burma and Manipur. Its occurrence in the Godaveri River needs confirmation.



Text-fig. 2.—Ventral view of two species of *Rohtee*, Sykes.
(*a*) *Rohtee belangeri*, showing keeled abdomen throughout.
(*b*) *Rohtee feae*, showing keeled abdomen only between vent and base of ventrals.

Barilius bendelisis var. **chedra** (Ham. Buch.).

1889. *Barilius bendelisis* var. *chedra*. Day, *op. cit.*, p. 347.

This species is represented in our collection by seven specimens captured in the Senapati stream near Kairong, Naga Hills. The water of this stream was very clear and my attention was drawn to a fairly big specimen of this species, which showed beautiful colour and special mucous bands on certain parts of the body. The fish was very sluggish in habit and we followed it from place to place till it was secured in an ordinary hand net Out of water the mucous bands were not so distinct and in spirit have

left those particular portions of the fish lighter in colour. The colour of the fresh specimens is thus described in the field-book :—" The caudal fin and the apex of the dorsal dusky ; other fins pinkish. The general surface silvery, with a black triangular spot at the base of each scale ; the cheeks yellow ; the operculum golden or deep orange with black borders."

The paired fins are broad and well-expanded and most of the outer rays in them have become stiff. The chest is flattened and the scales in this region are poorly developed. There are characteristic muscular pads in front of the bases of the pectorals. The open pores on the snout are absent.

Barilius bendelisis var. *chedra* is found along the base of the Himalayas.

Barilius barila (Ham. Buch.).

1889. *Barilius barila* Day, *op. cit.*, p. 348.

The character of the barbels on which Day has based his synopsis of the species of this genus is faulty ; not only because the barbels are very small, but also because they are liable to be overlooked owing to their being hidden underneath folds of skin. In the Manipur examples both pairs of barbels are present, the rostral pair being slightly longer than the maxillary. There are 22 rows of scales in front of the dorsal fin The chief character on which I have based the identification of this species is the inequality of the two lobes of the caudal fin ; the lower lobe being slightly the longer. This character is more marked in young individuals.

Barilius barila exhibits considerable variations with age and locality. In young individuals the pectorals do not reach the ventrals, nor the latter, the anal, and the origin of the dorsal is equidistant from the middle of the eye and the base of the caudal fin. With the growth of the fish, especially in hill-streams, the paired fins become much expanded and the area in front of the pectorals is specialized as in *B. bendelisis* var. *chedra*. In a specimen about 13 cm. long, the pectorals extend beyond the ventrals and the ventrals reach the anal, and the dorsal is equidistant from the hinder edge of the eye and the base of the caudal fin.

The vertical blue bands on the body are better marked in young specimens than in the adults. I have the following note in the field-book about the colouration of a living specimen from the Sikmai stream :—" Upper surface dark olivaceous, sides silvery with blue bands extending to the lateral line ; fins pinkish ; iris deep orange ; opercular piece dark while the rest of the gill-cover orange."

A specimen from the Khurda stream is of special interest, because it lacks the ventral fins. The absence of the ventrals has been considered to be a character of generic importance, but in the case of this specimen I consider it an abnormality, as it is impossible to separate this individual on any other character from *B. barila*, of which I have examined a large series.

The following are the measurements of the unique specimen :—

Total length including caudal	..	..	94·0 mm.
Depth of body	..	..	18·5 ,,
Length of head	...	..	19·0 ,,
Diameter of eye	..	..	6·0 ,,
Length of snout	..	..	5·5 ,,
Interorbital width	..	..	6·3 ,,
Length of rostral barbels		..	2·0 ,,
Length of maxillary barbels	..	..	1·5 ,,

The species is widely distributed in the streams of the valley. A few specimens were taken in the Senapati stream near Kairong in the Naga Hills.

Barilius dogarsinghi, sp. nov.

D. 2/7. A. 3/9. P. 13. V. 8.

The length of the head is contained 5—5⅓ times, the depth of the body 4—4⅓ times, the length of the caudal 5 times in the total length including the caudal fin. The eyes are situated somewhat in the anterior half of the head, their diameter being contained 4 times in the length of the head, 1¼—1½ times in the length of the snout and 1¼ times in the interorbital width. *Barbels.*—There are two pairs of short barbels. *Scales.*—There are 38—39 scales along the lateral line, 7—8 rows above it to the base of the dorsal fin and 3 below it to the base of the ventrals. There are 20 rows of scales in front of the dorsal fin. *Fins.*—The origin of the dorsal is equidistant from the end of the upper lobe of caudal and the anterior margin of nares. It is situated far back and extends to about the middle of the anal fin. The paired fins are well developed and possess a number of stiff rays. The pectorals do not reach the ventrals, which in some examples extend to the base of the anal fin. The auxiliary processes do not go beyond the bases of the pectorals. The free margins of both the dorsal and the pectoral fins are rounded. The lower lobe of the caudal fin is slightly longer than the upper.

The mandibular knob so characteristic of the genus is absent in this species.

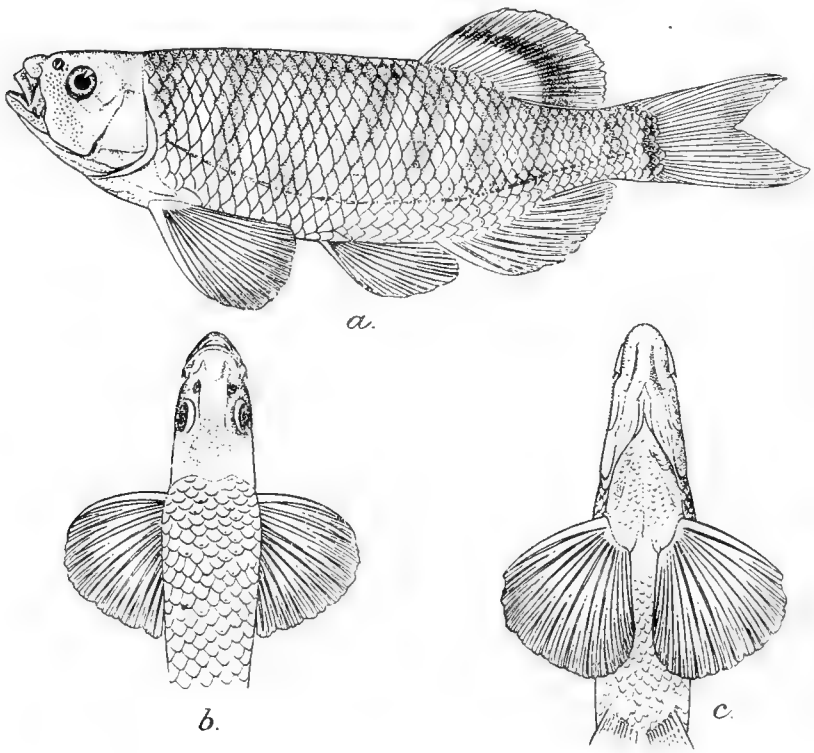
The dorsal profile in front of the dorsal fin is almost straight, but posteriorly it curves to the base of the caudal fin. The ventral profile is deeply arched and is convex throughout. The skin on the sides of the head is prominently tuberculate.

Colour.—The dorsal surface of the head and body is black with about 9 blue lateral bands. The band at the base of the caudal fin is deeper in colour than the rest. The belly and the under surface of the head, and the pectoral, the anal and the ventral fins white. The caudal is dusky in its posterior half, and the dorsal has a characteristic deep black band across its middle.

The young individuals have longer barbels, a smooth snout and normal paired fins, and the band at the base of the caudal fin shows a deep black spot in its centre.

As in the preceding species, I find that in one example the ventral fin of the left side is absent and the surface is covered with scales in the region from which the fin is lacking.

A specimen 85 mm. in length was found on dissection to contain eggs.



TEXT-FIG. 3.—*Barilius dogarsinghi*, sp. nov.
(*a*) Lateral view of type-specimen (slightly enlarged).
(*b*) Dorsal view of head of same (slightly enlarged).
(*c*) Ventral view of head of same (slightly enlarged).

I have great pleasure in associating this fish with the name of my friend S. Dogar Singh, State Overseer at the time of our visit to Manipur, who toured in the valley with me and helped me in various other ways.

Type-specimen.—F 9983/1. *Zoological Survey of India* (*Ind. Mus.*).

Twelve specimens of this species were captured in the Etok stream near Chanderkhong and one young individual in the Sikmai stream near Palel.

Barilius dogarsinghi is quite distinct from the rest of the species included in the genus in the form and position of the vertical fins and in its general facies. It might perhaps be regarded as the type of a new genus or subgenus, but, for the present at any rate, I prefer to place it in *Barilius*.

Danio dangila (Ham. Buch.).

1889. *Danio dangila*, Day, *op. cit.*, p 356.
1889. *Danio dangila*, Vinciguerra, *op. cit.*, p. 306.

Two specimens were found at Ghaspani (alt. 1500 ft.). The largest specimen is 58 mm. in length.

Danio dangila is found in Bengal, Bihar, Darjiling, Burma and the Naga Hills.

Danio aequipinnatus (McClell.).

1889. *Danio aequipinnatus*, Vinciguerra, *op. cit.*, p. 304.

Specimens of this species were captured in various streams in the Naga Hills and three from a small hill-stream north-west of Potsengbaum and one from Itok stream near Chanderkhong.

I have the following note in the field-book on the colouration of a living specimen caught in a small stream near Ghaspani:—"Three blue bands on either side—the one in the middle reaching the base of the caudal fin which is infuscated in the middle. Intervening between these blue bands are others of a yellowish-orange colour. The blue bands break up behind the operculum and form a characteristic pattern. There is a black spot behind the angle of the operculum and a golden streak runs along the dorsal surface. The fish is partially transparent with a dusky back and a white belly. The caudal and the pectoral fins are reddish; the dorsal is provided with a blue stripe. The remaining fins are of an orange colour."

Danio (Brachydanio)[1] acuticephala, sp. nov.

D. 2/6—7. A. 2—4/9.

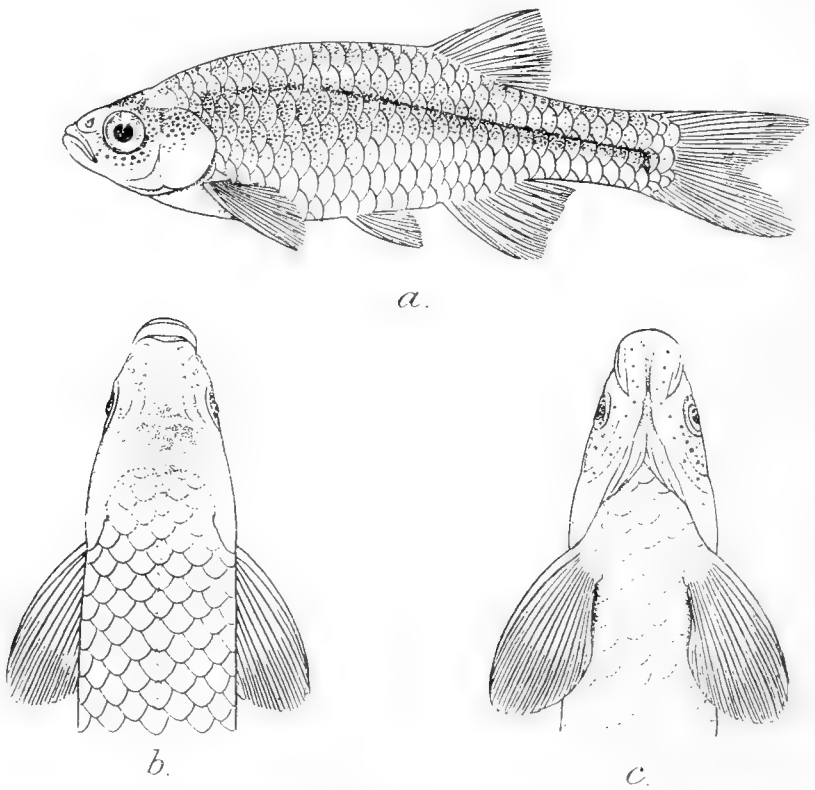
This little fish is fairly stout and deep and has a characteristic facies, being highest in the middle and tapering towards both ends. The head is short and pointed. The eyes are prominent and are situated in the anterior half of the head. The mouth is small, semicircular and is turned upwards. The nostrils are placed midway between the antero-superior margin of the eye and the end of the snout. There are open pores distributed all over the head and those on the under surface are along the pre-opercular borders and the mandibles. In some specimens the pores are absent.

The dorsal fin is short with 6—7 branched rays, its origin is equidistant from the end of the snout and the hinder end of the

[1] Weber and Beaufort, *Fish. Indo-Austra. Arch.*, III, p. 85 (1916).

caudal fin. The pectorals are rounded and when adpressed do not reach the ventrals, which in turn do not extend to the base of the anal. The anal fin is truncate and its base is covered with a scaly sheath. The caudal fin is deeply emarginate both the lobes are pointed, the lower one slightly the longer. Both the pectoral and the ventral fins are provided with scaly appendants.

The length of the head is contained $4\frac{2}{3}$—5 times and the length of the caudal $4\frac{1}{4}$—$5\frac{1}{4}$ times in the total length including the caudal fin. The diameter of the eye is contained 3—$3\frac{1}{2}$ times



Text-fig. 4—*Danio* (*Brachydanio*) *acuticephala*, sp. nov.
(*a*) Lateral view of type-specimen, × 2.
(*b*) Dorsal view of head of same, × 3.
(*c*) Ventral view of head of same, × 3.

in the length of the head. There are 30 scales along the lateral line and 8 rows in an oblique line between the bases of the dorsal and the ventral fins

Colour.—In the specimens preserved in spirit the upper surface is dusky and the lower pale-olivaceous. A broad black longitudinal band is present on either side of the body and a black narrow streak is to be seen along the dorsal surface.

The colour of a fresh specimen from Bishenpur, Manipur, is thus described in the field book :—"Upper part of body dull olivace-

ous, speckled with black, dorsal surface of head and a narrow line extending all along the dorsal surface of the body, black. A metallic bluish line running along the middle of each side. Sides of head silvery speckled with black. Ventral surface as far as the vent, white and silvery. Lower part of body behind the vent tinged with salmon, fins white, minutely speckled with black and an obscure salmon stripe along the centre of the caudal."

Type-specimen.—F 9981/1. *Zoological Survey of India* (*Ind. Mus.*).

Danio acuticephala is widely distributed in the small streams and ponds of the valley. It does not occur in big muddy streams.

Measurements in millimetres.

	Type	A.	B.	C.	D.
Total length including caudal	44·8	42·4	29·7	39·2	41·5
Length of caudal ..	8·5	9·7	7·0	8·4	8·2
Depth of body ..	10·8	9·8	6·5	9·1	10·0
Length of head ..	9·3	8·8	6·4	7·9	8·3
Diameter of eye ..	2·6	2·5	2·1	2·3	2·5

Most of the female specimens were found to be full of eggs.

Family COBITIDAE.

Botia berdmorei (Blyth).

1860. *Syncrossus berdmorei*, Blyth, *op. cit.*, p. 166.
1889. *Botia berdmorei*, Vinciguerra, *op. cit.*, p. 345.

Numerous individuals of this species were collected in the Imphal River and its tributaries in the valley.

Vinciguerra points to the inconsistency as regards the number of barbels in Day's description of the species. I have examined the type-specimens and a large series of individuals from the Manipur Valley and in all I have been able to make out only six barbels, four of which are rostral and united at their base. The arrangement of the rostral barbels and the structure of the lower lip is very characteristic of the species.

The colour varies greatly. Usually there are 10—18 oblique transverse bands on the body and about 5 longitudinal rows of black dots. The upper surface of the head is black, with two black streaks running from the eye to the snout. The belly and the under surface of the head are white. In one specimen the body was uniformly pale except for light bands on the caudal fin.

Botia berdmorei occurs in Burma and the Manipur Valley.

Botia histrionica, Blyth.

1860. *Botia histrionica*, Blyth, *op. cit.*, p. 166.
1889. *Botia histrionica*, Vinciguerra, *op. cit.*, p. 346.

Only two specimens of this species were obtained from the Amambi stream. They are 118 and 153 millimetres in length.

The Manipur examples agree with Vinciguerra's description of the species except for a little variation in colour which is, otherwise, characteristic of the species. In the younger specimen the number of bands on the caudal and the dorsal fins are fewer in number and in the adult black dots are present between the vertical bands on the body.

Measurements in millimetres.

Total length (including caudal) ..	153	118
Length of caudal	32	25
Depth of body ..	30	21
Length of head ..	30	22
Diameter of eye	5	3·8
Length of snout ..	18	13
Height of dorsal fin	20	15
Length of pectoral	23	18
Length of caudal peduncle ..	21	12
Height of caudal peduncle ..	19·5	14

Botia histrionica is only found in Burma and the Manipur Valley.

Lepidocephalichthys guntea (Ham. Buch.).

1889. *Lepidocephalichthys guntea*, Vinciguerra, *op. cit.*, p. 339.

There is only one specimen of this species taken at Ghaspani (1527 ft.) at the base of the Naga Hills, Assam.

Lepidocephalichthys berdmorei (Blyth).

1889. *Lepidocephalichthys berdmorei*, Vinciguerra, *op. cit.*, p. 341.
1918. *Lepidocephalus berdmorei*, Annandale, *op. cit.*, p. 43.

This is the commonest loach in the valley being found everywhere, both in the muddy and the hillstreams of the valley. It was curious to note that not even a single specimen of this species was obtained in the Loktak Lake, whereas it was quite common in a sluggish muddy stream near Potsengbaum.

The chief character that distinguishes this species from the preceding one is the mandibular flap. The mandibular flap in *L. berdmorei* is thickened and pliated anteriorly while posteriorly it is produced into three or more short barbel-like processes.

Lepidocephalichthys irrorata, sp. nov.

Plate IX, figs. 5, 5*a*, 5*b*.

D. 2/7. A. 3/5. V. 1/6. P. 7—8. C. 15—16.

This comprises small fish with the body slightly compressed from side to side. The dorsal profile is slightly arched while the ventral is straight and horizontal throughout. The length of the head is contained $6\frac{2}{5}$—$7\frac{3}{5}$ times, the depth of the body

$6\frac{1}{3}$—$7\frac{1}{3}$ times in the total length including the caudal fin. The eyes are minute and are situated in the anterior half of the head. The suborbital spine is bifid, the posterior prong being longer and stronger. The mouth, which is situated on the ventral surface, is semicircular and is provided with thick lips. The vent is placed on a slightly raised papilla and is provided with thick lips, which are not continuous posteriorly. It is situated in the beginning of the posterior third of the distance between the base of the caudal fin and the eye. There are two nostrils on each side lying close together but separated by a valvular flap. The anterior nostril is oval while the posterior is rounded. *Barbels.*—There are eight barbels, two rostral pairs, one maxillary pair and one pair mandibular. The bases of the mandibular barbels are broadened outwards to meet those of the maxillary barbels and thus a membranous flap stretches between the bases of the mandibular and the maxillary barbels. In some individuals the membranes are wanting and all the barbels are free. Under the lens the barbels show spiny projections all over their surface. *Fins.*—The dorsal fin is almost as high as the depth of the body below it ; its origin is considerably behind the ventrals and is much nearer to the base of the caudal fin than to the end of the snout. The origin of the ventral is equidistant from the end of the snout and the base of the caudal fin. The free posterior border of the caudal fin is concave. *Scales.*—The scales are minute and there are about 34 rows in an oblique line between the base of the dorsal and that of the ventral fins.

The specimens from the Loktak Lake have a characteristic colouration. They are pale olivaceous, more or less densely speckled with black There is a series of fine dark spots running along each side. On the dorsal surface and the sides of the head the dark specks are more closely aggregated. The fins are whitish with numerous dark transverse bars on their rays ; narrow, irregular pale bars are also to be seen on the dorsal surface. There is also a dark streak from the eye to the snout.

The specimens from other lakes and streams in the valley are of a uniform pale colour, with short bars across the back and a row of fine spots along the sides. The fins are banded or speckled with black dots.

Type-specimen.—F 9904/1. *Zoological Survey of India* (*Ind. Mus.*).

Lepidocephalichthys irrorata is widely distributed in the lakes and streams of the Manipur Valley.

Acanthophthalmus pangia (Ham. Buch.).

1889. *Acanthophthalmus pangia*, Day, *op. cit.*, p. 222.
1889. *Acanthophthalmus pangia*, Vinciguerra, *op. cit.*, p. 347.
1916. *Acanthophthalmus pangia*, Weber and Beaufort, *op. cit.*, III, p. 31.

In describing *Barilius barila* I referred at some length to an abnormal specimen in which the ventrals were totally absent and it

was pointed out that this character did not seem to me of either specific or generic value. The genus *Apua* is distinguished from *Acanthophthalmus* by the absence of the ventral fins. Vinciguerra does not recognise the genus *Apua*, but in doing so he does not assign any valid reasons. According to him "le ventrali fossero mancanti per pura accidentalitá o che per la loro estrema piccolezza sieno sfuggite all' osservazione di entrambi questi naturalisti." I have examined the two type-specimens (No. F $\frac{2647}{1}$) of *A. fusca*, Blyth, but can find no trace of the ventrals in them; and cannot, therefore, agree with Vinciguerra when he says that the ventrals must either have been overlooked or accidentally broken in the unique type-specimens of the genus. I look upon these cases as abnormalities, though it is surprising that both the specimens should have lost the ventrals. I have already referred to an abnormal specimen of *Barilius dogarsinghi* in which the ventral fin of the left side is absent. I have also examined a specimen of *Rita rita*, in the collection of the Government College Museum, Lahore, in which the pectoral fin of one side is absent. In view of what I have stated above I do not regard *Apua* as a distinct genus.

There is another interesting observation which might be referred to in this connection. After a careful examination of a large collection of *A. pangia* from Manipur, I am of the opinion that the form hitherto known as *Apua fusca* is only a hill-stream phase of *A. pangia*. Vinciguerra distinguishes *A. pangia* from *A. fusca*, by the greater depth of its body, by the ventrals being placed midway between the base of the caudal and the middle or the posterior margin of the orbit, and by the position of the dorsal, which in *A. fusca* ends just above the origin of the anal fin. I have not been able to verify the above characters in the case of the type-specimens of *A. fusca*. In these specimens the dorsal fin is in advance of the anal, and its origin is not equidistant from the base of the pectoral and the end of the caudal fin. It arises in the posterior $\frac{1}{4}$ of the body.

The specimens from the hill-streams like Sikmai, Amambi, Phaidinga, etc., are slender, elongated and less deep, while those from the muddy streams are stouter and deeper. The muddy stream forms possess a soft dorsal fin like that of the genus *Adiposia*.[1]

The structure of the soft dorsal fin of *A. pangia* is very simple. The wall consists of a thin layer of epithelium and of a muscular layer internal to it. There are no specialized gland-cells and the muscular sheath consists of fine fibrils running transversely. The inner core consists of a highly vacuolated tissue, supplied with a few blood vessels which lie in the middle. The muscles do not run across the dorsal muscles but are continued along the body-wall.

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[1] Annandale and Hora, *Rec. Ind. Mus.* XVIII,, pp. 183—186 (1920).

It is unfortunate that the collection of *A. pangia* in the Indian Museum is very poor. There is only one specimen No. 2590 from Mandalay and even that has been allowed to desiccate and is not fit for examination. I am, therefore, unable to decide whether the two species should be united until further collections from various parts of India are available for examination.

The largest specimen in our Manipur collection is 60 mm. in length. On dissection the females were found to contain eggs.

Acanthophthalmus pangia has a very wide range, extending over North Eastern Bengal, Manipur, Shan States, Burma to Java and Sumatra.

Nemachilus manipurensis, Chaudhuri.

1912. *Nemachilus manipurensis* Chaudhuri, *Rec. Ind. Mus.*, VIII, p. 443, pl. xl, figs. 4, 4*a*, 4*b*, and pl. xli, figs. 1, 1*a*, 1*b*.

Numerous specimens of this species were collected in the Auwlok and the Maklang rivers in the Kangjupkhul Hills; also a large number of specimens from Kangjupkhul *pukhri* (pond) behind the inspection bungalow.

Except for slight variation in the colour of some specimens, they argee with Chaudhuri's description of the species.

Nemachilus botia (Ham. Buch.).

1889. *Nemachilus botia*, Day, *op. cit.*, p. 227.
1919. *Nemachilus botia*, Annandale, *Rec. Ind. Mus.*, XVI, p. 127.

A single specimen 68 mm. in length was obtained at Ghaspani among the Naga Hills. The specimen is provided with a free orbital process below the eye and is probably a male. The lower lip is interrupted in the middle and is provided with characteristic cushion-like swellings.

Nemachilus botia is widely distributed all over northern and central India and also occurs in the Shan Plateau.

Nemachilus zonalternans (Blyth).

Plate X, figs. 3, 3*a*.

1860. *Cobitis zonalternans*, Blyth, *op. cit.*, p. 172.
1889. *Nemachilus zonalternans*, Day, *op. cit.*, p. 232.

This species is one of the commonest fish found in the Manipur Valley. Of 112 specimens, 77 are females and the rest males. The sexual dimorphism exhibited by this species is like that found in *N. botia* and consists in the males having a groove in front of the eye and a movable process of the preorbital bone.

N. zonalternans has hitherto been known from two specimens from Tenasserim. Both of these specimens are in the collection of the Indian Museum. One of these has been allowed to dessicate and the second one is not in a good condition for detailed examination. Moreover as the descriptions of Blyth and Day are meagre, I take this opportunity of writing a short note on the type-speci-

mens and a description of the species from fresh specimens, together with figures.

Having been long in spirit, the type-specimens have lost their natural colouration, except for certain markings on the caudal fin. There is also a faint black ocellus at the upper portion of the base of the caudal fin. The upper jaw is provided with a prominent knob in the middle. The lower lip is interrupted in the middle. The dorsal is considerably in advance of the ventrals. The lateral line is incomplete, ending below the origin of the dorsal. The eyes are nearer to the snout than the posterior extremity of the head.

Measurements of type-specimens in millimetres.

	A ♀	B ♀
Length of body (caudal excluded) ..	30·4	26·8
Length of head	7·3	6·4
Diameter of eye	1·9	1·6

The following is a description of the fresh-specimens from Manipur:—

D. 3/9—10. A. 2/5. P. 11. V. 7.

The length of the caudal fin is contained $4\frac{4}{5}$—5 times, of the head $4\frac{4}{5}$—$5\frac{1}{4}$ times and the depth of the body $5\frac{1}{4}$—$6\frac{1}{3}$ times in the total length including the caudal fin. The diameter of the eye is contained 4—$4\frac{1}{3}$ times in the length of the head and $1\frac{2}{3}$ times in the length of the snout. *Barbels.*—There are six barbels, two rostral pairs and one pair maxillary. The maxillary barbels are slightly longer than the outer rostrals and are $1\frac{1}{2}$ times as long as the diameter of the eye. The inner rostrals are equal in length to the diameter of the eye. *Fins.*—The dorsal fin arises in advance of the ventrals and is almost as high as the depth of the body below it; its origin is nearer to the snout than to the base of the caudal fin. The caudal fin is slightly emarginate, with the upper lobe slightly the longer. The caudal peduncle is almost as high as long.

The mouth is small and semicircular and the mouth-opening reaches to just below the nostrils. The lips, the jaws, and the lateral line are as described in the type-specimens.

The colour of this loach has thus been described by Blyth and agrees with the Manipur specimens:—"It has a dark lateral streak, crossed by twelve short transverse bands, which alternate with about the same number of dorsal dark cross-bands. The dorsal fin is marked with three and the caudal with four rows of black spots; the other fins being spotless." There is, however, considerable variation even in specimens from the same locality. Some are uniformly pale and in some the dorsal surface is black and the belly white. There is always a black ocellus near the superior margin of the base of the caudal fin.

Nemachilus zonalternans is known from Tenasserim district (Burma) and is common all over the Manipur Valley.

Some female specimens on dissection were found to contain eggs.

Measurements in millimetres.

	♀	♀	♀	♂	♂	♂
Total length including caudal ..	40·0	40·0	40·7	36·3	40·8	35·7
Length of caudal	7·6	8·2	8·1	7·2	8·9	7·3
Length of head	8·1	8·3	7·8	7·5	8·2	7·0
Depth of body	7·6	7·0	7·2	6·1	6·4	5·3
Diameter of eye	2·0	1·9	1·8	1·8	1·9	1·6

Nemachilus sikmaiensis, sp. nov.

Plate IX, fig. 4; plate X, figs. 1, 1*a*.

D. 2/8. A. 2/5. P. 11—12. V. 8.

In this fish the head is slightly depressed and the ventral profile is almost horizontal. The dorsal profile rises gradually from the end of the snout to the base of the dorsal fin, beyond which it slopes gradually to the base of the caudal fin. There are definite rows of open pores all over the head and those just above and below the eye meet posteriorly and are continued along the lateral line, which ends just above the middle of the anal fin.

The length of the head is contained 5—5$\frac{1}{5}$ times, of the caudal fin 5—5$\frac{2}{3}$ times and the depth of the body 7—8 times in the total length. The eyes are minute and are situated in the middle of the head. They look upwards and outwards and are invisible from below. The diameter of the eye is contained 4$\frac{1}{2}$ times in the length of the head. There are two pairs of nostrils, one on either side. Their position is nearer to the eye than to the end of the snout. A fold of skin, provided with a sharp, barbel-like process, separates the nostrils of each side. It has an inferior, semicircular mouth, which is surrounded by thick lips. The lower lip is slightly notched in the middle and is devoid of any swellings or papillae. *Barbels.*—There are six barbels, two rostral pairs and one pair maxillary. The outer rostrals are the longest and extend to the posterior margin of the nostrils. *Fins.*—The dorsal fin is slightly in advance of the ventrals and is as high as the depth of the body below it; its origin is equidistant from the nostrils and the base of the caudal fin. The pectorals are rounded and are shorter than the head and are separated from the ventrals by three-fourths of their own length. The ventrals are well developed and are provided with scaly appendages to their bases. The ventrals reach the vent. The caudal fin is deeply forked; the lower lobe is slightly the longer.

The colouration of this species is very characteristic. There are 12—13 black rings round the body, separated by an equal number of slightly narrow white ones. In front of the ventrals the rings are incomplete and the under surface of the head and body is dull white. There is a black bar across the base of the

caudal fin and a black spot at the base of the first few dorsal rays. The rays of the dorsal fin have black markings along their length in the middle. The caudal fin is dusky and the rest spotless. In some examples the rings in the anterior portion are hardly distinguishable and the colour has become uniformly black.

The males of this species are provided with a thick, triangular pad below the antero-inferior margin of the eye.

Nemachilus sikmaiensis is distinguished from the rest by the simplicity of its lips, by the nature of the caudal fin which is deepy forked, by the fact that the lateral line does not extend beyond the middle of the anal fin and that the dorsal fin possesses only eight branched rays.

Type-specimens.—F 9932/1. *Zoological Survey of India* (*Ind. Mus.*).

Only nine specimens of this species were obtained in the Sikmai stream near Palel on the Burma Road.

Measurements in millimetres.

	♂	♀	♀	♀	♀
Total length including caudal	41·3	43·3	31·4	33·0	32·5
Length of caudal ..	7·2	8·1	6·3	6·3	6·2
Length of head ..	8·2	8·3	6·4	6·4	6·3
Depth of body ..	5·8	6·2	4·2	4·2	4·1

Nemachilus kangjupkhulensis, sp. nov.

Plate X, figs. 4, 4*a*.

D. 2/6—7. A. 2/5. V. 6—7. P. 9.

In this species the dorsal profile is slightly arched and the ventral is horizontal throughout. The head is bluntly pointed and slightly depressed. The under surface of the head and body is flat. There are open pores scattered all over the head, and a row of these just below the eye is continued along the lateral line. It has a ventral mouth, which is situated only a short distance behind the anterior end of the snout and is surrounded by thick lips. The upper lip is slightly notched and the lower widely interrupted in the middle. Behind the lower lip there is a cushion-like muscular pad, resembling the central callous portion of the disc of *Garra*. The lower lip is slightly fimbriated.

The length of the head is contained $5\frac{1}{5}$—$5\frac{3}{5}$ times, of the caudal 6—$6\frac{1}{2}$ times and the depth of the body 6—$8\frac{1}{3}$ times in the total length including the caudal fin.

The eyes are dorso-lateral in position and their diameter is contained $5\frac{1}{2}$ times in the length of the head. The snout is twice as long as the diameter of the eye. The caudal peduncle is $1\frac{1}{5}$ times as long as high. *Lateral line.*—The lateral line is incomplete and ends before the commencement of the dorsal fin. In some examples it extends to just above the end of the pectoral

fins. *Nostrils.*—There is a pair of nostrils on each side and their position is nearer to the eye than to the tip of the snout. *Fins.*—The dorsal commences almost opposite the ventrals; its origin is equidistant from the anterior margin of the orbit and the base of the caudal fin. It is almost as high as the depth of the body below it. The pectorals are shorter than the head and are separated from the ventrals by their own length. The ventrals do not reach the vent, which is situated on a raised papilla and is provided with thick lips. The caudal fin is slightly emarginate and in some examples the lower lobe is longer than the upper. The bases of the ventrals are provided with fleshy pendants.

There are seven to eleven broad black bands on the body separated by an equal number of white ones which are only half as broad. There is a black bar at the base of the caudal fin and a black spot at the base of first three rays of the dorsal. In some examples the bands in the anterior region get mixed up and the surface becomes uniformly dusky. The under surface of the head and body is white. Usually there are two black streaks radiating from the eye to the snout.

I have not been able to discover any outward signs of sexual dimorphism in this species. Some specimens on dissection were found to contain eggs. The eggs in this species are fairly big. In a specimen 43 mm. long, the diameter of an egg is 1·8 mm.

Nemachilus kangjupkhulensis is widely distributed in the hill-streams of the Manipur Valley.

Nemachilus prashadi, sp. nov.

Plate X, figs. 2, 2*a*.

D. 4/8. V. 8. A. 6. P. 11.

The length of the head is contained 5—5½ times, of the caudal fin 4⅘—5 times and the depth of the body 5—7 times in the total length including the caudal fin. In ripe females the greatest depth of the body is contained 5 times in the total length. *Eyes.*—The eyes are invisible from below and their diameter is contained 3⅘—5 times in the length of the head. *Barbels.*—There are six fairly long barbels, the inner rostrals extend to the nasal opening and the outer reach the beginning of the second third of orbit. The maxillary barbels are as long as the outer rostrals and are twice as long as the diameter of the eye. *Lateral line.*—The lateral line is well-marked anteriorly, gradually it fades away and ultimately disappears behind the anal fin. *Fins.*—The dorsal fin is in advance of the ventrals and its origin is nearer to the snout than to the base of the caudal fin. The pectorals are longer than the head and when adpressed almost reach the base of the ventrals which are provided with a short fleshy pendant. The caudal fin is deeply forked and in some female examples the upper lobe is slightly the longer. The caudal peduncle is 1¼ times as long as high. In mature females the pectorals do not reach the ventrals.

The open pores, noticed in the preceding species, are present all over the head and are continued along the lateral line as well. There is a well-marked prominence in the middle of the upper jaw and the lower lip is interrupted in the middle.

The lateral line is crossed by 13 short, black vertical bands. Above the lateral line the body is marked by a characteristic reticulum formed by numerous dark bands and blotches. The under surface of the head and body is pale olivaceous. There is a deep black bar at the base of the caudal fin and two dotted bands across it. The dorsal fin is marked by two bands and a black spot at the base of the first few rays. The remaining fins are spotless or in some examples very indistinctly marked.

The specimens of *Nemachilus prashadi* were obtained in Thonagpal tank and in Thoubal and Sikmai streams. Of 74 specimens, 40 are males and the rest females.

I have great pleasure in associating this fish with the name of my friend Dr. Baini Prashad, Assistant Superintendent, Zoological Survey of India, who has given me every possible encouragement in my work in the Museum.

Type-specimen.—F 9987/1. *Zoological Survey of India* (*Ind. Mus.*).

Order ACANTHOPTERIGII.

Family PERCIDAE.

Ambassis ranga (Ham. Buch.).

1889. *Ambassis ranga*, Vinciguerra, *op. cit.*, p. 163.

The individuals of this species from different localities show considerable variation in colour. Those from the Loktak Lake are dirty yellowish-orange, shot with minute black dots all over. These dots are aggregated to form 6—11 transverse bands on the body. A similar arrangement of dots forms a black blotch over the shoulder. The upper portion of the iris and the head are stained with black. In the young individuals the transverse bands are absent. The specimens collected in streams are lighter in colour and do not show any black dots, though in some cases the transverse bands are well marked.

Family NANDIDAE.

Badis badis (Ham. Buch.).

1889. *Badis buchanani*, Vinciguerra, *op. cit.*, p. 166.

There are altogether three specimens of the species, two of which were captured in Dhanashori stream and one in a small pool in thick jungle near Dimapur, Assam. In colouration the fish agree with Day's description of the Assamese specimens.

This species is said to occur all over India and Burma, but I did not get a single specimen of it in Manipur.

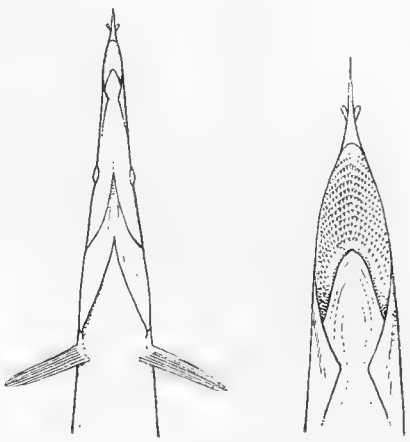
Family MASTACEMBELIDAE.

Rhynchobdella dhanashorii, sp. nov.

Plate IX, fig. 2.

D. 19/45. A. 3/47. C. 16. P. 17.

The length of the head is contained 7 times, of the caudal 14 times and the depth of the body $9\frac{1}{3}$ times in the total length including the caudal fin. The diameter of the eye is contained about 5 times in the length of the head. The vent is situated nearer to the base of the caudal fin than to the tip of the snout. The mouth is small and does not extend to below the nostrils. There are no preorbital or preopercular spines. The fleshy appendage of the snout is broad and concave with transverse striations on the under surface. *Fins.*—The first dorsal consists of nineteen spines, which increase in length posteriorly except for the last one which is shorter than the rest. It commences at the beginning of the second third of the distance between the anterior end of the orbit and the base of the caudal fin. There are three anal spines close together, the middle one is the longest. The caudal fin is free both from the dorsal and the anal fins.



Text-fig. 5.—Under surface of head and snout of *Rhynchobdella dhanashorii*, sp. nov.

This species has a well-marked colouration. In spirit it is dull olivaceous speckled with numerous very characteristic pale lines extending downwards and forwards from the base of the dorsal fin and becoming obscure in the belly region. Behind the vent these lines are joined together in an irregular manner to form a reticulation. A pale longitudinal band extends backwards from behind the eye and becomes obscure in the post anal region. The lower surface is pale, speckled with black on the lower surface of the head. The fins are dark, minutely banded or speckled with dull white.

The only other known Indian species of the genus is *Rhynchobdella aculeata* which is said to occur in brackish waters within tidal influence and also throughout the deltas of large Indian and Burmese rivers. The new species differs from it in having a characteristic colouration and different proportions and also in the fact that *R. dhanashorii* occurs far inland in freshwater.

Type-specimen.—F 9989/1. *Zoological Survey of India* (*Ind. Mus.*).

A single specimen of this species was obtained in Dhanashori stream, about a mile from Dimapur, Assam.

Measurements in millimetres.

Total length including caudal	98·0
Length of caudal fin	7·0
Depth of body	10·5
Length of head	14·0
Diameter of eye	3·0

Mastacembelus manipurensis, sp. nov.

Plate IX, fig. 3.

The proportions show considerable variation with the age of the fish. In a specimen about 23 cm. long, the depth of the body is contained 9 times in the total length and the length of the head about 6 times. In an older specimen 44 cm. in length, the depth of the body is contained 13 times and the length of the head 7 times in the total length. The diameter of the eye is contained 7—11½ times in the length of the head. The vent is situated much nearer to the base of the caudal fin than to the end of the snout; its position can thus be located in the older specimen :—

Distance of vent from	end of snout	.. 22·7 cm.
,, ,, ,,	base of caudal fin	.. 19·6 ,,
,, ,, ,,	end of caudal fin	.. 21·0 ,,

The preorbital spines are absent, but there are three well-marked preopercular spines which increase in length from below upwards. The fleshy appendage to the snout is short and is 7 mm. in length in the older specimen. *Fins.*—The caudal fin is completely united with the dorsal and the anal fins. The spiny portion of the dorsal consists of 37 spines and commences above the middle of the pectoral. The rayed portion of the dorsal is leathery and low, so it is rather difficult to count the number of rays with exactness. There are, however, 66—72 soft rays. The anal fin has three spines close together, the middle one is the longest and the stoutest. The anal spines can only be made out after a careful dissection. There are about 50 rays in the anal fin.

In the older specimen, the dorsal surface of the head and body and the whole of the tail portion is black, with about 23 short black bands across the dorsal surface. The colour of the body below the lateral line and on the under surface of the head is pale olivaceous, gradually fading into yellow on the ventral surface. There are four irregular dark longitudinal bands on either side of the body, commencing from near the head and becoming indistinguishable in the region behind the vent. There is a characteristic dark band along the midventral line extending from the

head to the vent. On the sides and the under surface of the head there are short irregular bands forming a reticulum. There is a short band between the eye and the base of the pectoral fin. The pectoral is marked with a few dotted bands.

The following short description may be given to facilitate the identification of the species according to the synopsis of the species of the genus given by Boulenger [1] :—

Snout scaly on the sides ; three anal spines ; caudal completely united with dorsal and anal ; vent considerably nearer caudal than end of snout ; preorbital spines absent ; 3 preopercular spines present ; dorsal fin with 37 spines ; mouth extending to below nostrils in adults while it does not extend so far in the younger specimen.

By these characters the new species approaches *M. erythrotaenia*, Blkr. and *M. caudatus*, McClell. From the former it differs in having 3 instead of 4 preopercular spines and in having fewer rays to the soft dorsal and the anal fins and also in colouration and proportions ; from the latter in the fact that the mouth does not extend to below the anterior third of the eye and the number of rays both in the dorsal and the anal fins is not so great.

Since his synopsis, Boulenger has described three new species of the genus *Mastacembelus*, viz. *M. moeruensis*,[2] *M. stappersii* and *M. mellandi*.[3] I have consulted the descriptions and do not find any close affinity with the new species

Type-specimen.—F 9990/1. *Zoological Survey of India (Ind. Mus.).*

Only two specimens of this species were obtained in Khurda stream, near Thanga Id.

Measurements in millimetres.

	A.	B.
Total length including caudal ..	440	129
Depth of body	35	14
Length of head excluding fleshy snout ..	64	21
Diameter of eye	5·5	3
Length of snout excluding fleshy portion..	18·5	7·2
Length of caudal	21	4
Length of pectoral	19	6·7

Family OPHIOCEPHALIDAE.

Ophiocephalus punctatus, Bloch.

1889. *Ophiocephalus punctatus*, Vinciguerra, *op. cit.*, p. 186.

Only one specimen of this species was obtained in a dirty pool in thick jungle near Dimapur, Assam.

[1] Boulenger, *Journ. Acad. Nat. Sci. Philadelphia* (2) XV, pp. 197—203 (1912).

[2] Boulenger, *Rev. Zool. Africaine*, III, p. 446 (1913—14).

[3] Boulenger, *Ann. Mag. Nat. Hist.* (8) XIV, p. 386 (1914).

In *O. punctatus* the subopercular bones overlap or come very close to each other on the under surface of the head. The body is sharply marked into two regions, the upper surface of the head and the body is dark, while the belly and the lower surface of the head are white. There is a dark band along the side of the head from the snout to the angle of the operculum. There are also a number of alternating bands above and below the lateral line. The belly and the under surface of the head are speckled with black dots. There is a white transverse bar at the base of the caudal fin and all the fins have dotted bands.

Ophiocephalus harcourt-butleri, Annandale.

1918. *Ophiocephalus harcourt-butleri*, Annandale, *op. cit.*, p. 54, text-fig. 2; pl. ii, fig. 7; pl. iv, figs. 16, 17.

Specimens from the Shan States show great variation as regards the number of fin-rays both in the dorsal and the anal fins. Dr. Annandale gives the formula as:—D. 28—38. A. 16—25. The specimens of this species from Manipur are, however, constant as regards this character. Of a large number of specimens in which I counted the rays, only in one case was the number of rays in the dorsal fin found to be 35, while 34 is the rule. The anal fin always had 23 rays. Both types of colour-forms occur in our collection and the young individuals are characterized by a black ocellus at the base of the pectoral fin, followed by a number of black lines. In almost all cases the vertical and the caudal fins have a narrow reddish-orange band along their edge.

Ophiocephalus harcourt-butleri is widely distributed in the Southern Shan States (Burma) and the Manipur Valley. In the Manipur Valley it is common in the Loktak Lake and in the marshes surrounding it.

FISHERIES OF THE MANIPUR VALLEY AND OF THE NAGA HILLS OF THE SOUTHERN WATERSHED.

Owing to their religious tenets the Manipuris are forbidden any kind of animal food except fish, which thus forms a very important item in their diet. In the Loktak Lake, where traps and other fishing appliances are used in great variety, the state does not levy any kind of tax, consequently near Thanga Island, which may be described as the headquarters of the fishermen, fishing is carried on throughout the year and at all hours of the day and night, and every Manipuri irrespective of age and sex is engaged in fishing. Even in other places it is a common sight to see young boys and girls catching small fish from ponds with baskets. *Lai*[1] Manipuris do not spare even the molluscs and *Acrostoma variabile*, the soft parts of which are sucked out after boiling, is highly esteemed.

[1] *Lai*=Villagers. The Manipuris of the big towns look upon villagers as of low caste and usually do not mix with them.

From the fisheries in other areas, the state realises a good income. The total is estimated to be between Rs. 60,000 and 1,00,000 annually. The main rivers of the valley are divided into stretches, each about a couple of miles in length. The fishery rights in each of these areas are publicly auctioned every year and each fishery fetches from Rs. 400 to 500. The money is paid to the state in instalments; but usually, as I gathered from a talk with Mr. A. C. Eleazar, the full amount is never realised. The Waithu-pat, a lake some ten miles from Imphal and lying on either side of the Burma Road, is the most important centre, not only because it brings an income of Rs. 8,000 to 10,000 a year, but because the entire supply for the Imphal market of the big edible fish (*Wallago attu*) comes from this place.

Fishing Boats.

The only type of boat used in the Loktak Lake is a dug-out. It generally consists of a single piece of wood with a flat bottom, hollowed out to form a boat. The anterior end is broad and somewhat squarish. The boat is rowed with a single paddle having a long blade. A small boat costs from Rs. 15 to 18. Near Thanga Island some big boats are also used for fishing and as a means of transportation. In the Imphal River, the tradesmen also use big boats which are not dug-out but real flat-bottomed boats of similar shape.

Manipuris are very fond of boat-racing. During the rainy season, a racing competition is held every year in the Imphal River. On this occasion two big boats are used with dragons carved on their sides.

Fish-traps.

A series of characteristic traps are used in running water for capturing large quantities of fish. A trap consists of three parts, each performing a definite function. The first part consists of a superficial dam, built of bamboo poles and dry grass and extends almost across the stream, leaving only a passage for boats. The function of this dam is to prevent floating weeds and other debris from choking the traps which are laid further on. About twenty yards below this dam, another stronger dam is built of the same material, but here the grass is held together by sticky mud. It does not come quite up to the surface, and the water either flows over it or through the boat passage. To the upper edge of the poles, just at the level of the water, numerous traps are fixed close together. Each trap consists of two parts. The *chora-ruh* or the upper part has the form of a conical tube and is attached by its wider end to one of the poles. The second portion or *lusak* is also conical but is closed at the narrow end. It telescopes a little over the end of the first part and is attached to it by means of a string. The *lusak* thus acts as a sort of a purse for all the fish that enter the trap and is detached from time to time and emptied of its contents.

By this elaborate arrangement all the fish crossing the dam near the surface are trapped.

The third dam is built about twenty yards still further down and is designed for the capture of bottom-fish which pass the second dam through the boat channel. It is only about a foot or so high from the bottom of the stream and is built across the whole of its breadth. Above the surface of the water the only traces of this dam are three pairs of strong bamboo poles firmly fixed in the ground; a pair is placed in the centre of the stream and one on each side of it near the bank. To the dam itself a series of spindle-shaped traps is attached. The *Kalio-ruh* is a spindle-shaped trap pointed anteriorly, and having an opening at the posterior broader end; this opening is plugged when the trap is laid. The entrance into the trap is on the under surface and consists of a conical tube made of bamboo splints; at the inner end these splints are sharply pointed so that a fish once it has passed into the trap is unable to get out again. The arrangement for keeping the trap in position is illustrated on plate xii, fig. 7. For this purpose strong bamboo pegs (*auúng*) about 46 cm. in length are employed. Each is made by doubling a length of bamboo on itself and thus possesses a loop at its upper end. One peg is thrust into the dam on each side of the trap and the two are lashed together by grass which is passed through the loops. Each trap is also secured by a length of bamboo with pointed ends which is bent over the trap and driven into the ground on either side. The double peg thus formed by the length of bamboo is called *chikap*. Under the *chikap* and all around it tufts of grass are woven in order to give the whole arrangement the appearance of an impassable barrier.

After every four or five hours the traps are taken out and emptied of their contents which frequently consist of a very large number of fish. The method of taking out the trap is rather peculiar. A long bamboo pole is thrown across the stream and is held in position by two of the three pairs of bamboo poles already mentioned. A rope is now tied to a boat and is passed along the horizontal bamboo pole. A man dives, releases the *chikap* on one side and brings out in turn the *kalio-ruh* in this region and passes them on to another man in the boat, who empties them of their contents by removing the plug at the broader end of each. When all the fish are jerked out the plug is replaced and the trap again set in position. This is a very successful and elaborate method and maunds of fish are daily trapped in this way.

The *kao* (pl. xii, fig. 1) is another kind of trap used in shallow streams. It is stuffed with grass and dry sticks and tied to a bamboo peg driven into the bank. Fish seeking shelter get amongst the grass and sticks and remain there. The trap is allowed to remain in the water for two to three days and is then rapidly dragged out. The fish are unable to free themselves quickly and are thus easily secured.

A *kao* which was seen in use in the Wang-jing stream near the village of the same name was 2 ft. 2 in. in height, 5 ft. in length and 6 ft. broad.

The fish generally caught in this trap are *Crossochilus latia* and *Botia berdmorei*, besides smaller species such as *Barbus ticto* and *Lepidocephalichthys irrorata*.

The *tikhau-ruh* or "trap of the Assamese" is the biggest trap used in the streams of the valley. It is circular, pointed at one end and with a funnel-shaped passage of bamboo spikes converging inwards at the other end. A strong bamboo pole is lashed to one of its sides for the attachment of ropes. Two ropes are used, one is tied to the closed narrow end of the trap and the other to the pole. A *tikhau-ruh* seen in the Imphal River was 7·5 ft. in length and 2½ ft. in diameter. The funnel was 2¼ ft. in length and the bamboo pole 3½ ft. The length of the ropes varies according to the stream in which the trap is used (pl. xii, fig. 4).

The method of using the trap is interesting and throws some light on the breeding season of Manipur fish. The open end is placed down stream during the months of February and March, whilst during September and October the same end is placed pointing up stream. According to the Manipur belief, the fish ascend the streams during February and March and descend during September and October. In using the trap, a long bamboo pole is fixed vertically in the middle of the stream. A rope from the narrow end of the trap is tied to the pole, while the broader end is attached by a second rope to a peg on the bank.

Many other varieties of traps are used in the Loktak Lake. These, however, do not differ from those commonly used in Bengal and which have been described by Anderson.[1]

Other characteristic traps are used by the Nagas and Manipuris for catching small hill-stream fishes. The *lo-lu* (pl. xii, fig. 3) of the Nagas is a funnel-shaped trap, with the narrow part greatly elongated and slightly dilated at the end. The bamboo sticks, of which it is made, have a spiral twist and are held in position by cane strings which run spirally from one end to the other. It is used in places where there is an abrupt fall in the water level. In such places the trap is fixed by means of a cane string and a peg, with its broad end pointing up stream. The narrow end is plugged with grass and small fish travelling with the current are carried into the trap. Owing partly to the rapidity of the flow of water and partly to the fact that they are confined in the narrow neck of the trap, they are unable to escape.

The Manipuri *lo-lu* (pl. xii, fig. 2) is similar but shorter and more massive. Instead of a single cane string it has two which are tied to two pegs one on either side of the small channel of water in which it is used. The Manipuris often use this kind of trap in their rice-fields, where the water from a field at a higher level flows to another at a lower level.

[1] Anderson, *Cat. Fish. Appliances, Bengal.* (1883).

Basket Appliances.

Only two kinds of baskets are used for catching fish in the valley and one is of a type only to be found in the country bordering on the Loktak Lake.

The *lóng* (pl. xi, fig. 6), which is widely used all over the valley is bowl-shaped and is made of coarsely woven bamboo strips. The circular brim of the basket is formed of strong bamboo tied to the lower net-like portion by cane strings. A man using the basket dips it into the water and then disturbs the grass in front of it with his feet. The fish are thus driven in the basket which is, then, suddenly taken from the water and the catch transferred to an earthen pot which is carried tied to the waist. One of the baskets was measured to be 47 cm. in diameter and 31 cm. in height.

The second type of basket, the *chigai-lóng* (pl. xi. fig. 5) is saucer-shaped and is generally provided with a bamboo handle, the *machai*. The basket is shoved underneath a floating island and the grass is disturbed from above. It is then quickly withdrawn and small fish and insects are taken from it. It is chiefly used for collecting insects for baiting purposes. One I examined was 85 cm. in its longest diameter, 12 cm. in depth and the length of the handle was 200 cm.

I may here refer to a peculiar type of basket which is used for scooping out water. In marshy places the thick grass is cut with a long sickle and removed. The water is then scooped out with the basket, the *ishto-machai* (pl. xi, fig. 3) and the wriggling fish are caught with the bare hands. This method is employed for capturing *Ophiocephalus harcourt-butleri* and *Clarias batrachus*. The measurements of one seen at Thanga Island were: length of the handle 140 cm., the length of the basket 95 cm. and the depth of the basket 17 cm.

Nets.

Besides the cast net and the big seine net, the well-known *maha-jal* of India, there are three peculiar types of nets which may be briefly described.

The *lungtharai machai* (pl. xi, fig. 4) is like the shallow basket-net, *chigailong-machai*. It is extensively used among *Hydrilla* plants on the Potsengbaum side of the Loktak Lake. A long bamboo pole is used for disturbing the weeds and for throwing them off the net. The net without the handle or *machai* is also used like the *lóng* in various marshy places in the valley.

The most characteristic net is the *ilb-hungen-paura* of the Manipuris. It consists of a rectangular net 7 to 8 ft. long and 3 to 4 ft. wide. The net is spread out by two bamboo arches placed diagonally across it, each arch consisting of two pieces tied together in the middle. Where they cross, the arches are lashed together by a cane string in such a way that they can be folded together when the net is separated from them. A long bamboo pole is tied to the junction of the arches. In the Loktak Lake

the net is used by women from a boat. The bamboo pole is held between the thighs and is alternately raised and lowered by a peculiar movement of the right leg and both hands. In each boat there are two women, one of whom manipulates the net while the other rows the boat and drives the fish into the net by beating the boat with a short bamboo stick. The peculiar noise thus produced is to be heard day and night at Thanga Island.

The arrangement and the method of using the net is different in other parts of the valley. A rope is tied to the bamboo pole near the junction of the two arches and the pole is loosely fixed in the ground to serve as a fulcrum. The net is lowered or raised by means of the rope. With this arrangement the net is called *ilb-jung-thauri* (pl. xi, fig. 1.).

A kind of gill-net is also used in the Loktak Lake. Large pieces of pith tied along the upper edge act as a float, while the lead-weights attached to the lower edge keep the net vertical. The net is shot in a suitable place; the boats manoeuvre in the vicinity, herding the fish into the net, in which they are meshed.

All kinds of nets used in the valley are provided with a small mesh only a few millimetres in width.

Fishing Enclosure.

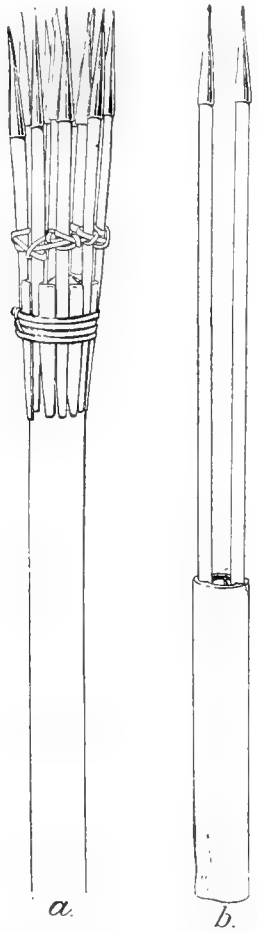
Big fishing enclosures are constructed in the Loktak Lake and sometimes large quantities of fish are captured in this way. A fairly big piece of a floating island is cut and drifted away to a suitable place and is fixed in position by passing long bamboo poles through it into the bottom of the lake. The island thus fixed is allowed to remain in one position for several days. After some time an enclosure of bamboo poles and grass is built around it, a little higher than the level of the water to prevent fish from jumping out. On the completion of the enclosure the floating island is cut into small pieces and cleared, but all the small fish which may be present in the grass are carefully collected. After the surface is cleared of floating material, the water is made muddy by making buffaloes move in it in all directions. Different kinds of nets are used for taking the fish out, the most efficient being the *ilb-hungén-paura*.

Near Thanga Island it is a common sight to see young boys and girls paddling a small piece of floating island to their homes by placing their small boat across it. Near their home the island is fixed in position by long bamboo poles and serves to attract fish by reason of the shelter it provides.

Fish Spearing.

The spears used in the valley are of two kinds, one with two prongs, the other with several (as many as eleven or more). The former is used in spearing *ngapuram* (*Monopterus albus*), and is known as the Naga *laou*. It consists of two long bamboo sticks bearing iron prongs at one end and tightly fixed by wedges at

the other end inside the hollow of a thicker bamboo which forms the handle. The handle of the spear is about 8 inches in length while the total length is five feet. The Manipuri *laou* is constructed on an entirely different plan. It consists of a fairly long and thick bamboo pole, at one end of which several short sticks with iron prongs at their ends are firmly fixed. Some of these are fixed inside the hollow of the pole, just as in the Naga *laou*, but others are tied all round it with a cane lashing. Bamboo splinters are wedged in between the prongs to keep them in position. This spear is chiefly used for catching big fish in the Loktak Lake. When a fisherman sees some disturbance in the grass, he throws his spear at the place. I was given to understand that as big nets cannot be used in the lake on account of the thick vegetation, all the large sized fish are captured with this spear.



Text-fig. 6.—Drawings of models of fish spears.
(*a*) Manipuri *laou* for spearing ordinary fish.
(*b*) Naga *laou* for spearing eels.

Hooks and Lines.

I did not see any fishing-rods in use in Manipur, but I was informed that a crude type of rod is used in the valley. Peculiar bamboo hooks, sometimes tied at intervals to a long line were seen in use in the Loktak Lake. The hooks consist of thin bamboo splinters sharpened at both ends and notched in the middle for the lashing. They are very flexible and the bait, which consists of worms and insects or of small species of *Barbus*, is put on by bringing the two ends together. The efficiency of the hook depends upon the elasticity of the bamboo, for as soon as the fish has swallowed the bait, the hook opens out; the ends penetrate the side of the mouth, often protruding through the gill openings. Several scores of these hooks are used in making a line.

EXPLANATION OF PLATE IX.

Fish from Manipur.

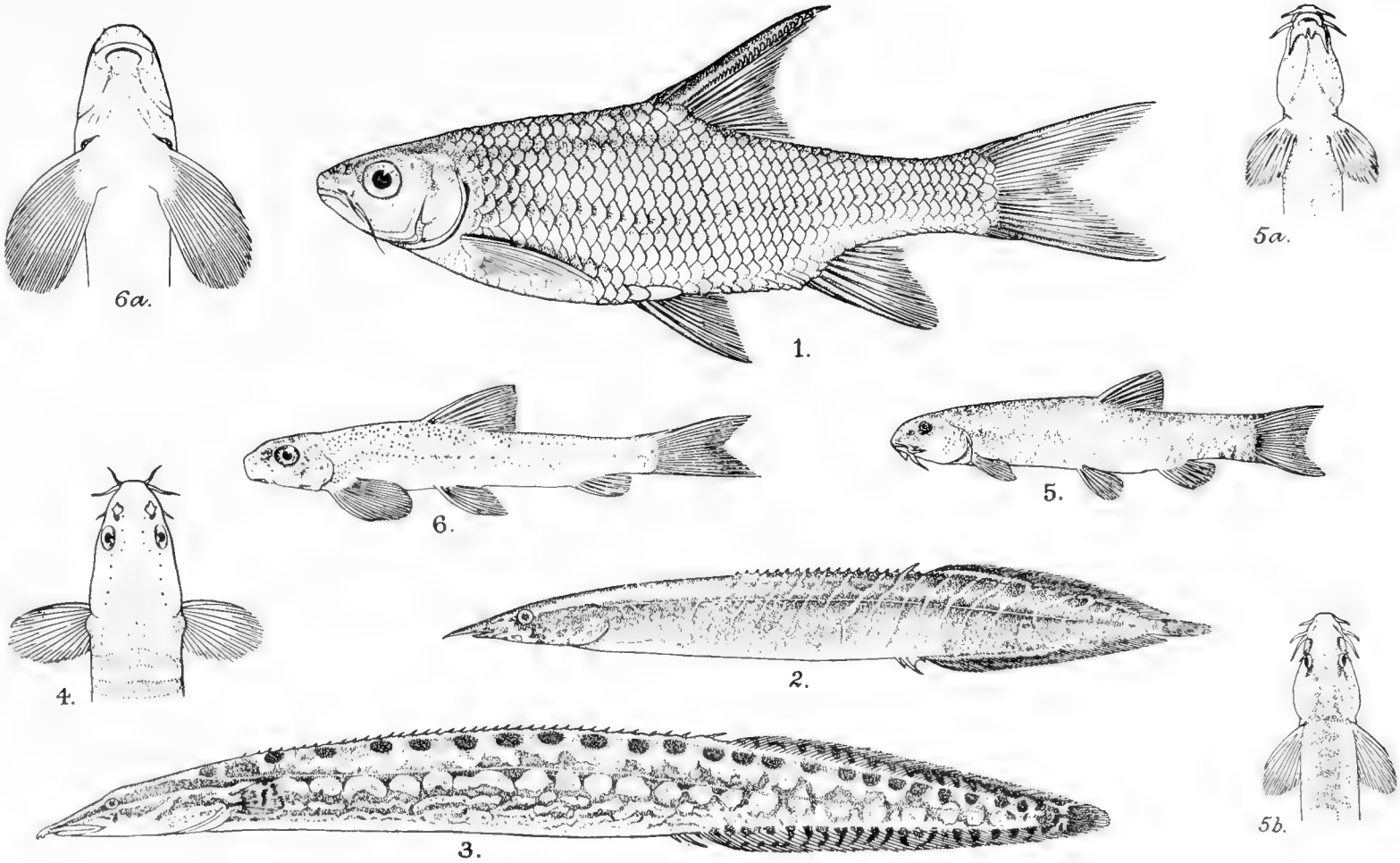
FIG. 1. Lateral view of *Barbus clavatus*, McClell., (reduced).
,, 2. Lateral view of *Rhynchobdella dhanashorii*, sp. nov.
,, 3. Lateral view of *Mastacembelus manipurensis*, sp. nov.
,, 4. Upper view of head of *Nemachilus sikmaiensis*, sp., nov., × $2\frac{2}{5}$.

Lepidocephalichthys irrorata, sp. nov.

FIG. 5. Lateral view of type-specimen, × $1\frac{3}{5}$.
,, 5*a*. Under surface of head of same, × $2\frac{2}{5}$.
,, 5*b*. Upper surface of head of same, × $2\frac{2}{5}$.

Psilorhynchus sp., Hora.

FIG. 6. Lateral view of immature specimen, × $3\frac{1}{5}$.
,, 6*a*. Under surface of head of same, × $4\frac{4}{5}$.



S. C. Mondul & A. C. Chowdhary del.

FISH FROM MANIPUR.

EXPLANATION OF PLATE X.

Nemachilus from Manipur.

Nemachilus sikmaiensis, sp. nov.

FIG. 1. Lateral view of type-specimen, × 2.
,, 1*a*. Under surface of head of same, × 3.

Nemachilus prashadi, sp. nov.

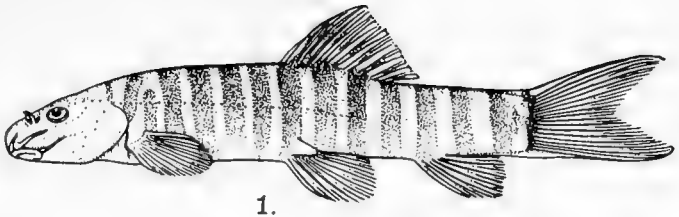
FIG. 2. Lateral view of male specimen, × 1½.
,, 2*a*. Under surface of head of same, × 3.

Nemachilus zonalternans (Blyth).

FIG. 3. Lateral view of a female specimen, × 2.
,, 3*a*. Under surface of head of same, × 3.

Nemachilus kangjupkhulensis, sp. nov.

FIG. 4. Lateral view of type-specimen, × 2.
,, 4*a*. Under surface of head of same, × 3.



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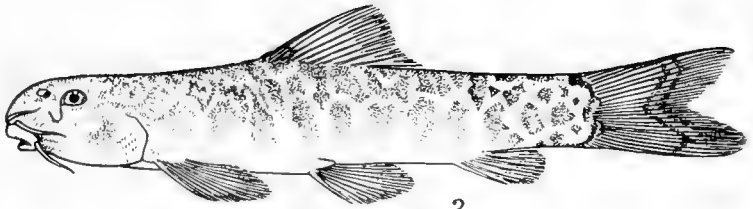

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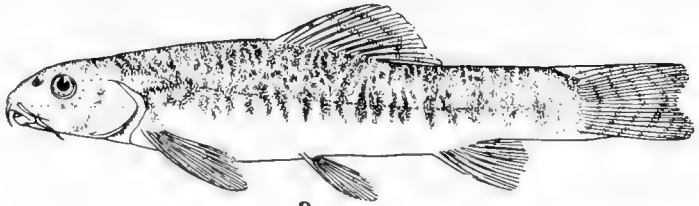

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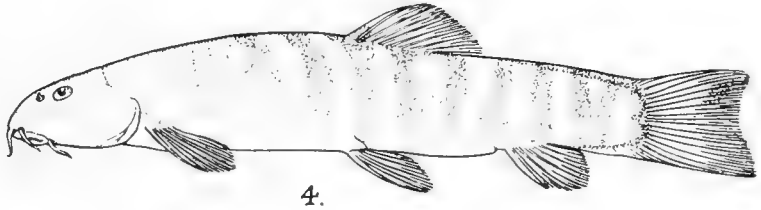

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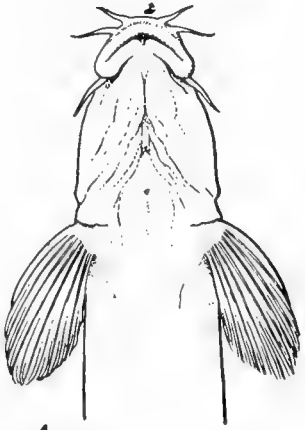

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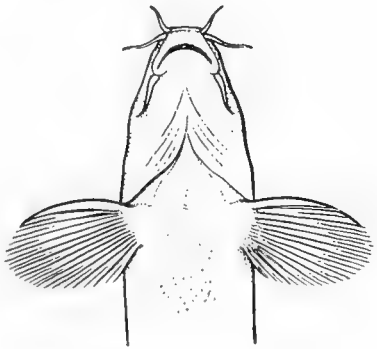

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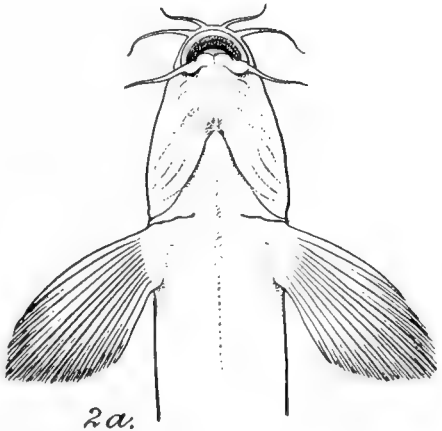

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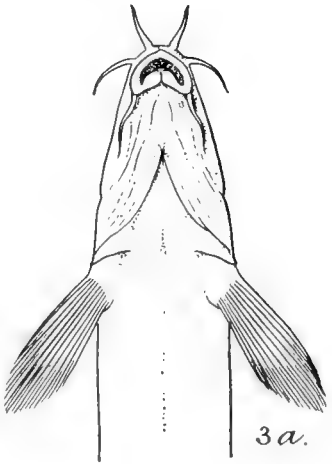

3a.

A. C. Chowdhary del.

NEMACHILUS FROM MANIPUR.

EXPLANATION OF PLATE XI.

Manipuri fishing nets and baskets.

FIG. 1. Shows a girl manipulating *ilb-jung-thauri*, the characteristic Manipuri net. A boy is seen using a crude type of fishing rod.

,, 2. Dam constructed by Manipuris in small streams for capturing fish that come to the surface. Notice especially the arrangement of *chora-ruh* and *lusak*.

,, 3. A type of basket, *ishto-machai*, used for scooping out water.

,, 4. *Lungtharai-machai*, a kind of net extensively used for capturing small fish in the Loktak Lake.

,, 5. *Chigailong-machai*, a fish-basket with a handle.

,, 6. *Lóng*, or the bowl-shaped fish basket.

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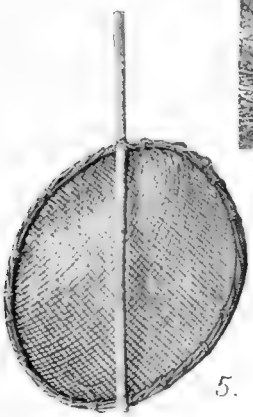

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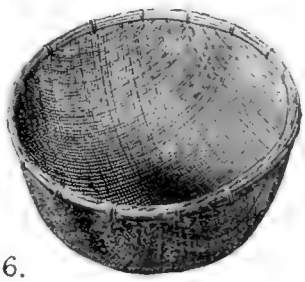


6.

S. C. Mondul Photo.

EXPLANATION OF PLATE XII.

Photographs of Manipur fish-traps.

FIG. 1. Photograph of a model of *kao*.

,, 2. Photograph of an original Manipuri *lo-lu*.

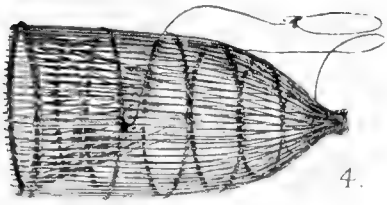
,, 3. Photograph of an original Naga *lo-lu*.

,, 4. Photograph of a model of *tikhau-ruh*.

,, 5. Photograph of a model of *chora-ruh* and *lusak*, the latter telescoping into the former.

,, 6. Photograph from an original *kalio-ruh*, etc. *Kalio-ruh* is shown in the centre, covered by *chikap*. Two double bamboo pegs at the sides are *au-ung*.

,, 7. Photograph of a model showing the arrangement of *kalio-ruh*, *chikap* and *au-ung* when used for capturing bottom fish.



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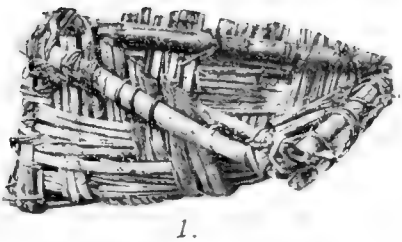

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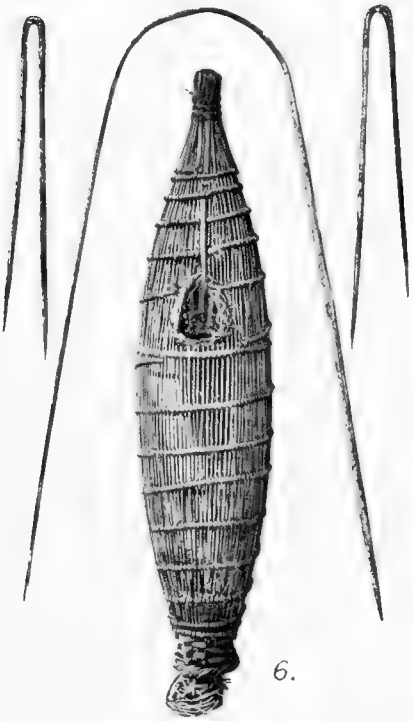

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3.

S. C. Mondul Photo.

XX. THE BANDED POND-SNAIL OF INDIA (*VIVIPARA BENGALENSIS*).

By N. ANNANDALE, *D.Sc., F.A.S.B., Director, Zoological Survey of India and* R. B. SEYMOUR SEWELL, *B.A., F.A.S.B., I.M.S., Surgeon Naturalist, Indian Marine Survey and lately Offg. Superintendent, Zoological Survey of India.*

(Plates I—III).

PREFATORY NOTE.

In writing this paper our main object has been to provide an introduction to the systematic study of the freshwater Gasteropod molluscs of India. In no single species had the anatomy of the animal been studied in detail, and very little was known about the life-history of any one form. Even for the common European species comparatively little information was available, and there is much indirect evidence that, in bionomics at any rate, considerable differences exist between tropical molluscs and those of temperate climates allied to them taxonomically. In the circumstances a minute comparative study was impossible and we have thought it better, while citing all relevant references to literature available to us, to deal precisely with one species as an isolated unit in the fauna, rather than to generalize on resemblances and differences prematurely. In only one part of the paper has this system been departed from to any great extent, namely in that on the edge of the mantle and the ornamentation of the shell. Here the comparative method was inevitable within the limits of the family, and it so chanced that abundant material was available both from within the limits of the Indian Empire and from a Chinese district on its eastern confines.

Our work has been undertaken in connection with the survey of the freshwater molluscs of India inaugurated at the request of the medical authorities in 1918 by Dr. S. W. Kemp and one of ourselves. There is one point to which we invite attention—that our paper is taxonomic in intention, but could have been prepared only in India and not without a study of the anatomy and bionomics of the species with which it deals. It has been held that systematic zoology is incompatible with bionomics and that different types of mind are necessary in their study. Against such views we protest. They are a libel on taxonomists, if not on taxonomy.

Our thanks are due to the artists of the Zoological Survey of India for the great help they have given us in the preparation of text-figures and plates.

TABLE OF CONTENTS.

PART I.—ANATOMICAL.

By R. B. SEYMOUR SEWELL.

The body of *Vivipara bengalensis*, as in practically all Gasteropod molluscs, is composed of three distinct parts or regions. In the fully-expanded animal the central portion forms a somewhat conical-shaped foot, by means of which the animal is able to crawl over the supporting surface. When fully extended the central aspect of the foot or sole is, roughly speaking, a broad oval, rather broader in front than behind, with a crescentic anterior margin. In young examples the shape of the sole is more elongate and tapers behind to a rounded point. In colour the sole is slate-grey, dotted over irregularly with spots of golden yellow pigment, and just within the anterior margin is a narrow but distinct line of demarkation, indicated by a grey streak, which corresponds to a groove between the more heavily pigmented anterior fleshy border and the less pigmented muscular sole. Above the expanded sole the foot rapidly tapers and on the upper aspect of the posterior region is situated the horny operculum.

The operculum is roughly oval in shape tapering somewhat towards its right side,[1] so as to adapt it accurately to the shape of the mouth of the shell. It is horny in structure and is composed of a number of concentric layers so that it is considerably thicker in the centre, where the opercular muscle is attached, than at the margin, which is often somewhat frayed and irregular in outline. The nucleus is situated excentrically about one-third of the distance from the anterior margin. The colour varies in different regions: around the nucleus it is a deep red-brown and immediately external to this is a narrow band of a pale yellow colour: outside this again the colour often deepens to a golden brown, while the extreme margin is of a blackish tint. The operculum is not absolutely flat, but is somewhat depressed in the central region owing to the pull of the columellar muscle. On the body aspect or lower surface the central portion of the operculum is occupied by the muscular scar to which the opercular muscle is attached. Surrounding this is a smooth ring, which during life is in close apposition to a thin fold of glandular tissue (*vide* Simroth, 1896–1907, pl xviii, fig. 16). In the living animal this fold almost exactly covers the whole of the body surface of the operculum lying outside the scar: owing to the muscle scar being slightly asymmetrical, the fold is somewhat broader on the right side than on the left. It is by the gland cells of this fold that the operculum is secreted.

[1] In the following description the terms right and left, anterior and posterior, etc., refer to the position in the fully extended condition of the animal.

The main mass of the foot is divided into two layers. The lower layer, which forms the sole and consists of soft greyish-coloured spongy tissue, is traversed by a network of muscle-fibres, which is in turn covered by a layer of columnar epithelium. [It is this tissue that forms the whole surface on which the animal crawls]. The upper and posterior portion of the foot is composed of white muscle-fibres. This mass of muscle, which arises from the operculum, becomes continuous with the columellar muscle, which runs upwards in the floor of the mantle chamber and is inserted into the columella about half-a-turn of the spiral above the mouth of the shell. Between the sole and the opercular muscle is a layer of tissue, consisting of a somewhat open reticulum, the meshes of which enclose numerous irregular spaces, and lying free in these are oval or rounded deeply-staining bodies, which closely resemble starch grains. Similar bodies are also found scattered through the reticulate tissue of the edge of the mantle. Between the two tissues of the foot the pedal nerves and the terminal portion of the cephalic artery pass backwards, and the central region is also occupied by a large venous sinus, running antero-posteriorly in the middle line.

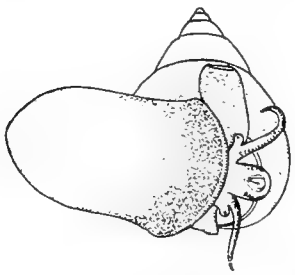

Fig. 1.—Living male of *V. bengalensis* as seen from below.

The anterior part of the body forms a well-marked 'head,' which is produced forwards in the middle line in a short trunk-like snout, on the anterior and central aspect of which lies the oral aperture. Projecting upwards and forwards on either side of the base of the snout is a slender tapering tentacle. Each tentacle arises from a short thick base which is produced on the outer side in a short wide pedicle bearing at its tip a well-marked globular, pigmented eye. Each eye is hemispherical in outline and is situated on the anterior and inner aspect of the pedicle. It consists of a clear cornea superficially, which is usually outlined with golden yellow pigment, and the optic cup is lined by a black, heavily-pigmented retina and encloses an almost spherical lens.

In the female both tentacles are symmetrical, but in the male the right tentacle is somewhat thickened and is curved in a sickle-shaped manner. In this latter sex this tentacle is traversed throughout its whole length by the ejactulatory duct, which opens through a small orifice at the extreme tip. The whole tentacle forms an intromittent organ or penis. Immediately behind and below the base of the tentacles the body surface is produced on either side in a fold—the epipodium. On the left side, the epipodium is triangular or quadrate in shape and is prolonged backwards along the side of the head almost to the point of origin of the mantle. On the right side the epipodium is more complex. Immediately below

and to the outerside of the tentacle is a small narrow fold with a rounded anterior margin and a free external border; this forms a gutter in which the base of the right tentacle and the right eye rest. As we trace the fold forwards and backwards it is seen to commence on the under-surface of the snout close to the junction of the snout and foot; it then runs backwards along the right side of the snout and near the base of the tentacle it curves outwards and forwards and becomes continuous with the syphon. The syphon is formed by a thin leaf-like process the two edges of which are curved upwards so as to form a tube, which is exhalent in function. The mouth of the syphon looks outwards and downwards and when fully extended, backwards. The inner fold of the syphon is continued backwards and becomes continuous with the branchial fold, which passes backwards and towards the left on the floor of the branchial chamber. The whole of the upper surface of the foot and the head as well as the epipodia and syphon are covered with ciliated epithelium; the only region devoid of cilia is the clear cornea of the eyes. The head is heavily pigmented with black, variegated with dots and splashes of golden-yellow in varying degrees of intensity. In examples taken from the tank in the Indian Museum compound the snout is frequently an almost uniform black, unrelieved by any lighter pigment and in some cases the tentacles are alternately banded in yellow and black. The syphon is as a rule of a golden colour.

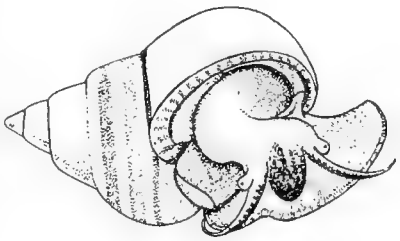

FIG. 2.—Living *V. bengalensis* extended from the shell as fully as possibly.

The part of the body enclosed within the shell is the visceral hump and in a fully-grown example possesses 5½—6 spiral whorls. The skin covering the visceral hump also shows a certain degree of pigmentation, which varies however in different areas as well as in different individuals. In the upper whorls it is often of a deep black colour, while in the lowest or body-whorl the pigment usually follows the lines of the blood sinuses, but as a rule the males are more heavily pigmented than the females. The upper 2½—3 body-whorls are occupied by the liver and the stomach: this latter organ appears on the surface between the lobes of the liver on the right and posterior aspects of the 3rd body-whorl. The penultimate body-whorl, when viewed from above, is seen to be occupied on the left side by a loop of intestine, in front of which is an area of thin skin separating it from the kidney and the upper end of the testis in the ♂ or the albumen gland and shell gland in the ♀. The whole of the lowest or body-whorl is occupied by the branchial chamber, and a series of organs extend throughout its whole length attached to its thin roof. On the extreme left of the

branchial roof, running obliquely forward from left to right, is the line of attachment of the gill, and close to it in front and to the left and extending back for only a comparatively short distance from the mantle margin is an opaque whitish-yellow narrow streak, which denotes the position of the osphradium, while extending for the whole distance along its right and posterior border is a brown band, the branchial gland. On the extreme right of the branchial cavity in the ♂ is the crescentic spirally-twisted testis, which is usually of a bright yellow or orange colour, though this character is often obscured by the dense black pigmentation of the skin; in the ♀ this position is occupied by the thin-walled distended uterus, which seems invariably to contain eggs and young in the sexually mature examples, no matter at what season of the year they are taken. To the left of the uterus is a narrow clear line which denotes the course of the ureter, and beyond this again is a broad brownish band, indicating the course of the rectum. The central portion of the roof of the branchial chamber is thin-walled and is traversed by numerous blood-sinuses which commence in the perirectal sinus on the right and pass transversely across to the left to open into the afferent gill vein which runs along the course of the branchial gland. The free edge of the mantle underlies the peristome of the shell, and is thickened and covered with ciliated epithelium. In young specimens it is produced into a series of blunt finger-like processes, which are usually of a golden-yellow colour (*vide infra*). These tend to disappear as age advances, but traces of them can still be made out in the adult. There is often a quite noticeable one situated on the mantle margin opposite the commencement of the gill, and the yellow pigment-splashes on the mantle margin possibly denote the former positions of others that have since disappeared.

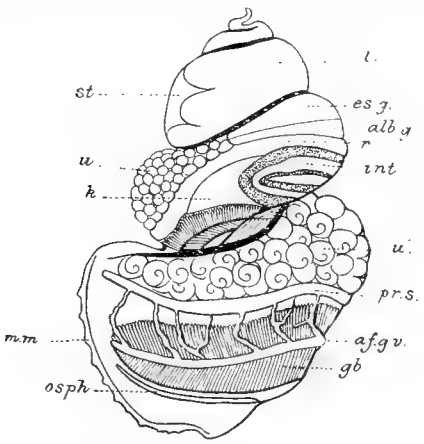

Fig. 3.—*Vivipara bengalensis*: view of the visceral hump from above. *af. g.v.*, afferent gill vein; *alb.g.*, albumen gland; *e.s.g.*, egg-shell gland; *gb.*, gill base; *int.*, intestine; *k.*, kidney; *l.*, liver; *mm.*, mantle margin showing traces of processes; *osph.*, osphradium; *pr.s.*, perirectal blood sinus; *r.*, rectum; *st.*, superficial area of stomach; *u.*, *u'.*, upper and lower parts of uterus.

Immediatly behind the free edge of the mantle, running parallel to it, is the shell-gland. This is most highly developed, as one would naturally expect, during early life, when the rate of growth is most rapid. A similar band exists in *Vivipara vivipara* and has been noticed by Villepoix (1895, p. 513). Laterally the

mantle, where it joins the sides of the body, is thickened owing to wing-like expansions of the body muscle which pass outwards and upwards within its substance. Posteriorly the edge of the mantle is continued round the lower aspect of the body, between it and the upper surface of the foot, as a narrow pigmented ridge. Running upwards in the floor of the branchial chamber is the branchial fold. This structure presents a somewhat different appearance in the two sexes. In the female it forms a thin crenated fold, which passes upwards to the extreme apex of the branchial cavity, and finally becomes closely connected with the upper end of the gill immediately in front of the pericardium. Below, it is continuous with the left fold of the syphon and the ridge passing forwards beneath the right tentacle on the right side of the snout. Throughout its whole length it bears on its right side a small subsidiary ridge or fold, which is usually of a brown colour and which lodges a blood sinus. In the male the ridge consists of a stout basal portion, which is surmounted by a thin lamella. The reason for this difference in the two sexes lies in the fact that in the ♂ this ridge accommodates throughout almost its entire length the vesicula seminalis. According to Moore (1901, p. 470, note to fig. 1, pl. xxv) in the closely-related mollusc, *Neothauma tanganyikense*, Smith, this ridge serves as a protection for the gill against damage from pressure against the distended uterus and contained young, and is better developed than in *Vivipara vivipara*. It is always a matter of some difficulty to compare living examples of one species with the published descriptions and figures of others, but it seems to me that in *Vivipara bengalensis* this branchial fold is every whit as well developed as in *Neothauma tanganyikense*, and a study of the living animal has convinced me that Moore is wrong in his view of its function. If a fully-expanded example of *V. bengalensis* be examined in the live state, it will be seen that the branchial fold extends vertically, inclining slightly to the right from the floor of the branchial chamber till its upper free border almost if not actually reaches the roof of the chamber, thus dividing the branchial chamber into two almost completely separate parts. On the left of this ridge is a wide cavity the upper and left wall of which is formed by the gill; and a little behind the mouth of the shell, the tips of the gill-filaments are in close apposition to the free border of the fold. A transverse section about half way up the body-whorl shows that the tips of the gill-filaments may actually pass across above the upper edge of the fold and project into the cavity on its right side. The cavity to the right of the branchial fold is never completely occluded by the uterus; there is always a free interval between the two which becomes continuous below with the syphon tube. The ridge is covered with a tall columnar ciliated epithelium, very similar to that covering the gill lamellae and the margin of the mantle. The presence of an equally well-developed branchial fold in the male indicates that Moore's explanation is not the true one and I entirely agree with Cuvier (1817, p. 6) that its function is respiratory, though it is

well known that the syphon is exhalent and not inhalent as he supposed (*l.c.*, p. 4).

The middle portion of the mantle is, as has already been mentioned, thin, and by carefully cutting through along this line and everting the two sides we are able to see the various structures contained within the cavity. The left side of the mantle is the same in both sexes. Commencing in the middle line in front and running backwards and to the left is the line of attachment of the gill. This is of the pectinate type and comprises roughly some three hundred filaments. Each filament or plate is of an elongate triangular shape, with a narrow base of attachment and tapering towards its extremity. The basal attached portion is to the left and the free margin of the gill lies towards the right side. Each gill-filament is covered with ciliated epithelium. Immediately on the right and, owing to the oblique course of the gill, a little posterior to it, is a raised, brownish-coloured ridge, the hypobranchial gland, which extends upwards along the whole length of the gill-base. It is covered with a tall columnar epithelium and lying immediately above it is a large blood sinus, the afferent gill-vein, which collects blood from the viscera and conducts it to the gills, where it is aerated. To the left and in front of the gill and extending backwards from just behind the edge of the mantle to a point about one-third the length of the gill is a raised narrow ridge of a whitish yellow colour; this is the osphradium, and from its upper end a narrow white line is continued upwards, parallel to the gill-base as far as the extreme apex of the mantle cavity. As already mentioned, the mantle cavity is divided into right and left halves by the branchial fold. Water entering the mantle cavity passes into the left of this fold, and having traversed the branchial chamber passes out again down the right side and through the syphon. From the position of the osphradium, which commences a little to the left of the middle line and runs outwards and backwards on the left and in front of the gill, it is evident that all the water entering the cavity must first pass over the osphradium before it can reach the gill-filaments. The osphradium forms a very sensitive sensory organ. It is covered with ciliated epithelium and on its gill-surface it bears a number of small microscopic pits, which are also lined by columnar epithelium. These pits are difficult to see in the natural state, but in some cases indications of them can be made out owing to the mouths being faintly outlined with yellow pigment. The organ is supplied by a special nerve or series of nerves, the osphradial nerves, which arise from the anastomosis between the mantle nerve, coming from the left pleural ganglion and the first gill-nerve arising from the supraintestinal ganglion of the right visceral nerve (for a detailed account of this organ in *Vivipara vivipara* see Bernard, 1890, pp. 244-250).

On the right of the mantle chamber are the rectum and ureter and, in the female, the uterus also. These pass down close together on the right wall of the mantle chamber and open close

to the mantle margin in the angle formed by the roof and floor of the cavity opposite the syphon, so that all excreta are at once carried out of the chamber away from the body.

In the female the uterus and ureter open close together. These two ducts run down side by side on the extreme right of the branchial cavity, the ureter being to the left of the uterus, and the rectum lying above and to the inner side of the ureter. The terminal portion of the uterus is known as the vagina: it forms a prominent rounded papilla, the walls of which are thick and spongy, and the orifice is situated at its apex. This orifice is extremely distensile and in the contracted condition is oval or slit-like. The aperture of the ureter lies above and to the outer side of the vagina. It is much smaller and is provided with a sphincter muscle. The rectum passes down above and to the inner side of the ureter, it is continued further forward, towards

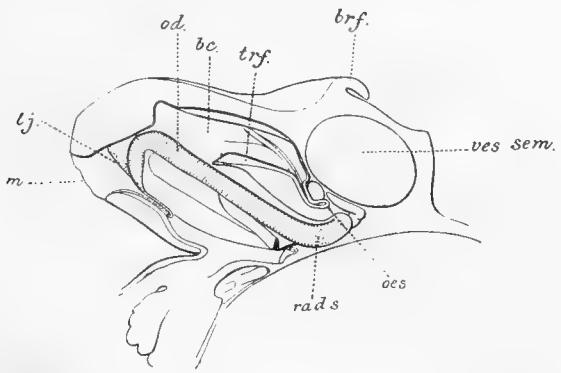

FIG. 4.—*Vivipara bengalensis*, view of the right half of the buccal cavity, cut in the sagittal plane. *bc.* buccal cavity; *br.f.* branchial fold; *l.j.*, lateral chitinous jaw; *m.*, mouth aperture; *od.*, odontophore; *oes.*, oesophagus; *rad.s.*, radular sac; *trf.*, transverse fold above and behind odontophore; *ves.sem.*, vesicula seminalis cut in oblique section.

the mantle margin than either the uterus or ureter and having passed the terminations of these ducts it bends downwards and to the right and opens at the tip of the anal papilla. The terminal papilla and orifice of the anus is usually of a bright golden-yellow colour.

In the male, the rectum and ureter occupy the relative positions as given above, but the position of the uterus is now occupied by the orange yellow testis.

The Alimentary System.

The mouth is situated ventrally at the anterior end of the snout and forms an oval aperture, bounded by fleshy lips, between which the radula is thrust out during the process of feeding with a rotary motion from above downwards. The mouth leads backwards and upwards into the cavity of the buccal mass and each lateral wall is furnished with a low ridge, running from above

downwards and backwards. These ridges are yellowish in colour and are armed with a simple chitinous plate. The buccal mass is heart-shaped. In front it becomes continuous with the lips of the mouth, while behind it is produced in two ventral and posterior rounded prominences, between which lie the radular sac below and the oesophagus above. The buccal mass is plentifully supplied with muscles. On cutting through the skin in the middle line of the dorsum of the head and reflecting it outwards, numerous delicate strands of muscle, the protractors, can be seen passing backwards from the sides and dorsum of the skin of the snout to the buccal mass. Below the buccal mass a pair of rather stouter bands passes downwards and forwards to the skin. These are the depressors. The anterior region of the buccal mass is plentifully supplied with intrinsic muscles, as follows :—

(1) Superficially and somewhat towards the ventral aspect on each side is a fan-shaped muscle, which arises by a narrow tendon from the lateral region of the ventral aspect and spreads out fan-wise as it passes forwards to be inserted into the oral tube.

(2) Immediately deep to this is a sphincter muscle, the fibres of which run concentrically around the tube.

(3) A band of muscle, rather narrower behind than in front, arises from the sides of the buccal mass, immediately posterior to the buccal nerve, across which it passes forwards, spreading out to be inserted round the oral tube.

Two pairs of strong muscles, the fibres of which are of a shining white colour in contradistinction to the fibres of the preceeding muscles which have a reddish tinge, arise from the main muscle mass of the body and pass forwards to be inserted into the buccal mass. These are the anterior and posterior retractors :—

(4) The anterior retractors are inserted into the anterior ventral aspect of the buccal mass by narrow tendons; passing backwards side by side they cross the pedal commissure dorsally and can be seen to arise from the main muscle mass near the base of the antennae.

(5) The posterior retractors arise from the main muscle mass and pass forwards and slightly upwards external to the pleuro-pedal commissure of the central nervous system. Here each gives off a slip to the lateral wall of the oesophagus. It then continues forwards internal to the cerebro-pedal commissure and finally joins the side of the buccal mass as a fine tendon which can be traced forwards below the buccal ganglion and ends in a delicate expansion internal and deeply to the muscle (3) noted above. These two muscles are not quite symmetrical for that of the left side arises from the main muscle mass of the body at a higher level than that on the right.

A series of small muscle strands, usually three in number, arise close to the origin of the above muscle and pass forwards and upwards to be inserted into the surface of the radular sac.

The upper wall of the buccal mass is thin and on cutting through it in the antero-posterior line we get a view of the buccal cavity. In the middle line in front arising from the floor is a stout pyriform mass the narrow end of which projects upwards and forwards; this is the odontophore and it can be seen to carry the radula which disappears posteriorly into the radular sac. The radula is a yellowish narrow ribbon, which carries a series of small spinose teeth. These teeth are divided according to their position and dentation into three series. In the middle line is the median row, consisting of a single central tooth, as it is called. The anterior border of this tooth is recurved and is cut into a series of denticles. There is a wide rounded median denticle and five smaller triangular denticles on either side. On each side of the central tooth are a pair of laterals. In both cases we get the rounded median denticle and a series of smaller triangular or claw-like denticles on each side of it.

FIG. 5.—Radular teeth of *V. bengalensis*.

As a rule there are five of these claw-like denticles on either side of the median denticle in each of these teeth, but occasionally we find that there are six denticles on the outer side of the second lateral tooth. This variation may occur in a portion of a radula the rest of which shows the normal condition. The marginal tooth is usually curved inwards towards the middle line, and bears on its margin a uniform series of small denticles. In some cases as in the radula figured, there may be a broad sharp extra denticle at the extreme margin. The radula of *Vivipara bengalensis* was figured by Fischer (1887, fig. 499, p. 732), but a comparison of his figure with that given above will render unnecessary any apology for refiguring it here.

Lying behind and above the odontophore is a transverse fold with a crescentic anterior margin, the median portion of which is somewhat thickened and is slightly notched. Each lateral wall of the buccal cavity is thick and swollen and contains a cartilaginous mass—the odontophoral cartilage. Each cartilage is roughly oval in shape, the anterior end being somewhat more sharply rounded than the posterior, and is concavo-convex, the concavity being towards the middle line. The lower border is thin and is curved inwards. From the outer aspect a little below and behind the centre of the cartilage numerous muscle-fibres

arise and spread out in the lateral walls of the buccal mass. At the posterior end of the buccal mass beneath the oesophagus lies the radular sac, in which the radular ribbon is secreted. It is a short stout tube having a somewhat dorsally directed nipple-like posterior end. Above the odontophore the cavity of the buccal mass is hour-glass shaped the upper portion having a very thin-walled roof. Opening into the cavity are the ducts of the salivary glands.

The salivary glands are irregular asymmetrical racemose glands, consisting of a number of branching and anastomosing lobules. It is impossible accurately to separate the gland into right and left portions, and hence in this respect *Vivipara bengalensis* offers a marked contrast to *Neothauma tanganyikense* in which the salivary glands are separate and form compact lobulated masses (vide Moore, 1901, fig 2, pl. xxv). The main mass of the salivary gland lies on the dorsal side of the oesophagus behind the central nervous ring and is intimately bound up with the supra-oesophageal nerve as it crosses the oesophagus from right to left. A pair of delicate narrow salivary ducts arise anteriorly and pass forwards beneath the cerebral commissure.

The oesophagus is thin-walled and usually presents a greenish appearance due to its contents. It passes backwards and to the left and then turns towards the right again to pass up the columellar aspect of the visceral hump. During its course backwards in the floor of the branchial cavity it lies beneath the branchial fold and above the main muscle mass: on its left side lies the supra-intestinal nerve, and during this part of its course it lies in a well-marked venous sinus and is in close relationship to the cephalic aorta. At the posterior end of the mantle cavity the oesophagus passes upwards in the floor of the pericardial chamber and so reaches the liver. Finally in the upper part of the visceral hump the oesophagus curves round and opens into the stomach. This is a wide cavity occupying the third and fourth whorl. On cutting away the superficial wall of the stomach the cavity is seen to be incompletely divided into three regions, of which the upper two represent the cardiac portion of the stomach, while the lower part is the pyloric cavity. The junction of oesophagus and stomach is marked by a crescentic fold, just beyond which lies the orifice of the duct from the upper lobe of the liver. On the inner aspect, and dividing the cardiac region into two, is a broad longitudinal fold which passes downwards, and which carries a well-marked blood vessel. Below, this ridge divides into right and left folds which diverge and form the line of separation between the cardiac and pyloric regions. In the right half of the cardiac chamber the wall of the stomach is thrown into a series of longitudinal parallel folds, each fold being marked with a brown streak. The lower portion of this cavity is lined by a thin layer of chitin, which becomes thicker and more marked over the ridge separating the cardiac and pyloric cavities.

The pyloric portion of the stomach is a wide cavity that

gradually tapers towards its lower end. Running across the posterior wall is a doube fold, of which the upper lip is often much more prominent than the lower. Between these two folds is a narrow gutter into which the ducts of the right and left lobes of the liver open. The junction of stomach and intestine is very clearly defined owing to the different character of the lining mucous membrane. The stomach is lined by tall columnar ciliated cells, which give the wall a soft velvety appearance, whereas the intestinal wall has a yellowish colour and is lined with a layer of chitin which gives it a smooth bluish metallic look.

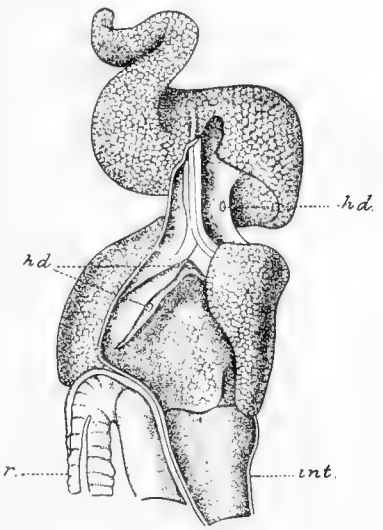

FIG. 6.—*Vivipara bengalensis*, view of inner wall of gastric cavity after removal of superficial wall. *hd.*, openings of hepatic ducts; *int.*, intestine; *r.*, rectum.

The liver, owing to the bulging of the stomach on its outer surface and the passage through it internally of the oesophagus, is incompletely divided into three lobes, an apical, occupying the upper turns of the spire, and a right and a left lobe inferiorly. The organ has a golden brown colour, which is, however, frequently obscured owing to heavy pigmentation of the overlying skin. It is a racemose gland, with elongate acini the tips of which reach the surface. Each acinus is hollow and is lined with a columnar or cubical epithelium. Each lobe is furnished with a separate duct, that of the upper lobe opening into the left part of the cardiac portion of the stomach, while the ducts of the right and left lobes open on the posterior wall of the pyloric cavity between the folds noted above. According to Leydig these folds probably serve to regulate the flow of bile.

The intestine passes forwards and to the right in the penultimate body-whorl and then turns sharply back again, forming a loop which overlies the pericardial cavity. In the first part of its course the lumen gradually narrows: it is lined by a yellow-coloured epithelium covered with a thin chitinous layer and running along its posterior aspect is a gutter with fleshy lips which are pigmented brown. At the apex of the loop, the character of this gutter becomes somewhat modified and the right-hand fold becomes proportionately larger and now appears to form a longitudinal ridge or typhlosole projecting from the posterior wall. The intestine having again reached the liver turns sharply forwards

once more and is now continued on as the rectum. It passes forwards on the right of the whorl, lying on the surface; in the ♀ it is in close apposition to the albumen- and shell-glands, and passes downwards and forwards immediately to the outer side of the kidney and the first part of the ureter. In the body-whorl it passes forwards, as we have already seen, in the roof of the branchial chamber and opens at the anus. In this latter part of its course its walls are thrown into numerous transverse folds. The contained faeces are moulded into small oval compact masses.

The Vascular System.

The heart lies in the pericardial chamber at the apex of the branchial cavity and on the inner side of the penultimate body-whorl. It is a closed cavity the walls of which are in places extremely thin and delicate and hence are very liable to become torn or ruptured. On its inner aspect the pericardium is separated from the shell only by thin membrane; above and in front it is bounded by the kidney, and above and behind is the loop of the intestine and the liver; on its right or outer side lie the genitalia and the rectum; while below it lie the oesophagus, the termination of the supra-intestinal and sub-intestinal nerves and the splanchnic ganglion and, in the female, the loop of the oviduct. On its outer and upper aspect the cavity of the pericardium communicates with the kidney through the reno-pericardial opening, the position of which will be studied when dealing with the kidney itself.

The heart consists of two chambers. Anteriorly is the soft-walled whitish-looking auricle, the walls of which are usually thrown into a series of irregular folds. In almost every adult example examined, the auricular wall was seen to contain a number of small round white bodies. These are cysts of an Echinostome Agamodistome and are present in such large numbers that they may almost fill the whole organ. The wall of the auricle is thick and glandular, and is said to form the haematic gland that is present in other molluscs (*vide* Perrier, 1889, p. 178). The ventricle lies posteriorly and is a rounded body of a pale brownish colour and its walls are thick and muscular. The auriculo-ventricular aperture is tube-like and projects into the cavity of the ventricle. From the inferior aspect of the ventricle arises a short wide aorta. In *Vivipara vivipara* (*vide* Perrier, 1889, pl. viii, fig. 38 x.) there is said to be a valve-like flap at the point of origin of the aorta from the ventricle, which prevents the regurgitation of blood during the ventricular diastole. Leydig (1850, p. 170) on the other hand states that there is a cresentic valve situated between the auricle and ventricle. In *Vivipara bengalensis* I have failed to find any indication of either. The common aorta almost at once bifurcates into two wide trunks, which run in opposite directions. One branch, the *cephalic aorta*, passes forwards and downwards to the inner side of and close to the oesophagus. In this position it passes forwards

below the floor of the mantle cavity and high up in the chamber it gives off a large branch that diverges towards the left side and, where the mantle margin merges into the foot, breaks up into branches. The main trunk of the cephalic aorta is continued on, crossing beneath the oesophagus to reach its right side. In this situation it has the sub-intestinal nerve, lying in a blood sinus, on its right and in the ♂ the vesicula seminalis lying directly above it. At the anterior end of the branchial chamber it comes into relationship with the radular sac, and passes forwards on its right side. It then dives ventrally, and below and behind the pedal commissure it gives off a branch to the snout and then divides into anterior and posterior branches which run to the respective regions of the foot. Throughout its course beneath the branchial chamber it gives off a number of fine branches to the muscles of the body.

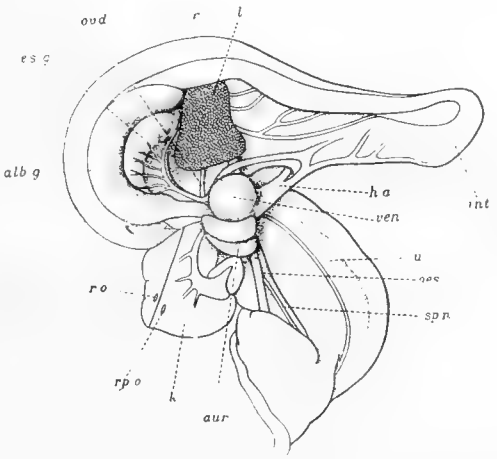

FIG. 7.—*Vivipara bengalensis*, view of the pericardial chamber. The loop of intestine has been turned over to the left side and the kidney downwards and to the right. *alb.g.*, albumen gland; *aur.*, auricle; *es.g.*, egg-shell gland (receptaculum seminis); *h.a.*, hepatic aorta, *int.*, intestine; *k.* kidney; *l.*, liver; *oes.*, oesophagus; *ov.d.*, oviduct; *r.*, rectum; *r.o.*, renal orifice into ureter; *rp.o.*, reno-pericardial opening; *sp.n.*, supra-intestinal nerve; *u.*, uterus; *ven.*, ventricle.

The *hepatic aorta* passes upwards and backwards in the floor of the pericardial cavity, immediately to the left of the oesophagus. It almost at once gives off a large branch which passes at first slightly inwards and upwards to reach the lower wall of the intestine, where it subdivides into two main branches. One of these curves forwards and runs along the under aspect of the first part of the intestine, supplying branches to it, and the main vessel passes at first forwards as far as the bend of the intestine and then continues on along the second part of the intestine, lying immediately beneath the typhlosole-like ridge on its under aspect. The other branch curves forwards and to the right, crossing behind the oesophagus, and sends branches to the testis in the ♂. In the ♀, after supplying branches to the albumen and shell glands, curves backwards and to the left and reaches the wall of the uterus where it finally divides into ascending and descending branches, the latter of which is much the longer and larger of the two and runs down the ventral wall as far as the point where the wing-like

expansion of the body muscle meets the mantle margin. The main hepatic artery is continued upwards between the liver and stomach, where we have already noticed it lying in the longitudinal fold on the posterior wall of the cardiac portion of the stomach, and ends in branches supplying the liver in the apical whorls.

The venous system consists very largely of wide spaces or sinuses, whose walls are very thin and in consequence are very difficult to define. Occupying the central portion of the foot, between the dense white muscle and the grey spongy tissue of the sole, is a wide irregular sinus, the blood from which, according to Leydig, passes upwards and backwards to reach the venous sinus on the ventral posterior aspect of the kidney. This sinus appears to be joined at the left posterior angle of the kidney by a venous sinus, which runs up the right side of the branchial fold in the floor of the mantle cavity, and it is also joined by a sinus crossing from right to left along the posterior and upper margin of the kidney and having its origin in the perirectal sinus. The conjoined vessel passes down superficially on the left side of the kidney between it and the branchial gland. This vessel is known as the afferent gill-vein. Lying to the right of the kidney in the body-wall is a large sinus which receives blood from the organs lying in the upper coils of the visceral hump; this passes downwards and at the apex of the kidney joins the afferent gill-vein that we have already seen passing down the left margin along the branchial gland. The afferent gill-vein can be traced down the whole length of the branchial gland on the right of the gill-base almost as far as the mantle margin; below the level of the kidney it is joined by a further series of small branches which arise from the perirectal sinus and pass across the thin median portion of the mantle roof. The perirectal sinus also received tributaries in the female from the wall of the uterus. The afferent gill-vein supplies branches to the gill-filaments and the blood after being aerated returns to the efferent gill-vein which lies on the left side of the base of the gill; this vein passes from below upwards and at the apex of the mantle cavity opens into the cavity of the auricle. A large vein runs down beneath the floor of the branchial chamber on the right side of the oesophagus. Superiorly it receives tributaries from the liver, and in the ♀ from the albumen gland and egg-shell gland while a large branch passes up on the inner aspect of the uterus and then crosses over behind the sub-intestinal nerve to join it near the apex of the branchial cavity.

The Renal System.

The kidney is a triangular pyramidal organ of a pale greenish colour, lying in the roof of the mantle cavity at its extreme apex. Along the external or right margin runs the rectum and the perirectal blood sinus, below which lies the commencement of the ureter, while along the left or inner margin is the commencement of the afferent gill-vein and the base of the gill. The posterior

border is connected with the loop of the intestine by an intervening fold of thin membrane. Of the four surfaces of the kidney, the upper lies just under the skin against the shell. The apex of the kidney lies to the front, and the left surface forms the upper part of the right-hand wall of the mantle cavity and is in close relationship with the terminal portion of the branchial fold. The base of the kidney, which is triangular in shape with the apex of the triangle directed ventrally, faces backwards towards the upper part of the visceral hump and forms part of the anterior boundary wall of the pericardial chamber. The right surface of the kidney is in relationship with the upper part of the ureter, which separates it from the testis in the male or the uterus and shell-gland in the female. A thin fold of membrane passes outwards and backwards from the right-hand border of the base of the kidney to the testis in the male and the shell-gland in the female and forms the upper boundary limit of the ureter.

The kidney is provided with two orifices that open respectively into the ureter and the pericardium. Both these apertures are situated close together near the right posterior border. The reno-pericardial opening is situated on the posterior or pericardial surface of the kidney near the supero-external angle: it is oval in shape and has thin walls. The external or ureteral orifice is situated on the external surface, close to the reno-pericardial aperture, but separated from it by the conjoined pericardium and wall of the ureter. It possesses thick protuberant lips, which are covered with ciliated, columnar epithelium and are often marked by a ring of black or brown pigment. The ureter is a thin-walled tube having in cross section a triangular lumen. Its right wall is bounded by the testis in the male or the uterus and part of the albumen- and shell-glands in the female: the left wall is thin and separates it from the branchial chamber, while its upper or superficial wall is formed partly by the rectum and perirectal blood sinus and a thin-walled portion in contact with the superficial skin. The orifice of the ureter lies, as we have already seen, near the right-hand margin of the mantle edge, in the angle between the rectum and the vagina in the female, or in the corresponding position to the left and above and behind the anus in the male.

The Genital System.

Vivipara bengalensis like all members of the genus is diœcious, or in other words the two sexes are separate. We have already seen that sexual differences are apparent in the structure of the right tentacle, which in the male is thickened and recurved and acts as a penis or intromittent organ. This change does not seem to have proceeded quite as far in *Vivipara bengalensis* as in the European species *Vivipara vivipara*, for in the former the modified tentacle is sickle-shaped, whereas in the latter it is figured as being completely contracted up into a rounded projection (*vide* Fischer, 1887, fig. 501, p. 733), which may actually be

enclosed in a small pocket (*vide* Baudelot, 1863, p. 218, pl. v, figs. 14–15).

♂. The testis in *Vivipara bengalensis* forms a compact semilunar organ lying on the right of the branchial chamber, and occupying the same position as the uterus in the female. It is of a bright orange-red colour and extends to the upper end of the branchial cavity, where its apex is in close relationship with the pericardial cavity and is connected by a thin fold of membrane with the lower surface of the liver. The gland is flattened from side to side, the right surface being in contact with the shell while the left surface forms in part the right wall of the ureter and below this the right wall of the mantle cavity. In possessing a testis formed of a single mass in this position in the body *Vivipara bengalensis* differs markedly from *Vivipara vivipara*, in which the testis consists of two distinct portions, the upper occupying the extreme apex of the visceral hump and the lower lying at the lower margin of the liver between the stomach and the coil of the intestine (*vide* V. Siebold, 1836, p. 241, and Simroth, 1896-1907, pl. xliii, fig. 9; also Erlanger, 1891, pp. 665-666).

Although the testis in *Vivipara dissimilis* (Müller) occupies the same position as in *V. bengalensis*, it differs in having a more or less quadrilateral extension from its upper pole, which passes upwards on the outer side of the pericardial cavity and abuts against and is firmly united to the lower aspect of the liver, from which, however, it can be readily recognised by its golden orange colour. This upward expansion is clearly demarcated off from the rest of the organ, which closely resembles the whole testis of *V. bengalensis*, and partakes more of the nature of a second lobe. *V. dissimilis* in this respect is intermediate between *V. vivipara* and *V. bengalensis*.

A series of narrow delicate ducts, the vasa efferentia, arise from the lower border of the testis and passing respectively upwards and downwards along its lower border converge to form a narrow tube, the vas deferens, which passes to the left beneath the floor of the branchial chamber, crossing above the sub-intestinal nerve, to reach the vesicula seminalis. The first part of the vas deferens is sometimes dilated to form a spindle-shaped swelling, but the portion of the duct near the vesicula seminalis is narrow. The vesicula seminalis forms a wide tube which passes downwards and forwards from just in front of and below the pericardium to the base of the right tentacle beneath the floor of the branchial chamber approximately in the middle line and exactly beneath the branchial fold. The upper portion of the organ curves round to the right to meet the vas deferens. The whole organ is pigmented and possesses an iridescent appearance like mother-of-pearl. Cuvier (1817, p. 7) described this structure in *V. vivipara* as the copulatory organ, but Treviranus subsequently referred to it as a seminal vesicle, and there seems to be some doubt as regards its true function. Later authors refer to it either as the vesicula seminalis or the prostate gland. Erlanger

(1891, p. 665), appears to consider it to be an ejaculatory duct, in which view Simroth (1896–1907, note to fig 9, pl. xliii) concurs. Baudelot (1863, p. 217), on the other, hand seems to consider that it is of the nature of a prostate gland, and describes the internal surface as consisting of a series of transverse lamellae, running parallel to each other. In *V. bengalensis*, this region of the duct is surrounded by a layer of circular connective tissue fibres and the lining mucous membrane is thrown into folds as described by Baudelot, though these are narrower and more numerous than he figures them. A transverse section shows that these folds are supported by a connective tissue lamella, on each side of which is a layer of cubical epithelium. The whole organ is glandular in character and is in my opinion a 'prostate' gland. The terminal portion of the male duct is comparatively narrow. It passes up the right tentacle and opens by a small orifice at its extreme tip. In this part of its course the duct-wall is thick and muscular, and constitutes an ejaculatory duct.

According to Smith (1881, p. 221) the right tentacle of the male *Vivipara vivipara* is merely the sheath of a true penis, "which, at the time of copulation, protrudes through it." As regards this statement he appears to be at variance with other authors. Simroth (1896–1907, p. 617) states that the short 'penis' can be coiled up in a pouch of skin at the outer side of the tentacle, and Baudelot (1863, p. 218, pl. v, fig. 14) shows this condition very clearly. It is this coiled up portion of the tentacle which is the 'penis,' and no portion of the genital duct is protruded through it during the act of copulation, for, as Baudelot points out, the terminal portion of the duct, which I have considered to be an ejaculatory duct, is intimately connected with the skin of the tentacle and could not possibly be everted. In this respect *Vivipara vivipara* and *V. bengalensis* appear to be identical. In this latter species the terminal portion of the ♂ genital duct is closely bound to the skin of the tentacle by connective tissue. I have not been able to observe the act of copulation, but the structure of the right tentacle in this species shows that here also it is the tentacle itself which is the intromittent organ.

The seminal fluid contains two quite distinct forms of spermatozoa. The first form, which appears to be that of the mature functional spermatozoon, consists of an elongate spiral head, with 6–7 turns in the spiral and of a refractile appearance: behind this is a single long flagellum. The second form is usually described as 'worm-shaped'; it may be straight or spirally twisted, is much stouter than the spiral kind and terminates in a tuft of numerous short flagellae. From the time of their discovery these two forms of spermatozoa have interested zoologists and accounts of them and their mode of development have been given by V. Siebold (1836), Leydig (1850), Baudelot (1863), Simroth (1891–1907) and others, but we are still ignorant of the function of the worm-shaped type.

♀. The genital organs of the female *Vivipara bengalensis* appear to agree exactly with those of *V. vivipara*. One of the best

accounts of these organs is that given by Baudelot (1863, pp. 218–220, pl. v, figs. 16–20). Erlanger (1891, p. 664) in his description claims to have followed Baudelot and to have reproduced his illustration of this system. But a comparison of the two figures serves to show how misleading the results of such a procedure may be, for Erlanger (*l.c.*, fig. 3) shows no trace of the duct of the albumen gland, though this is clearly seen in Baudelot's figure (*l.c.*, fig. 16).

In *Vivipara bengalensis*, the ovary consists of a few small scattered follicles along the commencement of the oviduct. It is of a red-brown colour and so in spite of its small size can be distinguished from the liver tissue: it lies in the third body-whorl, in close contact with the posterior wall of the cardiac region of the stomach and along the course of the hepatic artery. The various follicles contain numerous small ova, which have a diameter of 0·021-0·025 mm. The oviduct passes downwards as a fine tube, also of a red-brown colour, to the lower margin of the liver and is then continued on along the floor of the pericardial cavity on the right of the oesophagus. At this point it is joined by the short wide duct of the albumen gland. This gland is situated just below the skin on the right of the pericardium. It is connected by a thin fold of membrane with the loop of the intestine on the upper surface of the pericardium and the rectum passes forwards and downwards along its superficial aspect, which is grooved to receive it. Below, the gland is intimately bound down to the U-shaped egg-shell gland, or receptaculum seminis as it is usually termed. The albumen gland is tongue-shaped and slightly curved. It is of a bright orange-red colour and its apex is in contact with the lower surface of the liver. From its inner and posterior border a wide duct arises which passes backwards internal to the first part of the egg-shell gland and joins the oviduct. The combined duct is then continued downwards and inwards for a short distance and then turns back again towards the apex of the visceral hump. This portion of the duct is of a brown colour and it can be traced to the lower and inner limb of the egg-shell gland, into which it opens at its extreme end on a smooth rounded papilla.

The egg-shell gland is, as already mentioned, a wide U-shaped tube the walls of which have a yellow-brown colour very similar to that of the liver. The ascending limb of the U is at first narrow, but as it passes upwards towards the liver it gradually dilates and then turns sharply round on itself and passes downwards again on the right of the ascending limb and in close contact with the shell. On opening the tube, the inner wall is seen to be thick and glandular and is thrown into a series of folds. At first these folds run parallel to the length of the tube, but as we trace them up they become more and more oblique curving towards the right and in the descending limb of the gland they run spirally. On the posterior aspect of the descending limb a smooth whitish ridge with a gutter on its right side can be seen to

arise at the upper and posterior end, passing downwards to the orifice through which the shell-gland opens into the uterus. At this point the smooth ridge becomes continuous with a longitudinal fold, which, as we shall see later, passes down the whole length of the lower wall of the uterine cavity. I have throughout referred to this **U**-shaped portion of the genital duct as the egg-shell gland. In the earlier descriptions of *V. vivipara*, such as that given by von Siebold (1836 p. 244), it is referred to as a receptaculum seminis, because free spermatozoa were found in the contents. That it serves as a repository for semen is beyond doubt, but it seems to me that its true active function is to produce the thin membranous covering which surrounds the eggs. The egg-shell gland opens below by a wide crescentic mouth into the thin-walled uterus. This is a wide cavity, which we have already seen lying on the right of the mantle cavity throughout the whole length of the body-whorl. It invariably contains eggs and developing young when once sexual maturity has been reached. Running along the whole length of the floor of the uterine cavity is a double fold of opaque-white colour which is in marked contrast with the thin translucent side walls. This double fold has a narrow base of attachment and the left-hand or inner fold is thin and convoluted while the outer fold is thicker and has a straight margin. This outer fold is covered with a ciliated epithelium and beneath this fold, between it and the floor, the seminal fluid, which has been introduced by the male is conducted up to the shell gland. The terminal portion of the genital duct is comparatively narrow and thick-walled. It opens on the right of the branchial chamber by an oval orifice, the vagina, which is situated terminally on a small papilla. During copulation the right antenna of the male is introduced through this orifice and the seminal fluid is deposited within the uterus.

The members of the genus *Vivipara*, as their name implies, produce live young, but they are actually ovo-viviparous. If we examine the contents of the uterus during the breeding season we find that the lower region of the duct contains numerous young, with $2\frac{1}{2}$ turns in the shell, ready to be born, but as we pass further and further upwards the state of maturity of the young becomes less and less, until at the extreme upper end we find large ova containing an extremely minute embryo, with only half a turn in the spiral of the visceral hump. These eggs are large and are pyriform or globular in shape. They are surrounded by a thin delicate membrane, which at one point is twisted up and produced into a kind of free pedicle. Filling the whole egg, and surrounding the young embryo is a mass of faintly blue albuminous material, which under the higher powers of the microscope, can be seen to contain large numbers of spermatozoa, so that it would appear that the seminal fluid of the male serves the double function of fertilizing the ovum and providing in part for the nourishment of the embryo. In addition to the spermatozoa we find numerous fine spicules which dissolve readily on the addition of glacial

acetic acid and are presumably calcareous in nature. It is probably from these spicules that the young embryo derives the calcareous substance necessary for the production of the shell.

The Nervous System.

A very full and complete account of the nervous system of *Vivipara vivipara* has been given by Bouvier (1887, pp. 63-72, pl. iv, figs. 15, 16) and that of *Vivipara bengalensis* agrees in almost every particular, so far as I have been able to ascertain. The type of nervous system is that known as 'dialyneurous,' in that the connection between the sub-intestinal nerve and the right pleural or parietal ganglion is an indirect one, brought about by the union of a branch arising from the right pallial nerve and a branch from the sub-intestinal nerve. A similar anastomosis exists on the left side of the body, between the left pallial nerve and a branch from the supra-intestinal ganglion. Moore (1903, p. 276) has distinguished three different types of nervous system, based on the relative positions of the three main ganglia of the central nervous system—those forms of nervous system in which, as in *Vivipara*, "the pleural ganglia are more or less half-way between the cerebrals above and the pedals below the oesophagus" he terms 'dystenoid.'

The cerebral ganglia are situated in the base of the snout on either side of the commencement of the oesophagus, immediately behind the buccal mass. Each ganglion is roughly triangular in shape, with the base posteriorly and the apex pointing forwards and outwards. On the external aspect a shallow groove divides the ganglion into two parts, an anterior 'labial' portion and a posterior 'cerebral' portion. Each ganglion is of a red-brown colour and is connected with its fellow across the dorsal aspect of the oesophagus by a wide, short cerebral commissure. The ducts of the the salivary glands pass forwards close to the middle beneath this commissure and above the oesophagus. The 'labial' portion of the cerebral ganglion is flattened dorso-ventrally and from its outer and antero-internal borders a number of nerves arise. From the antero-internal border two fine nerves arise close together and pass forwards over the dorsum of the buccal mass to the skin of the snout. Near the apex of the ganglion, but still from the inner border, a stout nerve arises and passes forwards on the side of the buccal mass to the snout and lips. At the extreme apex of the ganglion three nerves arise close together: (i) this runs forwards on the side of the buccal mass to the lips and snout; (ii) this is the stoutest of all three and is the buccal nerve. It first passes downwards and forwards on the lateral aspect of the buccal mass towards the ventral aspect: here it turns upwards and passes deep to the lateral retractor muscle of the lips, and just above and behind the origin of this muscle from the side of the odontophoral cartilage it ends in a rounded or triangular yellowish-brown body, the buccal ganglion, which lies just in front of and below the point of entrance of the salivary duct into the buccal cavity.

From each buccal ganglion three nerves arise, two of these pass obliquely upwards towards the dorsal aspect of the buccal mass, but the third and largest passes backwards and downwards around the posterior aspect of the buccal mass, below the oesophagus and above the radular sac to the ganglion of the opposite side. This is the buccal commissure. (iii) This nerve arises just external to the buccal nerve and passes forwards and downwards to the lower part of the lip of the mouth; it gives off a branch which passes

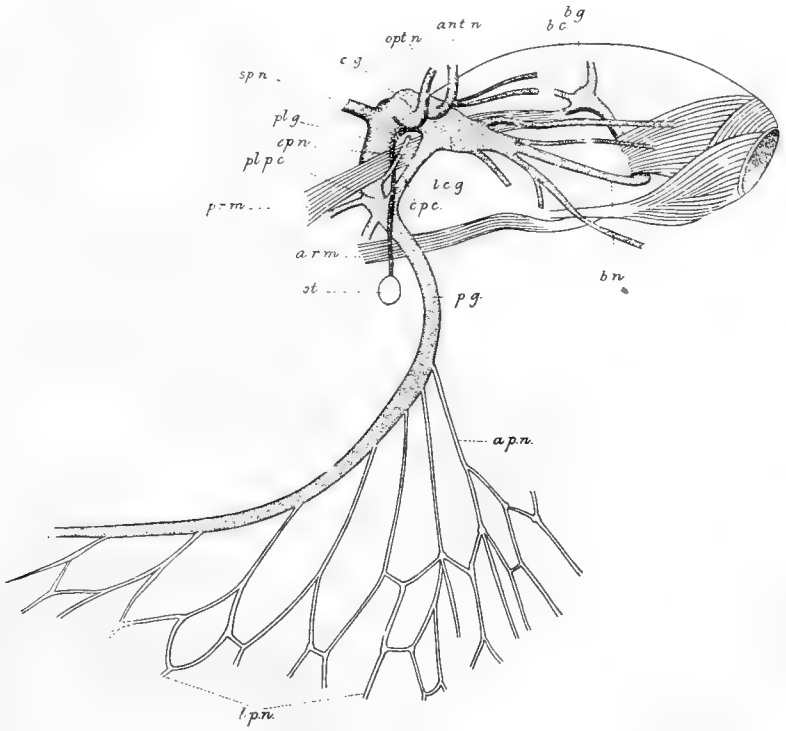

FIG. 8.—*Vivipara bengalensis*, nervous system of the right side. *ant n*, antennal nerve; *a.p.n.*, anterior pedal nerve; *a.r.m.*, anterior retractor muscle of buccal mass; *b.c.*, buccal commissure; *b.g.*, buccal ganglion; *b.n.*, buccal nerve; *c.g.*, cerebral ganglion; *c.p.c.*, cerebro-pedal commissure; *e.p.n.*, epipodial nerve, *l.c.g.*, labial portion of the cerebral ganglion; *l.p.n.*, lateral pedal nerves; *opt.n.*, optic nerve; *ot.*, otocyst; *p.g.*, pedal ganglion; *p.r.m.*, posterior retractor muscle of buccal mass; *pl.g.*, right pleural ganglion; *pl.pc.*, pleuro-pedal commissure; *sp.n.*, supra-intestinal or right parietal nerve.

across below the oral tube, joining with its fellow of the opposite side to form the labial commissure. Three nerves arise from the rounded upper and outer aspect of the cerebral portion of the cerebral ganglion. From the upper aspect a stout nerve, the antennal nerve, arises and passes forwards and outwards to the antenna; although in the male the right antenna serves the double function of a tactile organ and the intromittent organ, the nerve that supplies it shows no obvious increase in size. From

the posterior and outer surface of the ganglion the optic nerve arises and passes forwards and outwards external to the antennal nerve and ends in the sensory epithelium of the eye. As we trace this nerve backwards to the brain it can be seen to end in a quite distinct rounded swelling which forms a localised prominence on the external and posterior margin of the cerebral ganglion. From the side of the cerebral ganglion immediately below the origin of the optic nerve a small nerve arises, which can be seen to pass directly downwards. This small branch, which is the nerve to the otocyst, passes down external to the lateral retractor muscle of the buccal mass and the pedal ganglion and finally ends in the otocyst, which lies a little behind and to the outer side of the pedal nerve

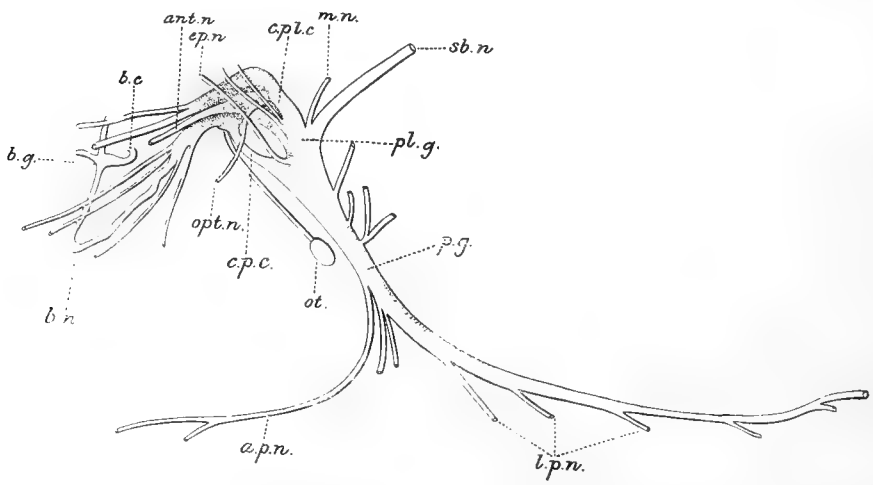

Fig. 9—*Vivipara bengalensis*, nervous system of the left side. *ant.n.* antennal nerve; *ap.n.*, anterior pedal nerve; *b.c.*, buccal commissure; *b.g.*, buccal ganglion; *b.n.*, buccal nerve; *c.p.c.*, cerebropedal commissure; *c.pl.c.*, cerebropleural commissure; *e.pn.*, epipodial nerve; *l.p.n.*, lateral pedal nerves; *opt.n.*, optic nerve; *ot.*, otocyst; *p.g.*, pedal ganglion; *pl.g.*, pleural ganglion; *sb.n.*, subintestinal or left parietal nerve.

close to its origin. Each otocyst is a small oval sac, the long axis of which is vertical; it has a shining refractile appearance and its cavity is filled with a number of small calcareous concretions of varying shape, the otoliths. [For more detailed descriptions of this organ, the reader is referred to the accounts given by Leydig (1850), and Lacaze Duthiers (1872).] The position of the pleural ganglia and consequently the arrangement of the nerve commissures that arise from the cerebral ganglia differ on the two sides of the body. On the left side, the pleural ganglion lies mid-way between the cerebral and pedal ganglia and the arrangement of the ganglia and commissures conforms to Moore's definition of the 'dystenoid' type of nervous system. On this side of the body two commissures, that differ markedly from each other, arise from the ventral aspect

of the hinder portion of the cerebral ganglion. The anterior cerebro-pedal commissure is long and narrow and of a white colour; it passes downwards external to the lateral retractor muscle of the buccal mass to join the pedal ganglion. The posterior cerebro-pleural commissure is broad and ribbon like, and can be seen to consist of two parts, an anterior brownish-coloured portion and a posterior white portion. Inferiorly it fades into a very ill-defined left pleural ganglion. Below this ill-defined ganglion a short broad commissure passes downwards, being joined by the cerebro-pedal commissure to the pedal ganglion. On the right side of the body there is no distinct cerebro-pleural commissure. The right pleural ganglion lies close against the posterior end of the cerebral ganglion and is only separated off from it by an ill-defined neck. The pleuro-pedal commissure is in consequence proportionately long. On this side of the body the arrangement of these ganglia conforms to what Moore (1903, p. 276.) terms the 'epiathroid' type of nervous system.

From the pleuro-pedal commissures several fine nerves arise; of these one, usually the largest, can be seen to arise from the commissure low down near its point of union with the cerebro-pedal commissure. This is the epipodial nerve and that on the left, which is usually slightly the larger, supplies the epipodium on that side, while the right supplies the fold beneath the right tentacle and the inner or left half of the syphon. The other nerves pass upwards and outwards to the tissues at the base of tentacle. The pedal ganglia are long ribbon-like structures of a brown colour, which are connected above with the cerebro-pedal and pleuro-pedal commissures. Each of these ribbons is composed largely of ganglionic nerve-cells, and in consequence the whole length of the structure must be regarded as being homologous with the more compact pedal ganglia of other molluscs. Immediately beneath the radular sac the two pedal ganglia are connected together by a wide short pedal commissure which passes from side to side below and in front of the posterior retractor muscles of the buccal mass, and behind and above them the terminal portion of the cephalic aorta passes downwards and backwards in the middle line. From this point the two ganglia pass downwards and backwards lying between the white muscle mass of the foot and the soft grey tissue of the sole. At first the two cords diverge somewhat, but posteriorly they again converge towards the middle line. A series of three or four transverse commissures pass across from side to side uniting them together at different points in their length. A series of nerves arise from the pedal ganglia and spread forwards and outwards. The first pedal nerve arises from just below the pedal commissure and passes forwards towards the anterior margin of the foot; it sends off a branch which passes inwards towards the middle line and forms an anastomosis with its fellow of the opposite side. The remaining nerves pass outwards in a radiating manner and form a very elaborate anastomosis around the margin of the foot. The nerves divide and

anastomose in a series of loops and at certain points of the network so formed slight swellings can be detected, which probably correspond to local collections of ganglion cells. From the posterior surface of the pedal ganglia and the pleuro-pedal commissure several nerves pass backwards and enter the muscles of the foot. Each parietal ganglion gives rise to two nerves. The most anterior and smaller of the two is the mantle nerve, and the larger and more posterior is the parietal nerve. The two parietal nerves pass backwards and form a figure-of-eight loop in the visceral hump. Each nerve crosses over to the opposite side of the body from which it originated, and having done so sends off a lateral branch which anastomoses with the mantle nerve of that side, thus forming the ' dialyneural ' connection.

The right parietal nerve, or supra-intestinal nerve as it is called, passes obliquely across the upper aspect of the oesophagus just behind the buccal mass. In this portion of its course it is closely connected to, and surrounded by the branching follicles of the salivary glands. Having reached the left side it gives off a large branch, the anterior branchial nerve, which passes to the left and, having given off a small branch to join the mantle nerve, breaks up into a number of fine branches which supply the anterior region of the gill and the osphradium. At the point where the anterior branchial nerve arises from the supra-intestinal nerve a slight swelling is to be seen, this is known as the supra-intestinal ganglion. From this point the nerve passes up beneath the floor of the branchial chamber on the left side of the oesophagus. During this part of its course it gives off a series of fine branches to the gills and finally, at the extreme apex of the branchial cavity, a considerably larger branch, which soon subdivides into smaller twigs, is given off to the upper part of the gill.

The left parietal or sub-intestinal nerve crosses over from left to right below the oesophagus. It then diverges somewhat to the right and gives off a branch which again subdivides; one twig passes forwards and outwards to join the mantle nerve of the same side and the conjoined nerve so formed supplies branches to the outer wall of the syphon and the terminal portions of the excretory and genital ducts and the anus. The main nerve continues backwards above the columellar muscle at some distance from the oesophagus and gives off a series of branches to the mantle roof and its dependent structures. At the apex of the branchial chamber both nerves are continued up for a short distance in the floor and outer wall of the pericardium and then unite to form a loop, in front and to the inner side of the **U**-shaped bend of the oviduct in the ♀. At the apex of the nerve loop the nerve is slightly swollen and is known as the visceral ganglion. From it a series of branches arise which supply the neighbouring viscera.

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PART II.—THE EDGE OF THE MANTLE AND THE EXTERNAL ORNAMENTATION OF THE SHELL.

By N. ANNANDALE.

In the first part of this paper Major Sewell has described the structure of the free part of the mantle of *Vivipara bengalensis* in general terms and has pointed out, as Leydig [1] observed in the embryo of *V. vivipara*, that the margin bears three short processes corresponding in position with the three rows of minute chaetae on the surface of the embryonic shell. He has further noted that in the adult additional processes are both intercalated between the three primary processes and produced to the left of the outermost row of chaetae in correlation with the development of dark spiral bands on the shell.

Similar facts struck me forcibly when examining two very large and peculiar species of Viviparidae in Manipur, namely *V. oxytropis* (Benson), the shell of which is ornamented with dark and prominent spiral ridges, and *Lecythoconcha lecythis* (Benson),[2] the shell of which is almost smooth and unicolorous.

The observations made on these species, supported as they were by Major Sewell's independent observations on *V. bengalensis*, led me to examine the edge of the mantle and the embryonic shell in all species of Viviparidae in which living or properly preserved material was available. The species I have examined living are *V. bengalensis* (Lamarck), *V. dissimilis* (Muller) [=*V. remossii* (Benson)], *V oxytropis* (Benson) and *L. lecythis* (Benson). I have also examined preserved material of the remarkable genera *Margarya*, Nevill, and *Taia*, Annandale, in both of which the shell is more highly and fantastically sculptured than in any species of *Vivipara*. My specimens of *Margarya melanoides* were collected in Yunnan by Mr. J. Coggin Brown, and those of *Taia intha*, *T. elitoralis*, *T. shanensis* and *T. naticoides* were preserved with great care by Dr. F. H. Gravely in the Southern Shan States. Some of them are in excellent condition for histological study.

In addition to this Asiatic material I have been enabled by the very kind assistance of Prof. J. H. Ashworth of Edinburgh University, to examine several series of fine sections of both the embryo and the adult of *V. contecta* (Millet), a European species with a smooth, broadly banded shell.

The material examined thus includes specimens and preparations of species both with smooth and with highly sculptured shells, both with almost unicolorous and with conspicuously banded shells.

[1] Leydig, *Zeits. f. wiss. Zool.* II, pl. xi, fig. 16 (1850).

[2] For the latter species I have recently proposed a new genus based partly on the structure of the mantle, viz. *Lecythoconcha*, Annandale, *Rec. Ind. Mus.* XIX, p. 114 (1920).

In considering the ornamentation of the shell both colour-pattern and sculpture can, therefore, be taken into account.

Ornamentation of the embryonic shell.

The ornamentation of the embryonic shell is almost uniform in pattern in all species of Viviparidae investigated, and the only important differences found are those in the degree to which the spiral sculpture is developed in different forms. Colour-pattern is usually absent, the shell being of a pale horny yellow or brown, with the protoconch darker and browner than the rest; but in those species in which the embryo has a comparatively large number of whorls before birth the dark spiral bands characteristic of some such forms begin to appear on the younger parts of the shell before it is set free from the egg-membrane.

The sculpture at this early stage is mainly periostracal, involving only the horny outer covering of the shell; but as this is not entirely so I propose to discuss the periostracal sculpture first and then that of the calcareous part of the shell or true test. It will be convenient to treat *V. bengalensis* as a typical form in discussing the periostracal sculpture of the embryo.

The shell of this species consists at birth of $3\frac{1}{2}$ whorls. Of these the apical whorl and a half constitute the true protoconch. They are flat, band-like and almost smooth, but with a strongly marked keel running round the outer edge of their upper surface in a spiral. Several faint, line-like spiral ridges, of which two are more prominent than the others, can also be detected on their surface under a high magnification. A single spiral row of extremely fine hair-like processes projects from the marginal keel, extending upwards to the tip of the apical half-whorl. Towards the base of the protoconch these processes become stiffer and are curved and retroverted at the extremity, the curvature of their tips being directed towards the mouth of the shell. They also become less crowded together. A little above the point at which the protoconch merges into the uppermost whorl of the younger part of the embryonic shell (*i.e.* that part in which the whorls begin to assume the essential characters of those of the adult), a second line of chaetae makes its appearance parallel to the first, and finally, on the penultimate embryonic whorl, a third. The oldest row, which I shall call in reference to its age and its position the FIRST or UPPERMOST ROW, is rather less developed than the SECOND or MIDDLE ROW. The THIRD or PERIPHERAL ROW, which continues to occupy the extreme periphery of the shell, is the largest and best developed of all. As the shell grows, however, and new whorls are added they destroy the chaetae that lie immediately above them by the pressure of their embrace.

Between the three primary rows of chaetae, above them to the left of the mouth of the shell, and particularly below them to the right (that is to say below the peripheral angle) there are other spiral lines on the external surface of the shell, running parallel

to one another and to the rows of chaetae, but forming only very fine ridges with minute irregular processes or serrations. These I shall call the SECONDARY PERIOSTRACAL RIDGES of the embryonic shell. Finally, still finer oblique longitudinal or vertical lines can be detected under a powerful lens, running across the spiral lines in such a way as to form a delicate reticulation with rhomboidal meshes. That all this ornamentation is mainly periostracal can be proved by dissolving the calcareous matter of the shell with weak acid. The lines and chaetae remain intact.

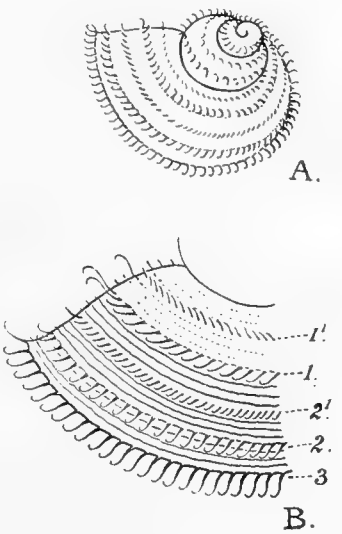

FIG. 10.—Embryonic shell of *Vivipara dissimilis* (Müller).

A. Oblique view of the whole shell at birth, showing lines of chaetae (magnified).

B. Part of the surface of the body-whorl of the same shell more highly magnified.

1 = uppermost primary row of chaetae;
2 = middle primary row of chaetae;
3 = peripheral row of chaetae;
1′ 2′ = secondary rows of chaetae.

In the other species of Viviparidae examined the periostracal ornamentation is essentially the same, but in several, the test-sculpture being more highly developed, the chaetae are given greater prominence. I will discuss this point later. In the embryonic shell of *V. dissimilis* (fig. 10), two of the secondary periostracal ridges bear minute chaetae considerably finer and shorter than those of the three primary rows but essentially similar in structure. These secondary rows are situated between the first and second primary rows and above the latter.

In some species the periostracal ornamentation of the embryonic shell becomes obsolescent at an early age, but in all I have examined the peripheral row of chaetae is continued, at any rate in some individuals, on to the body-whorl of the full-grown shell, and the apparent disappearance of the chaetae of the other rows is more apparent than real. These structures are of extreme fragility and in a comparatively heavy organism such as an adult *Vivipara* are liable to be rubbed off at a touch. In a nearly full-grown *V. bengalensis*, in which the shell is receiving its final addition, I have found that the three rows of chaetae are still produced, but disappear almost as soon as they are formed. In *V. dissimilis* traces of the embryonic periostracal sculpture are more persistent and the basis of the five rows of chaetae can frequently be detected in the form of fine punctures. Even in the adult of *L. lecythis* the

periphery of the body-whorl is often surrounded by a line of extremely fine hairs representing degenerate chaetae. In the Siamese *V. ciliata* (Reeve),[1] in which a larger number of secondary periostracal ridges probably bear chaetae than in *V. dissimilis*, they persist throughout life on all the whorls of the shell, and in some individuals of the Chinese *V. lapillorum* (Heude)[2] they are coarsely developed on the peripheral keel of the body-whorl.

In species of *Vivipara* such as *V. bengalensis*, in which the embryonic shell is extremely thin and fragile, it is difficult to demonstrate the existence of any true test-sculpture as distinct from that of the periostracum, but by means of careful manipulation of lighting under a binocular microscope it can be seen that each of the rows of chaetae is situated on a slight elevation. This can be more readily demonstrated in such forms as *L. lecythis* (fig. 11), in which the test is much thicker at birth; while the chaetiferous ridges are conspicuous from the first in certain other species, such as *Margarya melanoides*,[3] *Taia intha*[4] and the peculiar Japanese *Heterogen turris*.[5] In these three species they are comparatively broad and blunt. In *V. dissimils* and *V. oxytropis*, although the embryonic shell is no thicker than in *V. bengalensis*, they are more prominent than in that species, but thin and sharp. Generally speaking, a strong development of the three primary ridges in the embryonic shell is correlated with a coarse and well-developed spiral sculpture in that of the adult, but this is not so in *Heterogen*, in which it becomes gradually much less conspicuous on the younger whorls. In *H. turris*, however, the only species of the genus known, as in the African *Neothauma*, Smith, and in many species

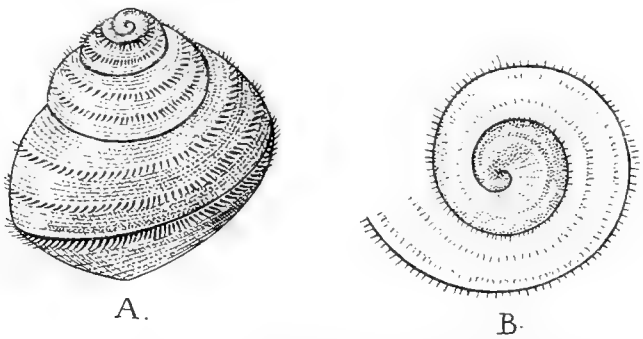

Fig. 11.—Embryonic shell of *Lecythoconcha lecythis* (Benson).
A. Lateral view of the whole shell at birth (magnified).
B. Protoconch as seen from above (more highly magnified).

[1] Reeve, *Conch. Icon.* XIV (*Paludina*), pl. vi, fig. 36 (1864).
[2] Annandale, *Mem. As. Soc. Bengal* VI, p. 314, pl. x, fig. 9 (1918).
[3] Kobelt on *Vivipara*, in new edit. of Mart. and Chemn., *Conch. Cab.*, pl. xxxvii, xxxviii (1909).
[4] Annandale, *Rec. Ind. Mus.* XIV, pl. xvii, fig. 7; pl. xviii, fig. 10 (1918).
[5] Annandale, *Mem. As. Soc. Bengal* VI, p. 400, figs. 1, 2. (1921).

of *Vivipara*, the third or lowest primary ridge remains conspicuous as a peripheral carina, even when the other two disappear or become obsolescent.

Ornamentation of the adult shell.

In the adult shell, as I have already pointed out, the periostracal sculpture is relatively unimportant. In many species of the family, including the great majority of those of *Vivipara*, the test-sculpture is not much more conspicuous. In *V. bengalensis* the oblique longitudinal lines on the periostracum are impressed on the test and remain distinct through life. Indeed, they are coarser and more prominent in the younger whorls. In most races and phases of this species the spiral sculpture disappears almost completely on the body-whorl, but in some individuals of certain phases and races, such as the phase *halophila*, Kobelt (pl. II, figs. 9, 10), and the race *balteata*, Benson, the primary spiral ridges and also a few of those of the secondary order are slightly thickened on the body-whorl, while in the Burmese race (*doliaris*, Gould, pl. I, fig. 9) both the uppermost of the three primary ridges and the peripheral ridge are prominent, forming more or less sharp-cut angles in the outline of this whorl. In *V. oxytropis* and a few other species of the same genus the peripheral ridge forms a prominent keel on the body-whorl, separating the shell into an upper and a lower region, while some or all of the other ridges remain more or less salient.

It is, however, in such forms as the more highly developed species and varieties of the genera *Taia* and *Margarya* that the sculpture of the test reaches its highest development in the adult shell. In *V. oxytropis* [1] the ridges are smooth and sharp: in the more highly developed forms of the two genera mentioned they are broad and coarse and are broken up into numerous tubercles, scales or spines. Even in shells with a comparatively simple sculpture such as those of *Taia theobaldi* [2] or *Margarya melanoides* var. *mansuyi* [3] the ridges have not the unbroken surface of those on the shell of *V. oxytropis* and other ridged forms of *Vivipara*.

In all the Viviparidae in which I have examined both embryonic and adult shells, the ridges of the test are grooved internally at first. They retain this structure in *V. oxytropis* throughout life. In some other ridged species and races of *Vivipara*, however, with thicker shells, and also in all forms of *Taia* and *Margarya*, the internal groove becomes more or less completely obliterated by the deposit of nacreous matter on the internal surface.

In describing the ornamentation of the embryonic shell I have alluded briefly to the fact that in *Taia intha* and some other Vivi-

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[1] Hanley and Theobald, *Conch. Ind.*, pl. lxxvi, fig. 5 (1876).
[2] Annandale, *Rec. Ind. Mus.* XIV, pl. xvi, fig. 1 (1918).
[3] Kobelt on *Vivipara*, in Mart. and Chemn., *Conch. Cab.*, new edit., pl. xxxvii, figs. 6, 7 (1909).

paridae in which the shell attains a relatively large number of whorls before birth, a colour-pattern appears on the lower whorls, while in *V. bengalensis*, in which there are only $3\frac{1}{2}$ whorls at birth, this pattern appears later. It cannot, therefore, be regarded as belonging to the primitive shell. Generally speaking, the shells of the Viviparidae may be divided into two categories so far as colour is concerned.[1] The external surface in one category is of an almost uniform olivaceous colour, occasionally with irregular black longitudinal streaks. In the other type it is marked with dark spiral bands.

Structure of the Marginal Region of the Mantle.

By the phrase marginal region of the mantle I mean the free edge of the roof of the branchial chamber and the immediate-

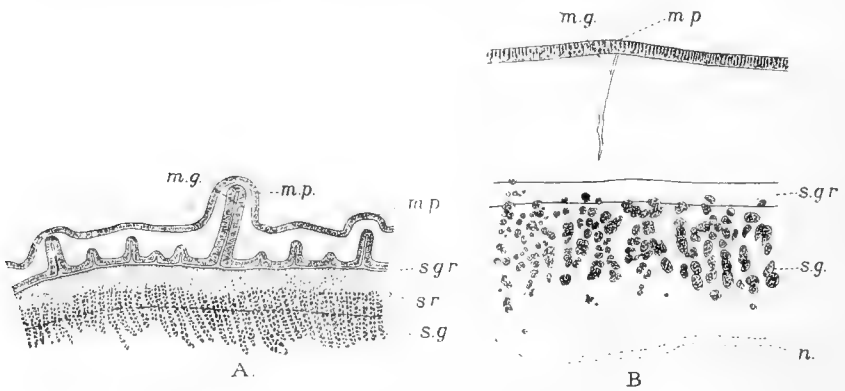

Fig. 12.—Edge of the mantle in *Vivipara bengalensis* (Lamarck), as seen by transmitted light (× 80).

A. In new-born young.

B. In half-grown individual at the end of a period of growth

m.g., marginal groove; *m.p.*, primary marginal process; *m.p.'*, secondary marginal process; *n*, nerve; *s.g.*, calciferous glands; *s. gr.*, supramarginal groove.

ly adjacent parts. For the sake of brevity I shall refer to it merely as the marginal region. I do not propose to discuss the structure of other parts of the mantle except in so far as it may be necessary to elucidate that of this region.

External Structure.—The external structure of the marginal region is uniform in all the Viviparidae examined, so far at any rate as its main features are concerned, but exhibits certain minor generic and even specific characters, and differs in details at different periods in the life of the individual. The free edge is sharp at birth in *Vivipara* and *Taia*, blunt in *Lecythoconcha* and

[1] The only real exception I know to this rule is to be found in *V. helmandica* Annandale, from Eastern Persia, the shell of which is olivaceous with rounded pale spots, but there is often an obscure pale band round or just below the periphery of the body-whorl of the shell in forms of the *V. dissimilis* group.

also probably in *Margarya*, in which, however, I have examined only adult individuals. In the first three genera, and probably in all Viviparidae, it bears at this period three distinct finger-shaped processes,[1] one situated just above the snout near the middle of the edge, the other two to the right of this point. The left process, which marks a very important point in the orientation of the ornamentation of the shell, I shall call the PERIPHERAL PROCESS. It moves along, in the expansion of the animal, under the most prominent line of the body-whorl of the shell and is usually, but not always, a little longer than the others. The two processes to the right of the peripheral process may be called the first and the second process, the former lying the furthest to the right. These three processes correspond in position with the three primary rows of chaetae on the young shell (p. 250, fig. 13) and bear the same notation in my figures. The peripheral process, though usually the most conspicuous and the most important in the future history of the shell, is morphologically the youngest, while the first process, the least important of the three from this point of view, is the oldest. These three processes I call the three PRIMARY PROCESSES. They were first observed and figured in the embryo of *Vivipara vivipara* by Leydig,[2] but are omitted in the figures of more recent authors. I find them just as well developed in the fully formed embryo of the European *V. contecta* as they are in Indian species.

In most other Viviparidae examined, at least traces of other processes between and to the left of the primary three can be detected at the same period. In *V. bengalensis* (fig. 12) they are small and inconspicuous, but in *V. dissimilis*, another common Indian species, four SECONDARY PROCESSES can be easily detected in fresh material, two of them being longer than the other two. The two longest secondary processes are situated one immediately to the right of the second primary process and the other to the right of the third. They correspond in position with the two secondary rows of chaetae on the embryonic shell (p. 248, fig. 12). The condition is similar in *V. oxytropis*, but in *Lecythoconcha lecythis* only the three primary processes can be detected as such, even in fresh material.

Even the seven processes of *V. dissimilis* and *V. oxytropis* are not all that actually exist, for between each pair associated with lines of chaetae two or three other minute projections occur, but can only be detected as projections if the mantle be examined in a fully expanded condition. These minute or TERTIARY PROCESSES correspond in position with the minute serrated ridges on the periostracum of the embryonic shell (p. 245, fig. 10). Both they and the secondary processes are probably present and functional, though often difficult to detect, in all Viviparidae.

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[1] It may be fixed in this condition by being subjected to gentle pressure between two glass slides as soon as it is removed, and treated with corrosive acetic solution while under pressure.

[2] Leydig, *Zeits. f. wiss. Zool.* II, pl. xi, fig. 16 (1850).

The external structure of the processes (be they primary, secondary or tertiary) is identical. They are not mere projections of the margin but organs with a definite form, position and function. When fully expanded in the living animal they are flattened dorso-ventrally and sharply pointed, but it is difficult to preserve them quite in this condition as they usually become blunter and thicker in preservations, as they do in life when the mantle contracts (fig 12). Along the external surface of each, from a point close to the tip, runs a narrow groove, and the whole of both surfaces, including the floor of this groove, is densely covered with long and powerful cilia. These extend also all over the edge of the mantle. Very often (fig. 12) the presence of a tertiary, or even a secondary, process is only indicated by the existence of this groove, which I shall call a MARGINAL GROOVE.

The marginal grooves run up the external surface of each process to a broader and rather deeper transverse groove that traverses the whole of the margin just above the bases of the processes and

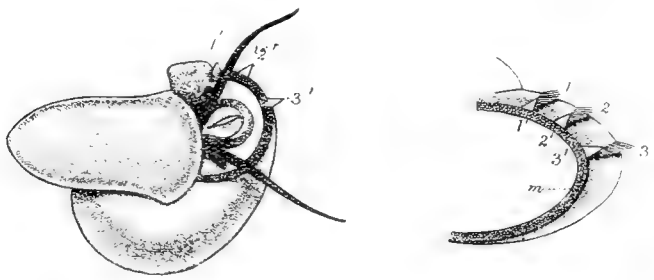

FIG. 13.—Living *Lecythoconcha lecythis* a fortnight old (magnified).
m., edge of mantle; 1, 2, 3, primary rows of chaetae on shell; 1,' 2,' 3', primary marginal grooves.

turns upwards for a short distance at the right extremity of the free edge. This groove I shall call the SUPRAMARGINAL GROOVE.

Immediately above the supramarginal groove on the external surface of the mantle is a broad and prominent ridge, which has been called the "white band" on account of its lack of epidermal pigment, but may be also known as the SUPRAMARGINAL RIDGE. Its surface is smooth and ciliated at birth in all the species examined at this period, and in *Lecythoconcha* its limits are not clearly indicated.

In the foregoing paragraphs I have described the external structure of the marginal region as it exists at the birth of the young mollusc, it remains to be seen how far it alters in the course of post-embryonic development. There is greater specific and generic variation in this respect than there is in the primitive structure, for while in some species and genera the marginal processes are greatly reduced in the adult, in others they retain their primitive condition, while in yet others they increase in proportionate development. I was under the impression that they disappeared com-

pletely in the adult of *V. dissimilis* and *L. lecythis*, so long as I examined only preserved material; but at any rate the three primary processes can be quite easily detected in the largest living individuals of the former species, while in full grown specimens of the *Lecythoconcha*, at least traces of the peripheral process sometimes persist and probably remain functional throughout life. In *L. lecythis* (fig. 13) the primary processes are very conspicuous for at least a fortnight after birth on account of their bright yellow colour as well as their prominence. Major Sewell (p. 220) has shown that even when the processes have apparently disappeared in *V. bengalensis* their position is apparently indicated by streaks of yellow pigment. In *V. oxytropis* both the primary and the secondary processes increase in actual size with the growth of the animal. In the living adult they are not so easily seen as the primary processes in the young of *Lecythoconcha*, because they are usually retroverted inside the shell when the animal is expanded, but even in material preserved by immersion in strong spirit and killed in a highly contracted condition, they can be detected without difficulty as soon as the shell is removed.

The fact seems to be, therefore, that these marginal processes are characteristic of the Viviparidae as a family. They differ in position and structure, and probably in function, from the processes present on the mantle of certain genera of Melaniidae,[1] and I have failed to trace them on that of any Hydrobiid. Their presence is, however, frequently concealed by contraction and shrinkage in preserved specimens, and the extent to which they actually degenerate or persist in the adult differs in different species.

Other questions that remain to be answered are those concerned with differences in the system of marginal and supramarginal grooves and in the supramarginal ridge at different periods in the life-history of the mollusc. What I have said of the marginal processes applies with equal force to the marginal grooves, except that in the adult of *Lecythoconcha* the peripheral marginal groove is sometimes still more distinct than the peripheral process, but in considering the subsequent history of the supramarginal groove another factor must be considered, viz. that of periods of growth and of rest. These affect the groove indirectly by affecting the ridge that lies immediately above it and can be discussed most conveniently when considering the internal structure of this ridge (p. 252). One point that may be noted here is that the cilia disappear from the surface of the ridge at an early period in post-embryonic life and that when the glands in it are in a state of activity its surface is minutely ridged at right angles to its own axis. Further, in growing specimens of *Taia intha*, preserved in a half-expanded state, the ridge bears cushion-shaped swellings opposite to, but much broader than, the primary processes.

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[1] See Benson, *Gleanings in Science* I, p. 21 (1830), and Annandale, *Rec. Ind. Mus.* XIX, p. 109 (1920).

It has not been necessary to say much about the edge of the mantle between the processes, the external structure of which offers no particular feature of interest at any time of life in most species. The difference between its conformation in *Vivipara* and *Taia* on the one hand and *Lecythoconcha* and *Margarya* on the other, already noted in the young (p. 249), is accentuated with the growth of the individual. It is, however, somewhat exaggerated in highly contracted or shrunken specimens. Another important generic difference, not following the same lines of division, may now be noted. It has a much more direct bearing on the special object of this section of our paper, as it is evidently correlated with the glyptic ornamentation of the shell. In *Vivipara* and *Lecythoconcha* the edge when fully expanded is straight, or rather curved in a wide arc outwards. It is, indeed, capable of considerable

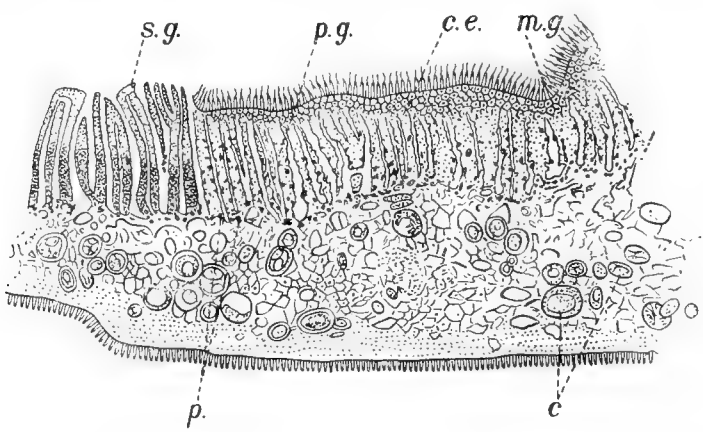

Fig. 14.—Horizontal transverse section through part of the edge of the mantle at the base of a primary marginal process of an adult *Vivipara oxytropis* (Benson), highly magnified and slightly diagrammatic.

c, calcareous concretions; *c.e.*, ciliated epithelium; *m.g.*, marginal groove of primary marginal process; *p.*, pigment granules; *p.g.*, periostracal glands; *s.g.*, calciferous glands.

change of shape and may become distinctly sinuate; but the irregularities of outline are mere irregularities without definite position or apparent function. This is also so in *L. lecythis*. It is unfortunate that I have not had an opportunity of examining either *Taia* or *Margarya* in a living condition in this connection, and in contracted specimens of these genera preserved in alcohol I can find no peculiarity of the edge of the mantle. In young examples of *Taia intha*, however, which were paralysed with menthol and fixed in 5% formalin without being fully contracted, a broad lobular projection can be detected at the base of the terminal scale-like projection on the peripheral ridge of the shell, proceeding for a short distance into the anterior cavity of the projection.

Epithelium.—The epithelium of the extreme edge of the mantle is, as already stated, provided with long and powerful

cilia. The cells are relatively deep and narrow and have large, deeply-staining nuclei. Unicellular glands do not occur among them. Epithelium of this type extends over both surfaces of the marginal processes and over the floors of the marginal and supramarginal grooves. Above the latter it gives place, but not abruptly, to non-ciliated epithelium containing unicellular glands. The change is gradual, the cells becoming shorter and stouter and the cilia more feeble and finally non-existent. On the surface of the supramarginal ridge, however, epithelium is usually absent after birth, the underlying glands being exposed on the surface.

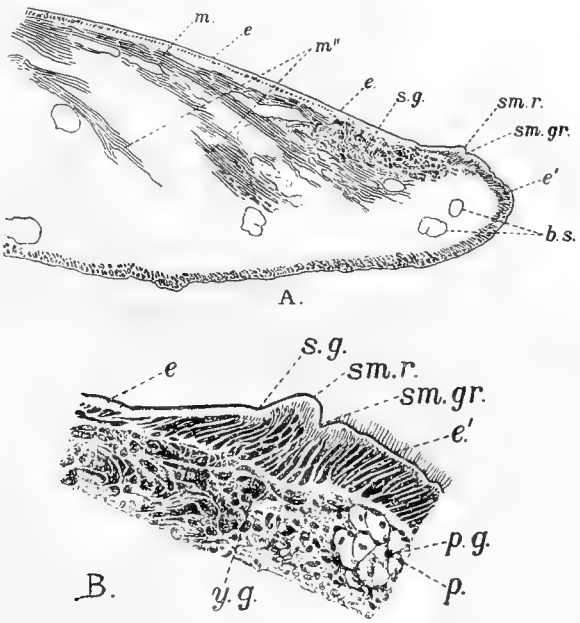

FIG. 15.—Vertical section through the edge of the mantle in the adult *Taia elitoralis*, Annandale, in a period of arrested growth.

A. The whole structure (×80).

B. Region of the supramarginal groove more highly magnified.

b.s., blood-sinus; *e.*, non-ciliated epithelium; *e'.*, ciliated epithelium; *m.*, external retractor muscle; *m''.*, muscular network; *p.*, pigment granule; *p.g.*, part of periostracal gland; *s.g.*, degenerate remains of shell-gland; *sm. gr.*, supramarginal groove; *sm. r.*, supramarginal ridge; *y.g.*, yellow granules.

CONNECTIVE TISSUE.—Two kinds of connective tissue can be distinguished in the marginal region of the mantle of the Viviparidae. The bulk of the roof of the branchial chamber consists of a peculiar kind of cells closely resembling that of which the adipose fins of fishes are mainly composed and identical with those of the foot of the molluscs. These cells are of very large size and of polygonal outline (pl. iii, fig. 3). Their walls are thick, their nuclei very small and they are gorged with a gelatinous substance evidently not protoplasmic. Immediately under the epithelium of both sur-

faces of the mantle a thin layer of undifferentiated connective tissue can also be distinguished. It is thicker at some places than at others but has no particular feature of interest.

MUSCLES.—The muscular system of the mantle is complex in all genera of the family, but more so in some than in others. In *Vivipara* it is comparatively simple. In this genus a relatively thin sheet of longitudinal fibres extends down the external surface as far as or nearly as far as the upper limits of the supramarginal ridge. This may be called the EXTERNAL RETRACTOR OF THE MANTLE. In a corresponding position on the internal surface a few fibres of a similar nature can be distinguished, but they are poorly developed. In the neighbourhood of the supramarginal ridge a strand of oblique or nearly transverse fibres runs along parallel to

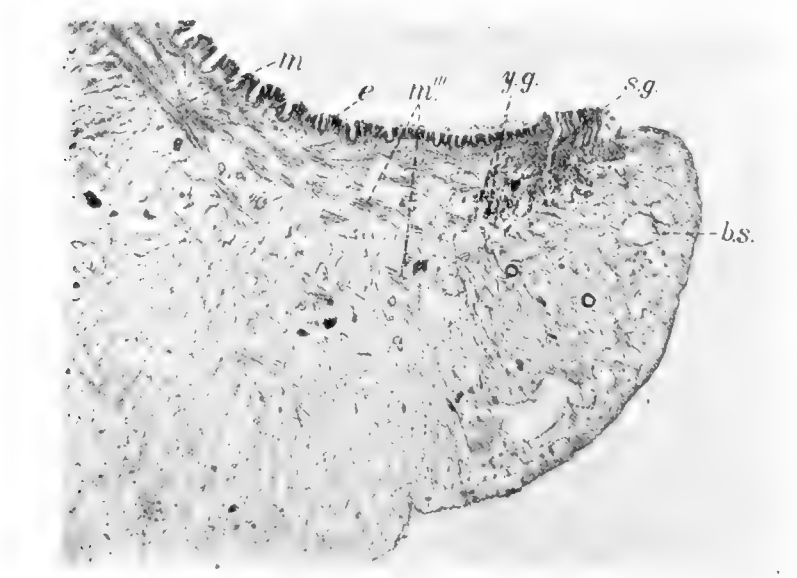

FIG. 16.—Microphotograph of vertical section through the edge of the mantle in *Margarya melanoides* var. *carinata*, Neumayr. The ciliated epithelium has been removed from the surface below the shell-glands.

b.s., blood-sinus; *e.*, epithelium; *m.*, external retractor muscle; *m'''.*, muscular network; *s.g.*, calciferous gland; *y.g.*, yellow granules.

the margin rather deeper in the tissues and forms the SPHINCTER OF THE MANTLE. Its structure is simple in this genus and it is not powerfully developed. Finally, the external retractor sends numerous fine branches obliquely into the thickness of the mantle, in which they ramify and anastomose to form a loose MUSCULAR NETWORK.

In other genera the same elements of musculature are found, but variously developed. In *Taia* and *Margarya*, in which the sphincter is still more feebly developed, the muscular network is closer and has much smaller meshes and the individual strands are finer. In *Margarya*, in which the mantle is greatly thickened, it is better developed than in *Taia*.

It is, however, in *Lecythoconcha*, in which also the mantle is thick, that the muscles are the most powerful among the forms examined. The external retractor and its branches are both very coarse, but the latter are not numerous and the muscular network is not well developed. The sphincter, however, is both thick and complex, consisting of several strands which run obliquely in the midst of the shell-glands. Their position in reference to the edge of the mantle differs in different states of expansion and retraction (figs. 3, 4, pl. iii).

NERVES.—I have not attempted to work out the nervous system of the marginal region in detail and have not observed any external sensory organs. The whole of the roof of the branchial chamber is supplied by nerves arising from the parietal ganglia (Sewell, p. 240). In the marginal region a fairly stout transverse nerve can be readily distinguished, pursuing an irregular course above the supramarginal ridge, some parts of it being much nearer the margin than others. From it finer nerves run down at irregular intervals among the shell-glands. Their position is not definitely correlated with that of the marginal processes (fig. 12 B, p. 248).

VASCULAR SYSTEM.—The marginal region of the mantle is highly vascular in all species of Viviparidae examined. Definite blood-vessels can be seen entering it, but for the most part the blood is contained in irregular sinuses without definite walls. These reach their maximum development in the primary marginal processes of *Vivipara oxytropis* (pl. iii, fig. 5), in which the connective tissue has a strictly cavernous structure. A vascular system of this type cannot be investigated in detail without careful injection. This method I have not attempted to adopt as it is quite sufficient for my purpose to know that the processes, and indeed the whole of the edge of the mantle, are erectile rather than muscular, though their erectility is doubtless correlated with the action of the muscles of the roof of the branchial chamber.

SHELL-GLANDS.—A most important part of this investigation refers to the structure, position and function of the glands that secrete the substance of the external layers [1] of the shell and their relation to the external structure of the marginal region of the mantle and the ornamentation of the shell. The main facts about these glands have long been known and certain important points were made clear by Leydig,[2] Mer and Longe [3] and Moynier de Villepoix,[4] but I have failed to find in zoological literature any discussion of their comparative anatomy and functions in any one family of Gasteropods. As my own observations are in general agreement with those of the authors cited I will give an account of what I have myself seen without further historical discussion.

[1] I do not propose to deal with those that secrete the internal nacreous layer.
[2] *Zeits. f. Wiss. Zool.* II, p. 123 (1850).
[3] *Comp. Rendus* XC, p. 882 (1880).
[4] *Comp. Rendus* CXIII, p. 317 (1891) and CXX, p. 512 (1895).

The glands (fig. 14, p. 252) concerned with shell-sculpture in the Viviparidae belong to two distinct series, differing in structure, position and function. We may call them respectively CALCIFEROUS and PERIOSTRACAL GLANDS in reference to the nature of their secretions.

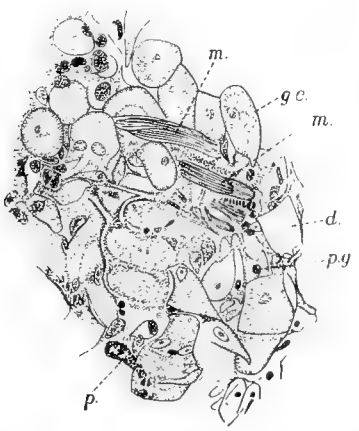

FIG. 17.—Vertical section through part of the periostracal gland in an adult *Vivipara contecta* (Millet) towards the end of a period of growth (× *ca.* 333).

d., duct of gland; *g.c.*, gland-cell; *m.*, fibres of sphincter of the mantle; *p.*, suffused black pigment; *p.g.*, black pigment granule.

The periostracal glands are the smaller, less conspicuous and nearer to the free edge of the two series. They lie opposite the bases of the marginal processes and extend both upwards beneath the calciferous glands and downwards into the processes, at the base of which they open into the supramarginal groove by a series of very minute pores, one for each gland (pl. iii, fig. 1). In the young molluscs at birth each gland is a simple tubule formed of a single layer of gland-cells and more or less twisted in its course, which is tangential to the free edge and lies amidst the thick-walled cells of the interior of the marginal region. Later the glands become contorted and the cells proliferate to form an irregular mass (pl. iii, fig. 3). A definite duct is then developed, lined with very minute flat epithelial cells. It makes its way to the external pore from a small reservoir lying in the substance of the margin and also lined with minute flattened epithelial cells. Into this the secretion of the gland is evidently poured. The gland-cells (fig. 17) are relatively small and ovoid in outline. Their contents do not stain deeply except at birth and they become very inconspicuous in periods of arrested growth. In those species of Viviparidae that have dark-banded shells, such as *V. bengalensis*, *V. oxytropis*, *V. contecta*, and the young of *Taia intha* and *T. elitoralis*, very minute granules of black pigment are found in the cells and lining the ducts of the glands, but they are absent or very scarce in species with unicolorous shells, such as those of *V. dissimilis* and *L. lecythis*, except at the end of growth-periods, when dark pigment may become widely suffused among the interior cells of the mantle and is then by no means confined to the immediate vicinity of the periostracal glands.

The calciferous glands are larger, more numerous and more conspicuous, and occupy a higher and more superficial position on the mantle than the periostracal glands. They undergo, more-

over, greater changes in the course of post-embryonic life and show a greater range of structural difference in different genera. I shall first describe them as they occur in the young of *Lecythoconcha lecythis* at birth, for they are greatly hypertrophied at the time in that species, occupying practically the whole of the external layer of the roof of the branchial chamber, lying immediately or almost

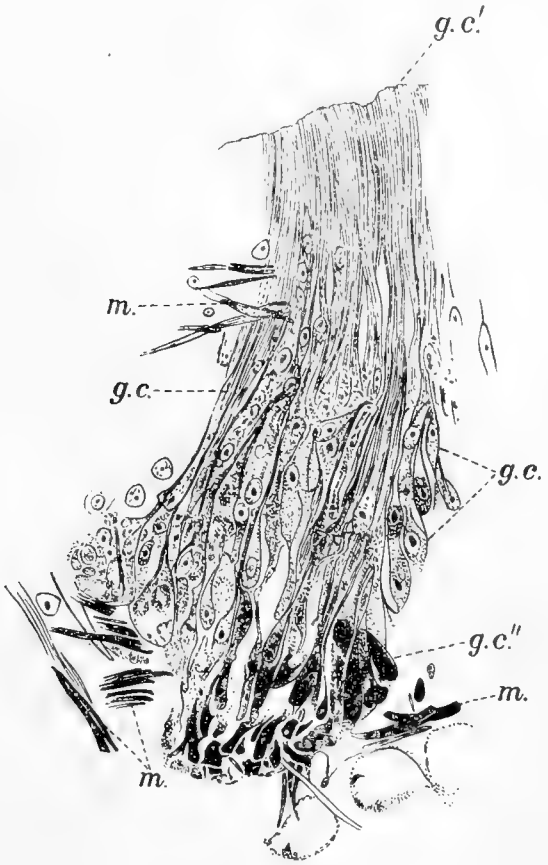

FIG. 18.—Vertical section (slightly oblique) through part of a calciferous gland of the same individual as figured in fig. 17 (same magnification).

g.c'., necks of gland-cells opening on the external surface of the mantle; *g.c".*, degenerating gland-cells. Lettering otherwise the same as in fig. 17.

immediately beneath the external epithelium and extending downwards into the substance of the mantle for nearly half its thickness.

In a vertical section of the mantle passing through the peripheral marginal process (pl. iii, figs. 1, 2) the tissues can thus be separated at sight under a low power of the microscope into an external glandular area and an internal vascular layer. It is with the former we are at present concerned. At the extreme margin, in the substance of the process, the periostracal glands can be dis-

tinguished, lying in the external part of the vascular layer. External to them, and not extending quite so far downwards or entering the process, the calciferous glands occupy the whole of the glandular area. These latter glands form in sections of the kind a series of minute tubules with their main axis at right angles to the surface, but a careful examination of a series of sections indicates that the tubules are not really separate but form a continuous or almost continuous tube with numerous closely adpressed loops. The uppermost loops are already degenerating and do not stain well and those quite near the margin are not closely adpressed and have their cells smaller and probably not yet functional. In the upper part of the marginal region, however, the glands are well

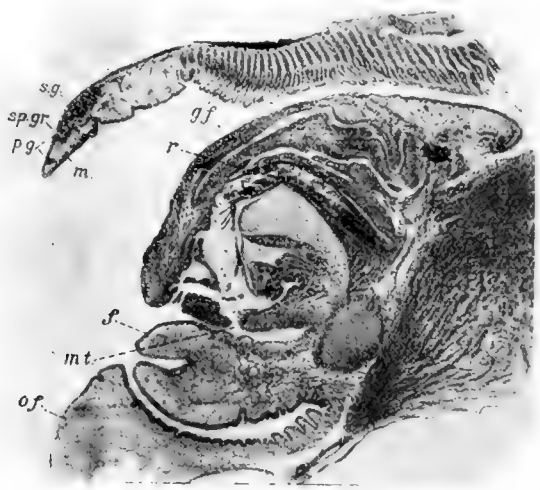

FIG. 19.—Microphotograph of a vertical section through the anterior part of the body of a young *Viviparа contecta* just before birth, to show general position of shell-glands.

g.f., gill-filaments; *f.*, foot; *m.*, mantle; *mt.*, mouth; *p.g.*, periostracal land; *gr.*, radula; *s.g.*, calciferous gland; *sp. gr.*, supramarginal groove; *o.f.*, operculiferous lobe of foot.

developed and evidently functional. Here they consist of large deeply staining cells arranged in parallel rows from just below the external epithelium inwards to the base of the glandular layer.

In the young of other species (fig. 19) the structure of these glands is not essentially different, though they do not occupy nearly so large an area and are relatively much smaller. Their tubular conformation and the adpressed loops of the whole gland are just as well marked and the cells are similar in form and appearance.

At subsequent growth stages, however, a considerable change takes place. The cells are greatly reduced in numbers but increased in size and become ampulliform with extremely elongate "necks" and swollen proximal parts. The loops of the primitive gland, moreover, are converted into groups of cells of the kind,

each arranged round a small and ill-defined space. Their swollen proximal extremities lie buried in the mantle, while their necks extend outwards, closely pressed together, and reach the external surface.

In a vertical section they have in the mass a fibrous appearance which renders them liable to be mistaken for muscle fibres unless differential stains are used, and as the main axis of the cells is not quite at right angles to that of the surface, sections have to be slightly oblique to show their structure in detail.

The extent to which degeneration of the calciferous glands takes place in the rest-periods that succeed those of active growth differ in different species and probably in different circumstances, but they never completely disappear and even when completely degenerate form a conspicuous feature of sections of the marginal region of the mantle even under low powers of the microscope. Generally speaking, the degeneration appears to be greater in forms from a colder climate than it is in tropical species, probably because the alternate periods of growth and rest are more absolute in the former. Major Sewell's observations on the rate of growth in *Vivipara bengalensis* in Calcutta (p. 280) seem to show that growth may be, if not absolutely continuous, at any rate very readily revived at any time of year, whereas in *Taia intha*, which lives at an altitude of 3000 feet in a much colder climate, few shells were observed in early spring that appeared to be in a state of active growth. I find that the European *V. contecta* agrees with this species and its congener *V. elitoralis* from the same lake and also with *Margarya melanoides* (fig. 16, p. 254), which lives at greater altitudes in Western China, in having the glands very degenerate in periods of rest, whereas in *V. bengalensis*, *V. dissimilis*, *V. oxytropis* and *Lecythoconcha* it alters little in structure.

In those species in which the glands become most degenerate in periods of rest, as for example in *Taia elitoralis* (fig. 15, p. 253), the periostracal glands practically disappear, while the calciferous glands are reduced to an amorphous mass in which the cell-limits are distinguished with difficulty. This is most marked in their "necks," which fuse together to form a structureless or almost structureless layer on the external surface. When this occurs the flat epithelial cells of the upper part of this surface encroach to some extent on the area previously devoid of epithelium, while the ciliated columnar cells of the extreme margin apparently become more vigorous but do not extend upwards beyond the position of the supramarginal groove, which practically disappears as such. In preserved specimens in this condition I am unable to detect any trace of the marginal processes and grooves, but possibly they may be still present in the living animal.

The degeneration of the gland-cells is correlated with the secretion of certain yellowish granules of variable size and irregular shape, which are formed in them and finally become very conspicuous, even when the mantle is examined whole as a transparent object under a low power of the microscope (fig. 12, p. 248).

Refractile Bodies.—Throughout the vascular parts of the anatomy of the Viviparidae, and especially in the mantle, numerous small refractile bodies can be distinguished under a low power of the microscope. They are spherical or occasionally ellipsoidal in form and become more numerous in the half-grown and adult animal than they are in the young. Their size varies in different species and they are largest (among the forms examined) in *Lecythoconcha lecythis*. Unstained they are colourless, but they absorb stains such as haematoxylin and borax carmine readily and these stains, if the bodies are cut in sections, penetrate throughout their substance. They dissolve, however, immediately in acid and therefore disappear in a technique in which the use of free acid is involved, leaving open spaces that may easily be confused with small blood-sinuses. Their position is extracellular, but they occur in the peculiar gelatinous tissue described above. When the mollusc is in a state of active growth they congregate in large numbers between the shell-glands and the internal surface of the mantle (fig. 14). Externally they are perfectly smooth. Their internal structure is lamellar and concentric, but the lamellae of which they are composed are not numerous.

The structure of the shell-glands of both series is essentially similar in the Melaniid genera *Melanoides* and *Acrostoma* to that here described in the Viviparidae. As de Villepoix[1] has shown that it is also similar in *Helix*, we may assume that it is of a type widely distributed among the Gasteropod molluscs. It will therefore be worth while, before discussing the function of the glands and of the marginal region generally in relation to the ornamentation of the shell, to summarize the description already given so far as its main points are concerned. I have been able to find no detailed account of the external structure of this region, which probably differs greatly in different forms, in any other family. Even if certain features are peculiar to the Viviparidae, parallel, if not precisely analogous, features probably exist in other families.

Summary Account of the Ornamentation of the Shell.

The ornamentation of the shell in the Viviparidae is partly periostracal, partly impressed on the outer calcareous layers. In the embryonic shell, including the protoconch, both horny and testaceous structures are already concerned, but the periostracal ornamentation, when magnified proportionately, is the more conspicuous.

The periostracal ornamentation is, at any rate in some species, both glyptic and coloured. Its sculpture is minute and consists of spiral rows of horny chaetae, fine spiral ridges and still finer oblique longitudinal lines. These are best developed in the fully-formed embryo and as a rule disappear or become obsolete (with the exception of the longitudinal lines, which tend to become more

[1] de Villepoix, *Comptes Rendus* CXX, p. 512 (1895).

prominent) in the full-grown shell. Three primary rows of periostracal chaetae can be distinguished, the best developed of which runs round the periphery of the whorls, while the other two are situated above it. The peripheral row, though the most important of the three, is the latest to be formed and only the first or uppermost row extends to the apex of the protoconch. In some species (e.g. *Vivipara dissimilis*), two additional rows of chaetae are present on the embryonic shell, one between the peripheral and middle row and one above the first row. These chaetae are, however, smaller than those of the three primary rows. They are homologous with two of the fine spiral ridges on the shells of other species.

In those species in which the shells are ornamented with bands of dark pigment the colour-pattern is periostracal in origin, though the calcareous matter may be slightly stained. The bands correspond in position with the rows of chaetae and spiral ridges.

The test-sculpture (*i.e.* that of the outer calcareous layers of the shell) also corresponds in position with that of the periostracum. In shells of the family in which it is highly developed, it consists mainly of prominent spiral ridges. These ridges may be smooth and uninterrupted (as in *Lecythoconcha lecythis*) or broken up more or less distinctly into series of tubercles (as in some individuals of *Taia naticoides*), scale-like projections (as in the most highly developed shells of *Taia* and *Margarya*) or even spines, as in the fossil *Rivularioides*.[1] They may be hollow as in *V. oxytropis* or solid as in the Chinese *V. lapillorum*. In practically all shells of all types the most prominent and most highly developed ridge corresponds with the peripheral row of chaetae, and in a large proportion those that correspond with the two other primary rows of chaetae are better developed than any others. Moreover, each ridge corresponds either with one of the primary rows of chaetae or with a secondary ridge of the periostracum.

Summary Account of the Structure of the Edge of the Mantle.

We may summarize the structure of the distal part of the mantle in the Viviparidae as follows:—

The free edge of the mantle is membranous, but much thicker in some genera (e.g. *Lecythoconcha*) than in others. The margin bears at least three digitiform processes, which are better developed in some species (e.g. *Vivipara oxytropis*) than in others, and are usually obscured by contraction and shrinkage in preserved material. In addition to those three primary processes other, smaller processes are present, probably in all cases, but are still more difficult to detect except in the living animal and may perhaps become vestigial in the adult of certain species. These primary and secondary processes correspond in position with the

[1] Annandale, *Rec. Geol. Surv. Ind.* L., pl. xxxiii, figs. 7–12 (1919).

periostracal sculpture. Immediately above the processes a groove runs transversely across the external surface and from it short longitudinal grooves are given off at right angles and run to the tip of the processes. Above the transverse supramarginal groove and running parallel to it, a convex ridge, varying in breadth and prominence at different stages of growth, can usually be traced. For it I have proposed the name of supramarginal ridge. The margin, including the grooves, is covered with columnar ciliated epithelium as far up on the external surface as the lower edge of the supramarginal ridge. Except at a very early stage in free life (*Lecythoconcha*) the epithelium is degenerate on the ridge, and above it consists of non-ciliate cells.

The substance of this part of the mantle is composed mainly of a peculiar kind of connective tissue consisting of polygonal cells with small nuclei, rather thick walls and gelatinous contents, in the main non-protoplasmic. It is cavernous in structure, including numerous ill-defined blood-spaces without cellular walls as well as true blood-vessels. Longitudinal muscles, sometimes powerfully developed, run down the mantle under the external epithelium, and certain oblique strands can also be followed out near the margin, forming a sphincter round the aperture of the branchial chamber. A fine network of muscle fibres also extends inwards from the outer layer. The musculature is much more highly developed in some genera than in others.

The nervous system of the margin has not been worked out in detail, but an irregular transverse nerve, some parts of which are nearer the edge than others, runs above the supramarginal ridge, and sends down fine longitudinal strands at intervals to the calciferous glands.

The glands whereby the greater part of the substance of the shell is secreted lie just above the edge of the mantle and are of two orders, the periostracal glands, which secrete the periostracum or epidermis of the shell, and the calciferous glands, which secrete the calcareous matter. The former are true multicellular glands of a vermiform shape, consisting of contorted tubules and opening to the surface by ducts with cellular walls. They lie some distance below the external surface in a transverse series along the extreme margin, for the most part beneath (*i.e.* distad of) the calciferous glands and with the main axis of each gland at right angles to the margin. Their ducts open into the supramarginal groove. The calciferous glands are much more bulky and differ considerably in structure. They occupy the supramarginal ridge and as a rule extend slightly beyond it both above and below, lying only a short distance beneath, or actually on, the surface and having no cellular ducts. Like the periostracal glands they form a transverse series, though the main axis of each gland is at right angles to the margin. Each gland is at first an elongate cylindrical tubule of gland-cells forming a large number of closely adpressed loops in the external margin of the connecting tissue. The cells are large and do not appear to have any very intimate

organic connection *inter se*. The lumen of the tubule has no special lining. At this stage ducts, perhaps of a temporary nature, can be detected in sections, but they form mere gaps in the epithelium, leading out from ill-defined spaces beneath it (fig. 2, pl. iii). Later the gland-cells become greatly enlarged and elongate and open direct on the external surface; while the tubular character of the gland disappears.

The calcareous matter secreted by the calciferous glands is apparently derived from concretions scattered through the connective tissue of the mantle and foot but congregated in large numbers immediately beneath the glands at times of active growth.

The secretion of the nacreous layers, probably affected by unicellular glands scattered over the whole of the upper part of the mantle, is not discussed here.

Function of the different parts of the Marginal Region in reference to the Shell.

We are now in a position to discuss the function of the edge of the mantle in relation to the ornamentation of the shell. The first structures in the soft parts to be considered in this connection are the marginal processes. They are not organs of secretion but, at any rate when hypertrophied as in *V. oxytropis*, perhaps accessory breathing organs. They are closely correlated in position with both the periostracal sculpture, the colour-pattern and the sculpture of the test. The connection between them and the periostracal sculpture can be traced without difficulty. They mould this sculpture, apparently as erectile rather than muscular organs. The horny matter that will form the thin outer cuticle of the shell is poured in a liquid condition into the supramarginal groove, in which it is kept in motion by the cilia of the epidermal cells. It runs down the longitudinal grooves on the external surface of the processes and by them is deposited on the edge of the lip of the shell, over which they are retroverted as it consolidates. The three primary rows of chaetae are thus formed by the three primary processes, and in such forms as *Vivipara dissimilis* in which there are more than three rows, those of the secondary rows by the best developed of the secondary processes. The upright form of the chaetae is due to the greater length of these processes. This enables them to project well beyond the lip and be curled up over it. The hooked tips of the chaetae are due to the fact that the tips of the processes are curved at the moment of formation of the chaetae. The fine subsidiary ridges of the periostracum, which when first formed project horizontally from the edge of the lip as fine hairs, are similarly produced by the subsidiary processes, their orientation being due to the fact that the moulding processes are short and cannot be curved upwards over the lip.

In those shells which like *Vivipara bengalensis* have a pattern of dark spiral bands in the periostracum, the dark pigment is also poured out along the grooves on the external surface of

the marginal processes. This is proved not only by the position of the bands and their arrangement on the shell but also by the close correlation of dark pigment with the periostracal glands in such species and by its absence from the margin in those species the shells of which are not marked with dark spiral bands. We may presume that, after the secretion of the horny fluid to form the chaetae and ridges, the pigment is poured out in a similar manner along the processes and deposited by them on the surface of the lip. The chaetae themselves are not coloured by it, and I do not think that the ridges are either, though this point is difficult to observe with certainty, because the dark bands do not appear until the sheli has become fairly opaque and the ridges project very little from the surface.

To return to the periostracal sculpture, the fine vertical lines are evidently due to a pouring out of horny matter direct from the supramarginal groove, with which they correspond exactly in orientation, each representing, so to speak, a separate act of secretion.

The sculpture of the test also corresponds closely in position and arrangement with that of the periostracum and, indeed, so far as the minute sculpture is concerned, is practically a cast of it from which the upright chaetae are necessarily omitted, just as single upright hairs cannot be represented in a plaster cast. In most forms of *Vivipara bengalensis*, and indeed in most Viviparidae, there is nothing more to be said on this point, but in those species which have highly sculptured shells, and even in some phases and individuals of *V. bengalensis*, a further exposition is necessary.

The highly sculptured shells among the Viviparidae fall into three categories, viz. (1) very thin shells with uninterrupted, *hollow* spiral ridges; (2) thicker shells with uninterrupted, *solid* or almost solid spiral ridges, and (3) shells, thick or thin, with ridges that are more or less distinctly broken up into nodules, scales or spines.

Of the first type, which is the scarcest of the three, V. *oxytropis* is an excellent example. The shell, in spite of its large size, is exceptionally thin and fragile and the ridges upon it though prominent are very little thicker than the intervening spaces on account of the well-marked concavity of their internal surface, which forms a regular groove. No peculiarity of the calciferous glands has been observed in connection with these ridges on the shell, and none is necessary to explain them, for they lodge the greatly hypertrophied marginal processes, the mere presence of which on the internal surface of the shell while the calcareous matter was soft is sufficient to account for their presence.

On shells of the second type with solid uninterrupted ridges no satisfactory direct observations have been possible, owing to imperfect preservation of the material available, but the marginal processes are not hypertrophied as in *V. oxytropis* and it may perhaps be assumed that the ridges are due to a certain

slight hypertrophy of the calciferous gland in a position on the mantle corresponding with them on the shell. This is indicated by the facts that even in smooth shells of *V. bengalensis* the dark spiral bands are slightly thickened and that at the end of a growth-period the calciferous glands are often a little larger immediately above the primary marginal processes than at other points on the periphery. It is clear, however, that some of the matter which occupies their base is nacreous, and we know that on the internal surface of the shell nacre can be deposited by almost any part of the mantle after the external ornamentation is complete.

The third, most highly sculptured type of shell is the most interesting of the three, not only because of its peculiar facies but also because it has appeared and become dominant among the Viviparidae[1] on different occasions and in different places and different geological epochs. The test sculpture, even in this type of shell, corresponds closely in fundamental pattern with the primitive periostracal sculpture of the embryo of *V. bengalensis*, that is to say that it consists essentially of spiral ridges bearing prominences and that these ridges have fundamentally a definite number and position on the shell exactly similar to that of the three rows of chaetae and the secondary ridges of the embryonic periostracum, and that the most prominent ridge corresponds with the peripheral row of chaetae. It follows that the interrupted ridges of the test in this type of Viviparid shell are correlated at least in position with the marginal processes of the mantle, but the connections between the structures on the shell and those on the soft part are certainly not so close as in the periostracal sculpture and cannot be stated with the same precision. Here again, however, we know that the test sculpture is not correlated as in *V. oxytropis* with any hypertrophy of the marginal processes of the mantle, which are small in both *Taia* and *Margarya*, and also that the processes show no essential difference of structure in individual shells of the former genus in which the sculpture is less and more highly developed.

If the mode of construction of the projections on the peripheral and other ridges of the more highly developed shells of the genera *Taia* and *Margarya* can be explained, that of the remainder of the ridges is a simple matter. They cannot have been formed, so to speak, in the air (or rather in the water) but must have been built up in continuity with the edge of the lip. In the fossil *Rivularioides* they may be nearly half as long as the diameter of the whole shell. Their form suggests that they must have been moulded by some comparatively broad projection of the mantle edge. In contracted specimens of *Taia* and *Margarya* no trace of any such structure can be detected, and the extreme margin differs little from that of *V. dissimilis*, which has a very smooth shell. It is unfortunate that I made no observa-

[1] Annandale, *Rec. Geol. Surv. Ind.* L, *p.* 209, pl. xxxi, figs. 8–11 (1919).

tions on the living *Taia* that would have thrown any light on this point, but I have been able to examine some well-preserved specimens of *T. intha* in which the animal is partially expanded and the mantle not completely retracted. In those in which the growth-period was completed when they were killed I can find no peculiarity in the margin of the mantle, which is either quite smooth or undulates gently, but in several specimens in which the extreme thinness of the lip proves that growth was still in progress, the base of the youngest scale-like projection of the peripheral ridge is still hollow and contains a broad lobe of the mantle-edge, evidently temporary in nature.

The projections on the shell, however, are not only of considerable length when highly developed, but contain a relatively large amount of calcareous matter. In both *Taia* and *Margarya* the calciferous glands degenerate greatly in the periods of rest and in full-grown individuals become very uniform all along the edge of the mantle, but in a young growing specimen of the *Taia intha* I find that immediately opposite the peripheral ridge there is a cushion-like thickening of the supramarginal ridge due to the greater depth of the glands at this point. In the individual in which this observation was made a scale-like projection was in the process of formation. In others, in which this was not so, the glands at the same point were not hypertrophied to any appreciable degree.

It follows, therefore, that the projections are formed owing to periodical hypertrophy of the calciferous glands in the part of the mantle that lies immediately beneath the ridge on the shell, and moulded into shape by temporary lobes of the mantle edge. The difference between the smooth ridges on the shell of such species as *Vivipara lapillorum* and the interrupted ridges, often with relatively long projections, of such forms as *Taia intha* or the var. *carinata* of *Margarya melanoides* is probably, therefore, due to the local hypertrophy of the calciferous glands being in one type of shell permanent, and in the other temporary. Elongate projections on the ridges of the most highly sculptured shells of the family are secreted thus and are modelled into shape by the temporary lobes. It is noteworthy that whereas the muscles are not so coarse, and the transverse fibres distinctly less well-developed, in the marginal region of the mantles of *Taia* and *Margarya* than in the smooth-shelled *Lecythoconcha lecythis*, the two former genera have a regular network of muscles pervading almost the whole mantle in a manner not observable in *L. lecythis* or any other species of the family examined. This may doubtless assist in the projection of temporary lobes from the edge of the mantle.

The secretion of the periostracal glands probably mixes to some extent with that of the calciferous glands and forms the organic basis of the shell.

The dark margin of the mouth of the shell to be noticed in many species of *Vivipara* when the growth-period is complete is probably due to a general suffusion of black pigment correlated with its accumulation in the tissues at such periods.

PART III.—SYSTEMATIC.

By N. ANNANDALE.

The smooth-shelled dark-banded Viviparae of India and Burma have given difficulty to all conchologists who have discussed them in a comprehensive spirit. This is because the shells are both variable individually and plastic in relation to environment. Local races are also liable to become differentiated, and we find a number of forms that appear at first sight to be specifically distinct but are actually linked together, as becomes evident where a sufficient number of specimens are examined, by innumerable intermediate types. Nevill in his unfinished *Catalogue of Mollusca in the Indian Museum* (1877), of which the only fragment published dealt with the Ampullaridae and Viviparidae, and in his later but also unfinished *Hand List of Mollusca in the Indian Museum* (1885), included most of those forms, with several others, as varieties and subvarieties under the name *Paludina bengalensis*. So far as the species found in India proper are concerned, I believe that his judgment was in the main just, but the forms he assigned in 1885 to *cingulata* (from Assam) and *polygramona*, von Martens, I regard as specifically distinct.

Under the specific name *Vivipara bengalensis* I include all the Indian forms of the genus with dark-banded shells, except the Viviparae oxytropides, undescribed species from Manipur and Preston's *Vivipara nagaensis*, the last of which I have not seen. Of *V. bengalensis* I recognise the following forms :—

Race *bengalensis* (Lamarck).
Race *mandiensis*, Kobelt.
Race *nepalensis*, Kobelt.
Race *balteata* (Benson).
Race *doliaris* (Gould).
Race *eburnea*, nov.
Race *colairensis*, nov.
Phase *annandalei*, Kobelt.
Phase *halophila*, Kobelt.
Phase *incrassata*, nov.
Phase *pachydolicha*, Annandale.

Vivipara bengalensis (Lamarck).

1822. *Paludina bengalensis*, Lamarck, *Anim. s. Vert.* VI (2), p. 174.
1920. *Vivipara bengalensis*, Annandale, *Rec. Ind. Mus.* XIX, p. 113.

The shell is ovate as a whole, sharply acuminate and with a relatively large subcircular or almost rhomboidal mouth, which is never very oblique. The upper part of the shell is slightly conoidal rather than strictly conical. There are $5\frac{1}{2}$ to $6\frac{1}{2}$ whorls, the suture is narrowly impressed and the whorls are somewhat but never very greatly swollen. The spire is relatively large, usually a little shorter than, but occasionally longer than the body-whorl. Its whorls increase in size evenly and gradually. The body-whorl is slightly oblique and always considerably broader than high, as seen in dorsal view. In this view it expands but slightly towards the

outer margin. The umbilicus is narrowly perforate or completely closed, rarely more open, the columella is strongly arched, with a narrow margin and by no means prominent, the outer lip is almost semicircular, sharp, thin and joined to the columellar margin above as a rule merely by a thin, glary deposit. In the adult shell the sculpture consists of fine longitudinal ridges, which are convex outwards and on the body-whorl sometimes take the form of fine irregular ribs or varices. Only traces of spiral sculpture can as a rule be distinguished on adult shells, but the young shell bears rows of very fine punctae, representing the bases of minute chaetae. The colouration varies considerably, but is always some shade of greenish-olivaceous, marked with dark spiral bands. These are as a rule narrow, but broader bands alternate with still narrower, often paler linear ones of the nature of 'shadow stripes.' The bands are occasionally rendered obsolescent, though rarely or never quite obsolete, either by a general deposit of dark pigment or by an incomplete albinism. The fully developed mouth usually has a narrow black rim.

The operculum is moderately thin and of a deep brownish colour. The external surface is concave as a whole. The outer margin is strongly curved, the inner margin slightly sinuate and the posterior extremity bluntly pointed. The muscular scar is moderately large and prominent, much deeper in colour than the rest of the operculum.

In all races two types of shell can be found. They may be called the normal type and the elongate. In the former the shell is considerably more globose, broader in proportion to its height, with a larger mouth and a shorter spire than in the other. The difference is not sexual, but apparently dimorphic. In most races the normal type is much the commoner, but in the phase *annandalei* the proportionate numbers of the two are reversed, and this is also so in the race *balteata*. In the race *colairensis* the normal type is about as elongate as the elongate type in the *forma typica*, but shells of a still more elongate type are also found occasionally.

In the *forma typica* and in the race *mandiensis* a third type of shell is sometimes found. It may be called the gigantic type, for its characters are great size, more swollen whorls, broader umbilicus and more projecting mouth. Sometimes, especially in large marshes, this type shows a tendency to predominate and almost assumes the rank of a phase.

Yet a fourth type occurs, much more rarely than the others, namely, the canaliculate, in which the outline is extremely broad and the surface outside the suture deeply impressed. Single shells of this type have been found in the *forma typica* and in the dark form of the race *eburnea*.

The elongate type of shell was called *Paludina elongata* by Swainson, the gigantic *P. gigantica* by Reeve and the canaliculate *P. bengalensis* var. *canaliculata* by Nevill, but I have avoided the use of these latinized names, for as a rule they apparently represent mere aberrations.

Soft parts.—As yet we know too little about the details of the comparative anatomy of the Viviparidae to say with certainty what characters in the soft parts are of specific importance, but the following four points may be noted wherein a definite anatomical difference exists between *V. vivipara* and other species for which information is available :—

1. The marginal processes of the mouth are moderately well developed, less so than in *V. oxytropis*, but more so than in the adult of *V. dissimilis* and *V. vivipara*. Three are much larger than the others.

2. The testis consists of a single lobe, not of two subequal lobes as in *V. vivipara* or of a large primary lobe with an ill-developed second lobe as in *V. dissimilis*.

3. The male tentacle is less differentiated than in *V. vivipara*, but not less so than in *V. dissimilis* and other Indian species examined.

4. The right pleural ganglion is almost completely fused with the right cerebral ganglion, whereas in *V. vivipara* there is a short but distinct commissure.

Radula.—The radula is chiefly noteworthy for the following points :—

1. The teeth are moderately large and stout and have their denticulation well but not immoderately prominent.

2. The central is relatively large and considerably broader than long. Its distal margin is distinctly concave. The lobe in the middle of its cutting edge is quadrate, much broader than deep and relatively large. It has on each side of it at least five triangular denticulations ; which are sharply pointed and decrease in size gradually from within outwards.

3. The two laterals and the marginal on each side are relatively broad and not very much longer than the central. Their denticulations are comparatively coarse and on the laterals closely resemble those on the central. On the marginal they are much finer and there are over twenty. The upper extremity of the edge of this tooth is usually expanded to form a small triangular process.

The foregoing description and observations are intended to apply to the species as a whole. I will describe separately the various races that occur in different parts of the Indian Empire, and then the phases, whose peculiarities are probably due to some physical factor in their environment acting directly on the individual, rather than to geographical isolation of the race.

The anatomy of the Viviparidae, so far as it has been studied, is strikingly uniform in most respects and little or no recognisable difference has been found in the different forms of *V. bengalensis* so far as the radulae and soft parts are concerned. In the radular teeth slight racial peculiarities might perhaps be found, but they are so ill marked that it would be misleading to lay stress upon them.

The different local races of *V. bengalensis* have the following distribution. The *forma typica* is peculiar to the lower Ganges

valley. Westwards it is replaced, apparently quite gradually, by *mandiensis* and southwards by *eburnea*. The race *nepalensis* occupies the base and lower valleys of the Eastern Himalayas from Nepal to the east of Assam, but in the plains of Assam is gradually replaced by *balteata*, which in its turn gives way to *doliaris* in the valleys of Burma. In no instance is it possible to draw a precise line, either structural or geographical, between the different races.

The form that I have called race *colairensis* differs from the others here recognised as races, in that it has been found only in one locality. A large number of individuals were, however, examined and the racial characters seem to be remarkably distinct.

In a sense two (*incrassata* and *pachydolicha*) of the four phases here recognised, are modifications of the local race *eburnea* rather than of the species as a whole, but in the other two (*annandalei* and *halophila*) the phase-characters mask the racial ones and the phase is found in the territory of more than one race.

For these reasons I have carefully avoided a specious appearance of precision in defining the diagnostic characters of races and phases. I have also refrained from giving measurements of individual shells. These I have found most misleading in diagnosis, the differences in form depending not so much on point to point measurements as on the curvature and inclination of the outlines. Such differences can be properly demonstrated only by good figures. Unless it is otherwise stated, I have examined large numbers of specimens of each race and phase from several or many localities.

Race **bengalensis** (Lamarck).

(Plate 1, figs. 1–3.)

1822. *Paludina bengalensis*, Lamarck, *Anim. s. Vert.* VI (2), p. 174.
1822. *Paludina elongata*, Swainson, *Zool. Ill.* Ser. I, II, pl. xcviii top.
1841. *Paludina bengalensis*, Delessert, *Rec. de Coquilles*, pl. 31, figs 2*a*, 2*b*.
1852. *Paludina bengalensis*, Küster, in Martin and Chemnitz's *Conch. Cab., Paludina* I, p. 17, pl. 3, figs. 15, 16.
1862. *Paludina bengalensis* and *P. gigantea*, Reeve, *Con. Icon.*, pl. ii, figs. 5*a*, 5*b*, and 7.
1876. *Paludina bengalensis*, and *P. bengalensis* var. *gigantea*, Hanley and Theobald, *Con. Indica*, pl. lxxvi, figs. 8, 9, 10 and pl. lxxvii, fig. 5.
1877. *Paludina bengalensis*, (Typical sect. in part) Nevill, *Cat. Moll. Ind. Mus.*, pp. 26–28.
1885. *Paludina bengalensis* (in part), with subvar. *phaeostoma*, *elongata*, *gigantea* and *canaliculata*, Nevill, *Hand List Moll. Ind. Mus.*, II, pp. 20, 21.
1909. *Vivipara bengalensis*, Kobelt, in Martin and Chemnitz's, *Conch. Cab., Paludina*, II, p. 271, pl. lv, figs. 1–4.

I regard the race found in the lower Ganges valley as the *forma typica* of the species. The typical shell of this race is about $1\frac{2}{3}$ times as high as broad and the spire and body-whorl as seen in dorsal view are about equally high. The whorls are rather tumid and the body-whorl is evenly convex in profile, not

biangulate. The mouth of the shell is sub-circular and has a narrow black margin when complete. It is nearly as high as the spire and very little oblique. The umbilicus is narrow. The colouration is never very brilliant. The ground colour is greenish and opaque. The dark bands are variable and irregular, but the alternating of broad and narrow bands can always be seen if the shell is clean. The bands are hardly incrassated. The interior of the shell is white.

The elongate type of shell occurs occasionally with the typica[1] one. In it the height is about 1½ times the maximum diameter. Its mouth is relatively small. The gigantic type is rarer than the elongate one, but occasionally occurs almost as a distinct phase. It is, however, also found with the typical form, apparently as an aberration.

Nevill has given the name subvar. *canaliculata* to a curious shell from Raniganj in Bengal. This specimen, which is the only one of the kind I have seen in this race, has a somewhat turbinate form and a broad, deeply impressed suture. It must be regarded as a mere abnormality.

This race is usually found in large ponds, marshes and backwaters with a properly aquatic vegetation. Where the vegetation is scanty the shells are usually dwarfed.

Race **mandiensis**, Kobelt.

(Plate I, figs. 4 and 10.)

1909. *Vivipara bengalensis*, var. *mandiensis*, Kobelt, *op. cit.*, p. 414, pl. lxxvii, figs. 8, 9.

This race is so like the *forma typica* that I have kept it distinct with some hesitation and only after ascertaining that the differences persist with fair constancy over a large territory. These differences, small as they are, are well shown on plate I. The spire is rather more conical and a little narrower than in the *forma typica*, the aperture not quite so broad, but more projecting, the umbilicus broader. There is great variation in colour, probably due to the nature of the water in which the animal lives. The shells in the type-series are pale, but have the alternating broad and narrow spiral bands well developed. Shells from Ambala in the plains of the Punjab are very similar. Specimens from shallow ponds in Lahore have the shell pale and translucent like opal glass, the periostracum extremely thin and evanescent and the dark markings often almost obsolete. In such specimens the animal is also very pale. Shells from the island of Bombay, on the other hand, are unusually brilliant in colouration, the ground-colour being bright olive-green and the bands well defined, dark and regular.

Type-series. No. M5081/1 *Z.S.I.*

Geographical range.—The type-series is said to be from Mandi, a small native state high up in the Kangra valley in the Western

Himalayas, but the fauna of this district is mainly Palæarctic and the occurrence of *V. bengalensis* needs confirmation. The specimens examined by Kobelt, moreover, agree precisely with those from the plains of the northern Punjab. The range of the race certainly extends from Allahabad at the junction of the Jumna with the Ganges to the northern limits of the plains of the Punjab on the one hand and to the shores of the Arabian Sea at Bombay on the other. It may be described as the common race of north-western India.

Both the "elongate" and the "gigantic" type of shell occur in this race occasionally, but the "normal" type is very much more common than either.

I have found this race in the Punjab in small ponds that in winter were extremely shallow and completely devoid of phanerogamic vegetation. In such environment the mollusc buries itself in the mud as the water dries up.

Race **nepalensis**, Kobelt.

(Plate I, fig. 7.)

1909. *Vivipara bengalensis*, var. *nepalensis*, Kobelt, *op. cit.*, p. 44, pl. xxlvii, fig. 10.

This race is rather more distinct from the *forma typica* than the preceding one, but many shells occur that would be difficult to assign to one race or the other and as a whole *nepalensis* merges so gradually into the still more distinct Assamese form *balteata* that it is impossible to draw a precise line between them. The shells are of moderate size, as a rule a little smaller than those of *bengalensis*. The whorls are more contracted and not so convex in outline, distinctly flattened as a rule outside the suture; the aperture is smaller, narrower and more pointed above and the umbilicus still narrower. The body-whorl often shows a tendency to become biangulate and the dark bands are sometimes incrassated. The colours are usually rather deep, but dull, and the bands are well developed.

The "normal" type of shell is much the commonest, but the "elongate" type occurs occasionally.

Type-series. No. M5080/1 *Z.S.I.*

Geographical Range.—The range extends from the Nepal valley along the base of the Eastern Himalayas as far east as Siliguri, below Darjiling. At or near this point the race merges into the Assamese race *balteata*. Specimens from Gauhati on the Brahmaputra, however, belong to it rather than to the latter. They are much more brightly coloured than specimens from Nepal.

I found the race common in ponds with submerged and floating vegetation at Gauhati.

Race **balteata** (Benson).

(Plate I, fig. 8.)

1836. *Paludina bengalensis*, var. *balteata*, Benson, *Journ. As. Soc Beng.* pt. 2, p. 745.
1909. *Vivipara* (*bengalensis* var.) *balteata*, Kobelt, *op. cit.*, p. 415, pl. lxxvii, figs, 11-12.

Were all the shells of this race like the one figured by Kobelt, there would be little doubt as to the propriety of regarding it as specifically distinct; but his figure represents an extreme type, which, though common, is by no means universal in the race. My own figure (pl. I, fig. 3) represents a shell that goes almost to the opposite extreme. Both types are present in several series examined from Sylhet and the eastern parts of the Brahmaputra valley. It will be noticed that Kobelt's figure represents a small shell of the "elongate" type, mine a larger one of the "normal" type.

Most shells resemble the former. They rarely exceed 20 mm. in height and are narrow in proportion. The whorls are somewhat contracted, the aperture ovoid and the umbilicus closed. The dark bands are well developed and sometimes all of them are very narrow. They are frequently thickened and prominent. Shells of the "normal" type are often larger, with a very large sub-circular aperture. Their body-whorl is frequently almost biangulate, and the dark bands alternate in width. Intermediates between the two types are not uncommon. In both types, the shell is very thin and quite translucent when fresh. Specimens can often be found so similar to some of those of the Burmese race *doliaris* that they can hardly be distinguished from them. Others closely resemble Peninsular shells of the phase *annandalei*.

Geographical Range.—The headquarters of this race is the Sylhet valley in southern Assam, but it also occurs in the eastern part of the valley of the Brahmaputra. It is absent from Manipur. There are specimens in the Indian Museum labelled Siliguri but this is probably a mistake for Silcuri in Cachar, where Benson originally obtained specimens.

I am informed that this race is often found in flooded rice fields.

Race **doliaris** (Gould).

(Plate I, fig. 9.)

1843. *Paludina doliaris*, Gould, *Proc. Bost. Soc. Nat. Hist.* I, p. 144
1869. *Paludina digona*, Blanford, *Proc. Zool. Soc. London.*, p. 445.
1876. *Paludina digona*, Hanley and Theobald, *op. cit.*, pl. cxv, fig. 7.

The most characteristic feature of this race is the one described in Blanford's name *digona*. The biangulate outline of the body-whorl is due to the presence of two spiral ridges which are merely dark bands thickened, but this feature is not equally developed in all individuals and in some is almost absent. In typical specimens the aperture is exceptionally large and wide, the columellar edge prominent, and the umbilicus rather broad;

but these characteristics are inconstant, especially in shells of the "elongate" type, which are found not uncommonly. In both this and the "normal" type, however, the shell is relatively broader than in the corresponding types in the *forma typica*, and the upper surface of the whorls is more or less broadly and obliquely flattened; the dark bands, which have the typical arrangement, are as a rule slightly incrassated and the aperture is subangulate, at any rate to a slight degree, at its outer and lower extremity. The size is usually larger than that of *balteata* but a little smaller than that of the *forma typica*.

In some respects the three eastern races (*nepalensis*, *balteata* and *doliaris*) represent a developmental series and would seem to indicate that there has been a tendency for the species to develop along certain lines as it proceeds eastwards, notably in the assumption of dark spiral bands of a prominent character and the special development of two of these bands as keels. A similar line of development can also be traced, but less completely, in the Peninsular phases of the species.

Geographical Range.—The race *doliaris* has its headquarters in the valley of the Irrawadi, down which its range extends at any rate from Bhamo to the delta. It is also found on the lower Siltang and probably on the lower Salween.

Race **eburnea**, nov.

(Plate II, figs. 1–2.)

In this race the shell is as a rule slightly narrower than in the *forma typica* and its aperture smaller; the body-whorl is also less enlarged and does not project outwards to the same extent in dorsal view. The whorls are narrow but distinctly flattened outside the suture and the body-whorl sometimes shows a tendency to become biangulate. The longitudinal striae are very fine and as a rule more regular than in *bengalensis* (s.s.), and strong traces of spiral sculpture can nearly always be detected with the aid of a good hand-lens. The aperture of the shell is slightly pyriform and the umbilicus is very narrow if not completely closed. The shell-substance when fresh has an ivory-like appearance. The outer surface is lightly tinged with yellowish olive and the spiral bands are never very dark. Sometimes they are obsolescent, but traces of them can usually be found at any rate on the upper whorls and the alternating broad and narrow bands are often quite clear. Sometimes the dark bands coalesce on the body-whorl. The aperture never has a black rim.

Elongate shells are not uncommon and individuals intermediate between this type and the normal one occur more frequently than in the *forma typica*.

The animal in this race is pale olivaceous and has a peculiar translucent appearance, but the yellow spots characteristic of all races are never obsolete.

Type-series. No. M11960/2 *Z.S.I.* (from the Keligiri reservoir Nellore district, Madras).

Geographical Range.—This is the race commonly found in the large reservoirs of the Madras Presidency and the central parts of India. It occurs in abundance as far north as Sambalpur in the interior of Orissa and has been collected occasionally in the south central parts of the Ganges valley. Specimens from the northern parts of its range are nearer the *forma typica* than those from the eastern districts of Madras. Nevill states (*Cat. Moll. Ind. Mus.* p. 27) that the spiral bands are sometimes absent in specimens from near Calcutta, but such specimens are mere albinistic aberrations and do not resemble *eburnea* in other respects.

The race is usually found in perennial bodies of still water. It reaches its maximum development among algae growing on stones.

I include provisionally in this race a small series of specimens from a large pond in the town of Godaveri in the eastern part of Madras. The shells are similar in shape but have the suture more impressed. In one specimen, indeed, it is canaliculate, and so deep that it forms an actual break in the shell at certain points, where the soft parts are exposed; but this shell was evidently diseased. The pigmentation of the shell is very dense, the outer surface being blackish brown with only traces of the spiral bands, while the interior is deep blue. The animal was also very dark.

These specimens were found amongst dense masses of the Water Hyacinth and *Pistia stratiotes*, so congested that many of the plants were rotting. Their peculiarities may be due to this fact.

Race **colairensis**, nov.

(Plate I, figs. 5–6.)

This race is one of the most distinct with which I am acquainted. It is remarkable for the elongate form of the shell and its relatively small aperture, which is almost circular. These features are noteworthy both in the normal and the elongate type, which occurs rarely with the former. The shell is of very large size, but thin and somewhat translucent. The pigmentation is rather deep, but dull. The alternating broad and narrow bands are distinct. The sculpture resembles that of the *forma typica*.

Type-series. No. M11961/2 *Z.S.I.*

Geographical Range.—I know this race only from a single pond at the village of Sriparptipada on the edge of the swamps that skirt the Colair Lake in the Kistna district of Madras. Specimens from the lake itself belong to the race *eburnea*.

Habits.—The pond in which my type-series was obtained was deep and contained abundant water although the district was

suffering from a very serious drought at the time of my visit (September, 1918). It had an abundant and healthy vegetation of submerged weeds and plants with floating leaves (Limnanthemum and water-lilies) were also abundant and healthy. The molluscs were taken among the leaves in great profusion. Their habitat was of a type more common in Lower Bengal than in Madras.

This exhausts the number of true races with which I am acquainted and we may now turn to the four well-marked phases of the species.

Phase **annandalei**, Kobelt.

(Plate II, figs. 5–8.)

1908. *Vivipara annandalei*, Kobelt, *Nachr. Malak. Ges.* LX, p. 161.
1909. *Vivipara annandalei*, Kobelt, in Martini and Chemnitz, *Conch. Cat.* I, 21 (21), p. 296, pl. 57, figs. 11, 12.

Kobelt refers to this form as "*eine kritische form.*" I was prepared to accept it as distinct until I had become acquainted with its habits and had ascertained the fact that in some ponds (*e.g.* the tank in the Museum compound, Calcutta) it graded insensibly into the typical form of *V. bengalensis*, or rather into a small but not otherwise peculiar phase thereof. Kobelt's description and figures were based on somewhat exceptional specimens of relatively large size and proportionately broad shell. Such individuals occur occasionally but are by no means typical of the phase. On pl. II four shells are shown. Fig. 5 represents one of Kobelt's type-series, which is from Vizagapatam in the north-east of Madras. The other three (figs. 6–8) are more typical. The shells examined by Kobelt were, moreover, old specimens and had lost the translucency characteristic of the phase.

The shell is always very thin and light and usually small. The more elongate type is the commoner of the two that occur, but the type-series chances to belong to the other. Apart from the thinness and translucency of the shell, the most characteristic features are the gradual increase in size of the whorls, the shallowness of the suture, and particularly the shape of the aperture, which is distinctly subrhomboidal and subangulate at its anterior extremity. The dark bands are sometimes a little incrassated. Some shells of the phase come very near to some of the Assamese race *balteata*. The animal is usually very pale in colour, but occasionally almost as dark as that of the *forma typica*. I have noticed that in living specimens kept in an aquarium it gradually becomes darker.

This phase is found in the territory both of the *forma typica* and of the race *eburnea*, but I can find no difference between specimens from Calcutta and those from Hyderabad, Deccan. It is commoner in the vicinity of both cities and almost always occurs in pools of rather foul water used for domestic purposes.

Phase **halophila**, Kobelt.

(Plate II, figs. 9, 10.)

1908. *Vivipara annandalei halophila*, Kobelt, *op. cit.*, p. 162.
1909. *Vivipara annandalei halophila*, Kobelt, *tom. cit.*, p. 297, pl. 59, figs. 17–20.

The type series of this phase was noted by Nevill as 'a short angulate form, almost indistinguishable from some of the Burmese var. *doliaris*.' It resembles *annandalei* very much as *doliaris* does *balteata*, but is certainly not a local race. The type-series was from the Punjab Salt Range, but I have also examined series from Calcutta and Burdwan in Bengal. The shell has a distorted appearance and is usually eroded at the tip. Its sculpture is coarse and irregular, the dark bands are usually incrassated and the body-whorl frequently sub-biangulate. The aperture resembles that of the shell of *annandalei*, but is usually larger and broader.

In calling this form *halophila*, Kobelt referred to the name of the locality of the type-series, but it is by no means improbable that the phase does live in water of abnormal chemical composition. Unfortunately I have never found it living myself.

Phase **incrassata**, nov.

(Plate II, figs. 3, 4.)

Shells of this phase differ from those of the race *eburnea* in being very thick and opaque and in having as a rule coarse irregular varices on the body-whorl. They are often almost devoid of pigment. Sometimes the umbilicus is more open than usual. I have examined a good series from Poona in western and from the Kurnool district in southern India. Unfortunately I know nothing of its habitat, but it resembles *eburnea* so closely in all but the thickness and sculpture of the shell that it can hardly be more than a phase of that race.

Phase **pachydolicha**, Annandale.

1921. *Vivipara bengalensis* phase *pachydolicha*, Annandale, *Rec. Geol. Surv. Ind.*, LI, p. 367, pl. xi, figs. 5–7.

I assign to this phase certain large elongate shells in which the umbilicus is more open than usual, and the mouth small and oval. The whorls are swollen and the sculpture impressed, with the upper surface of the whorls broadly and obliquely, but somewhat obscurely flattened, just outside it. There are numerous distinct minutely sinuate, spiral striae on the surface, and the longitudinal striae are coarse and irregular. The epidermis is a dark olivaceous brown in colour with numerous longitudinal black streaks. The spiral bands are narrow and obscure.

I have seen only two fresh specimens of this phase, but there is a series of fine subfossil shells in the collection of the Geological Survey of India.

The fresh shells were found on the sea-shore at Puri in Orissa near small pools of fresh water in the almost dry bed of a stream, the mouth of which was temporarily blocked. The subfossil specimens are from the alluvium of the Narbadda.

I should have regarded this phase as specifically distinct, were it not for the fact that some specimens of the phase *incrassata* approach it closely. It is probably another modification of the race *eburnea*.

PART IV.—BIONOMICS.[1]

By R. B. SEYMOUR SEWELL.

The Life-history.

The breeding season of *Vivipara bengalensis*, that is to say the period during which the young are born, commences early in the year and seems to extend throughout the whole of the hot-weather and monsoon periods up to and probably beyond September; but the period of most intense reproduction is from April

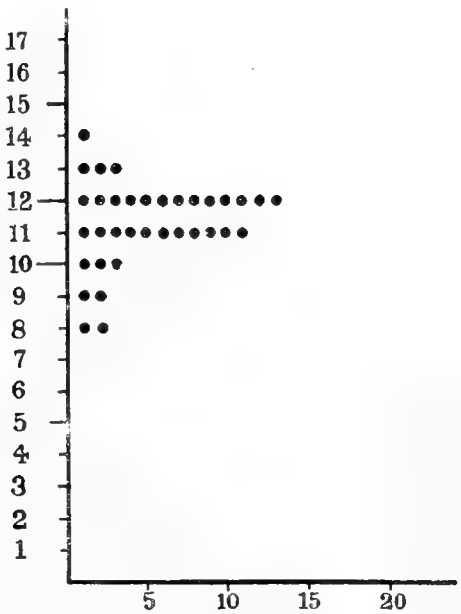

FIG. 20.—Length measurements of 35 examples of young *Vivipara bengalensis*, born in experimental tanks, at the age of 3 months old.

to July. During this period the uterus of a mature female is crammed with eggs, containing young in varying stages of development, but young Viviparidae are to be found *in utero* at all seasons of the year. I have even found them to be present in examples that had buried themselves in the mud at the bottom of a tank in Lahore at the onset of the cold weather and were dug up in December. Examples of *Lecythoconcha lecythis*, dug from

[1] In compiling this section I am greatly indebted to Dr. Annandale for many additional notes and observations.

dried mud at the edge of a swamp in Manipur, and brought to Calcutta in March, produced living young when placed in water.

Newly born examples of *V. bengalensis* are comparatively well-developed and already show $3\frac{1}{2}$ turns of the spiral in the shell. In a preceding part of this paper Dr. Annandale has described the young shell.

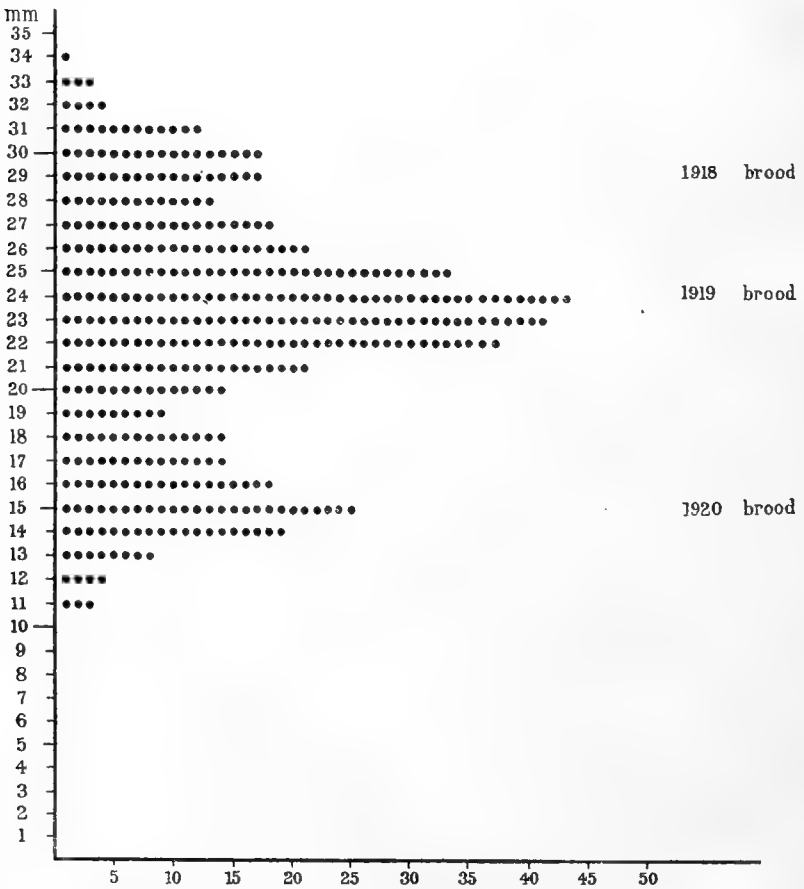

Fig. 21.—Length measurements of 409 examples of *Vivipara bengalensis*, taken from the tank in the Indian Museum compound, July 26th to August 2nd, 1920.

Growth at first proceeds rapidly. Newly born individuals measure approximately 3 mm. in maximum height from the apex of the shell to the margin of the peristome, but in less than three months a complete extra whorl has been added and the height of the shell is now approximately 15 mm. During May and August, 1919 a number of examples of *Vivipara bengalensis* were kept under observation in experimental tanks in the Indian Museum. These adults were introduced into the tanks between the 2nd and 23rd of May, 1919. Young were deposited in large

numbers and at the end of July several were collected and measured, and the results obtained are given in fig. 20. The measurement taken was the maximum height as defined above, and the individuals fall into a well-defined regular group, the measurement ranging from 8 mm. to 14 mm. and having an average of 11·3 mm. Since all these examples were less than three months old, we get some idea of the very rapid growth that takes place in early life. At the same time a number of adult examples from the pond in the Museum compound were measured and were found to fall into a group having a length measurement of 20 mm. to 27 mm. This I believed to represent the size attained after one year of life, and, in order to check this, between July 26th and August 2nd, 1920, 409 examples from the same pond of all sizes except the very smallest, which had obviously only recently been born, were collected and measured. The results are given in fig. 21. It will be seen that we have two well-defined groups with their maxima corresponding to a height measurement of 15 mm. and 24 mm. respectively.

The members of the first group correspond very closely both as regards size and degree of development with the examples hatched and reared in the experimental tanks in 1919. They are somewhat larger, but the experiments of Semper (1874), De Varigny (1894), and others have shown that growth is more rapid under favourable conditions and in large areas of water with efficient natural aeration than it is under artificial conditions in small aquaria, and it seems reasonable to conclude that the individuals comprising the group of the 1920 brood were approximately three months old and had been born about April. This rapid rate of growth, from 3 mm. in height when born to 12–15 mm. at approximately three months, corresponds closely with the results obtained by Lyon (*vide* Baker, 1911, p. 51) in which examples of *Limnaea* (*Galba*) *reflexa*, measuring 2·00 mm. at 6 weeks old, attained to a height of 5–10 mm. at 12 weeks and 26·0–28·5 mm. at one year old, or by Woodruff (*loc. cit.*) who found that examples of *Limnaea* (*Radix*) *auricularia* increased from 0·75 mm. in height when born to 11·50 mm. at 4 weeks. As age progresses, the rate of growth naturally becomes slower, since other and equally important processes are going on in the young individual, especially the attainment of sexual maturity.

The second group, having an average height of 24 mm., corresponds exactly with the adult examples taken from the pond in August, 1919.

It seems clear that these two groups of *Vivipara bengalensis* correspond respectively to the 1919 and 1920 broods, but there are indications of a still further group having an average height of 29–30 mm.; this however does not appear very clearly in the chart owing to overlapping with the group of the 1919 brood. These large individuals, which were much fewer in number than those of the preceding group, I take to represent individuals who have survived for a further period of one year and who represent the

1918 brood. The great majority of these large examples show a well-marked 'varix' across the middle of the body-whorl of the shell, thus indicating that there has been a period of arrested growth followed by a subsequent increase in size. The distance from the apex of the shell to the umbilical end of the varix measures approximately 24 mm. which corresponds closely to the average height attained by examples that are one year old, and it is evident that the period of arrested growth corresponds to the second winter of their life-history. The maximum length of life of any individual appears then to be two years, but the vast majority of individuals die after one year. Each year towards the end of the rains there is a very heavy mortality among the molluscan fauna of the ponds and tanks, etc., in this country. This was first noticed in a period of exceptional drought by Dr. Annandale, who called attention to it in his preliminary report to the Government of India on the mollusc survey of the Madras Presidency, but he attributed it to the partial drying up of the pools and the consequent foulness of the remaining water. The same mortality, however, occurred, though perhaps on not quite so large a scale, in ponds in Calcutta in August, 1919, where no such causative agent could be suspected, and it appeared to be a natural phenomenon affecting many different genera of molluscs, including *Vivipara.*[1] In *V. bengalensis*, the vast majority of individuals born in the preceding year die during this period, only a few surviving for a second year. This heavy annual mortality among the freshwater molluscs is a phenomenon of considerable antiquity, for Annandale (1920 (*a*), p. 53) has adduced evidence that it was in existence in the Intertrappean (late Cretaceous) beds of this country.

The sexual differences in the antennae of *Vivipara bengalensis* render it easy to carry out an investigation regarding the influence of sex on the individual. I have been quite unable to detect any difference in the shape of the shell, but measurement of a number of individuals of both sexes, collected haphazard from the pond in the Indian museum compound[2] shows very clearly that there is a quite appreciable difference in height. In fig. 22, I have given the measurements of 147 female and 57 male examples and it shows that the average height of females of one year old is 25·0 mm. and of two years old 30·0 mm., whereas males of the corresponding length of life have an average height of only 22·0 and 27·0 mm. respectively.

Difference in size in the two sexes of *Vivipara vivipara* was noticed as long ago as 1695 by Lister, and more recently Wood-Mason (1881, p. 86) has recorded the same sexual character in

[1] *Vide* Annandale and Sewell "Progress report on a Survey of the Freshwater Gastropod Molluscs of the Indian Empire and of their Trematode Parasites." *Ind. Journ. Med. Research* VIII, p. 119.

[2] Examples living in this pond are considerably smaller than those found in certain other localities.

examples of *Vivipara crassa* (Hutton) that he obtained and examined in Sylhet. This difference in size is also known to occur in other genera and according to Cooke (1895, p. 134) "is markedly the case in *Littorina*, *Buccinum*, and all the *Cephalopoda*." It is generally assumed that the difference in the two sexes is related to the viviparous habit and is dependent on the necessity for

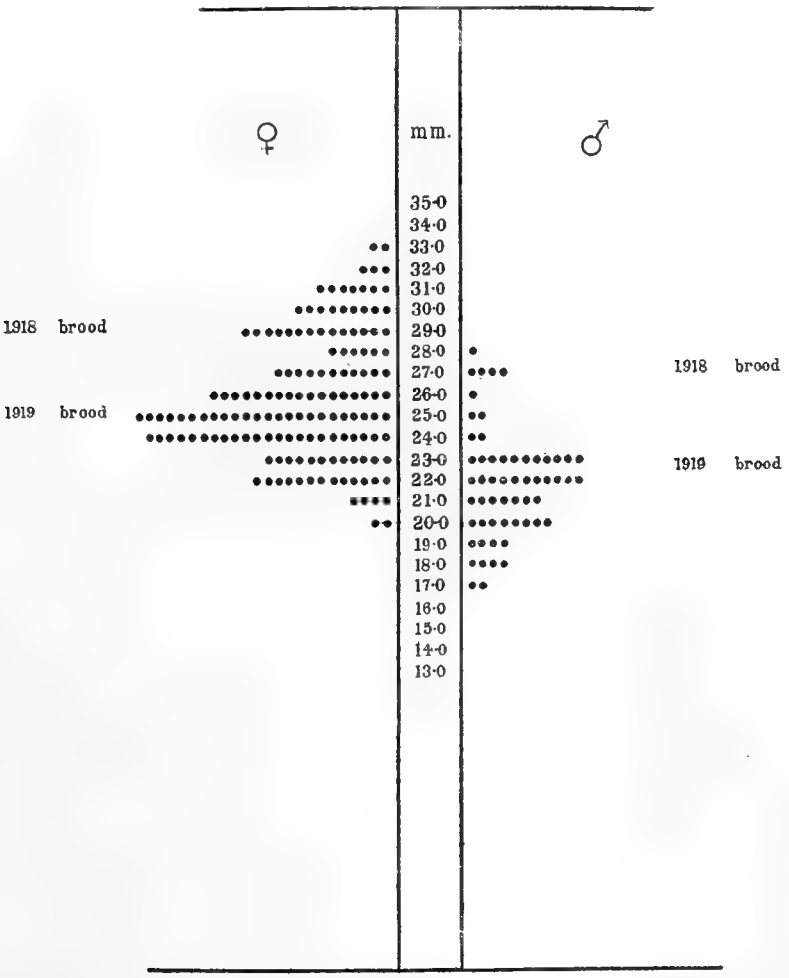

FIG. 22.—Measurements of 147 ♀ examples and 57 ♂ examples of *Vivipara bengalensis*.

increased space in the shell of the female in order to accommodate the large numbers of contained young in utero. If this were the sole causative agent, one would expect to find the condition constantly present, but this expectation is not fulfilled in the Viviparidae of this country, for in certain species no difference can be detected in the two sexes, while in others there is a difference

in the shape of the shell though not in height. In *Vivipara oxytropis* (Benson) Annandale found that while there was no difference in the height of the shell of the two sexes in the adult, the female shell was considerably broader than the male. In *Lecythoconcha lecythis* (Benson) also large shells were of the same height, but the whorls of the spire increased in size more gradually in the female. In the genus *Taia* Annandale (1918, p. 137) found that there was very little sexual variation in the shell in *T. intha*, though he found specific differences in sexual variation in the genus as a whole. In *Lecythoconcha* and *Taia* the young *in utero* are relatively large as compared with *Vivipara bengalensis* but this is not so in *V. oxytropis*. It appears probable, therefore, that there is some reason other than the mere necessity of increased space for the accommodation of young to account for this difference in height of the shell in the two sexes, and a possible cause may be found in the natural antagonism between bodily growth and the attainment of sexual maturity. In *Vivipara bengalensis* and probably in many other species of mollusc in this country sexual maturity is attained at a very early date. Whitfield (1882) states that examples of *Limnaea* (*Bulimnaea*) *megasoma* Say, which he hatched out from the egg and managed to rear successfully in the United States, America, became sexually mature at the age of one year. According to Baker (1911, p. 50) "the duration of life in the family Limnaeidae is from three to four years, full maturity being reached in about two years," and though I have no information regarding other genera in temperate regions it is probable that they much resemble the Limnaeidae in this respect. In this country and in Egypt, however, the general condition is vastly different. Manson-Bahr and Fairley (1920, p. 65), who were engaged in investigations regarding Schistosomiasis in Egypt, state that in that country examples of *Bullinus* and *Planorbis* become sexually mature at the early age of three months, and the same undoubtedly occurs in examples of *Vivipara bengalensis* in India. Dissection of fifty examples belonging to the 1920 brood, during July, showed that already many of them were sexually mature, and this was especially so in the males. In many cases the gonad was well developed and was full of ripe spermatozoa. In the females, only comparatively few were sexually mature. The smallest sexually mature male measured 13 mm. in height, while the smallest female with eggs and young *in utero* was 16 mm. Two others of the same height had a quantity of seminal fluid in the egg-shell gland, so that copulation had taken place. Assuming that the rate of growth is equal in both sexes up to the onset of sexual maturity, it would appear that the males become mature at an earlier date than the females, and the antagonism between growth and the attainment of sexual maturity occurs when the males are smaller, thus producing a disparity in size between the two sexes. In spite of their increased bulk females of the age of two years are remarkably less fertile than those of only one year old. In only three examples out of a total of fourteen

belonging to the 1918 brood and examined by me in August, 1920 were eggs, in which development was in an early stage, found *in utero*; in five others the uterus contained a few embryos in a comparatively advanced stage, with 3 to 3½ whorls in the spire; and in the remaining seven the uterus was empty. The average production of these examples was 2·8. On the other hand nine females belonging to the 1919 brood yielded an average of 12·0 eggs or developing young, so that in spite of their greater size, examples of the age of two years show very distinct evidence of senile decay, and it is not improbable that in many cases the young offspring found *in utero* had been retained since the previous breeding season.

Under certain conditions of cold, drought, etc., *Vivipara bengalensis* appears to be capable of undergoing 'hibernation.' In December, 1919 I examined a series of examples that had been obtained during that month by Mr. Sunder Lal Hora from the mud, in which they had buried themselves, at the bottom of a pond in Lahore. In every case the uterus contained a certain number of live young, which must obviously have been the product of the previous breeding season, and which would doubtless have been set free during the following season, in the event of the parent having been able to survive. Annandale has pointed out that *V. bengalensis* is less modified, especially in the structure of the operculum, for resisting drought than the species of the *V. dissimilis* group (sub-genus *Idiopoma*, Pilsbry). In a bottle full of specimens of *V. bengalensis* and *V. dissimilis*, recently brought to Calcutta from the Ganjam district of Madras, the difference in the behaviour of the two species as the water became foul was very marked. The individuals of *V. bengalensis* crowded round the edge at the top of the water with the aperture of the branchial chamber above the surface and widely open, as though inhaling air, while those of *V. dissimilis* closed their opercula tightly and sank to the bottom.

A further interesting point brought out by a study of the two sexes is the greater mortality among males during the period following the attainment of sexual maturity. Out of the fifty examples of the 1920 brood that were examined the proportion of the sexes was 24 ♂ and 26 ♀, so that at this period of life the numbers are approximately equal. A reference to fig. 21 shows that at the end of the first year of life the proportion of the sexes was 203 ♀ to 51 ♂ or roughly 4 : 1. While at the end of the second year of the life the proportion had become still greater and there were as many as 44 ♀ to 6 ♂ or 8 : 1. Wood-Mason (1881, p. 87), when examining a series of examples of *Vivipara crassa*, found that in seventy-six specimens forty-six were females and only thirty were males. He was, however, doubtful whether this difference in the numbers was due to an actual minority in the males or was merely the result of his collector having naturally tried to secure the largest possible specimens, but in view of the figures obtained by me in *V. bengalensis* I am inclined to believe that we get a similar disproportion of the sexes in both these

species. This disparity in numbers is not, however, of universal occurrence in the Viviparidae for Dr. Annandale informs me that in the Loktak Lake adult females of *Lecythoconcha lecythis* were at least as numerous as adult males, whereas in the case of *Vivipara oxytropis* females were distinctly less numerous than males.

As I have already mentioned, examination of 50 examples of the 1920 brood in July, taken from the pond in the Indian Museum, showed that the proportion of ♂ to ♀ was 24 : 26. A further examination of 35 examples from the same source in August gave a corresponding proportion of only 15 : 20, so that there had already been a considerable drop in the proportion of ♂ examples present. I give below a table showing the proportion of the two sexes in individuals of different sizes.

Table 1.—*Showing the proportion of sexes in individuals of different sizes from the pond in the Indian Museum.*

Length of shell.	11 mm.	13 mm.	14 mm.	15 mm.	16 mm.	17 mm.	18 mm.
♀	3	3	2	5	4	2	1
♂	1	...	1	1	5	4	3

This shows clearly that in the larger examples the proportion of ♂ sex is high whereas the exactly opposite condition prevails among the smaller examples. We have already seen that individuals of 11 mm. in length are of an age of three months or less, and these must therefore have been born about the beginning of June, whereas those having the greater length of 18 mm. were almost certainly born in April or earlier. It seems clear, then, that at the commencement of the breeding season there is a very distinct tendency to produce ♂ offspring, whereas later in the season it is mostly ♀ examples that are produced. I am inclined to attribute this alteration in sex-production to the variation in external conditions. I know of no data that would enable one to form an estimate of the length of the period of gestation, during which the developing embryo is retained within the uterus, and it probably varies at different periods of the year, but it seems likely that offspring born in April are derived from ova that became mature and were fertilized during the winter season, whereas offspring born later in the year will be derived from eggs that became mature during the warmer weather. If this be so, we have here another example of the influence of adverse surroundings in the production of male offspring.

Food.

A study of the contents of the stomach of a number of examples, as well as observations carried out on living specimens,

show that the normal food of *Vivipara bengalensis* consists almost entirely of algae and minute particles of vegetable matter which are rasped off from the surface of submerged plants, stones, decaying vegetable matter, etc. Along with these fragments of vegetable origin, a considerable quantity of fine mud and sand is ingested and swallowed in consequence of which the bulk of faecal material is very large. After passing up the oesophagus the food is mixed in the stomach with the bile which is poured out by the hepatic ducts, so that the stomach contents have a brown appearance and are liquid in character. As the contents are passed down the intestine, they become more and more solid and are finally moulded into small oval pellets which are at first usually rounded at one pole and more or less acutely pointed at the other. Later on, however, both poles become rounded. Finally these pellets are ejected through the anus into the syphonal tube and are forcibly swept out of the body by the outflowing current of water.

At times individuals have been found whose stomach and intestine were crowded with enormous numbers of a species of *Volvox*. These invariably contained within the parent colony a number of daughter colonies, and it is interesting to note that although the superficial cells of the parent colony were digested, the daughter colonies, being more deeply seated, entirely escaped digestion, and passed out of the body in the faeces in apparently a perfectly healthy condition. Gravely (*vide* Annandale, 1911, p. 216) has noted a somewhat similar phenomenon in the fresh-water polyzoon, *Plumatella repens*.

If aquatic vegetation is not available, as was the case where examples were kept in earthen basins or glass bowls, the animals could frequently be seen rasping off the algae that were growing on each others shells.

Although normally vegetable feeders, this *Vivipara* is by no means averse to a carnivorous diet, and feeds on the bodies of other dead snails. This habit appears to be by no means uncommon in molluscs that are normally vegetable feeders. Benson (1829, p. 363 and 1830, p. 126) has called attention to the carnivorous habits of a species of *Paludina*, under which generic term *Vivipara* was formerly included, but from his description of the animal it seems probable that he was referring to a species of *Bithynia* or *Amnicola*. Baker (1911, p. 42) has also pointed out that *Limnaea* is at times carnivorous though normally a vegetable feeder, but his statement that "the part they play as natural scavengers renders their presence in water-troughs and other sources of drinking water highly desirable" seems to overlook the fact that the presence of these snails may be and almost certain would be highly dangerous as a source of trematode infection.

More recently Annandale (1920 (*b*), p. 1) has noted that *Pachylabra* (Ampullariidae) is occasionally carnivorous.

Parasites and Incolae.

Amongst the normal inhabitants of the alimentary canal of *Vivipara bengalensis* and probably of other species of the same genus are several different types of ciliate protozoa, and it seems worth putting on record that in almost every individual examined. I have found what appear to be Spirochaetes in both stomach and intestine. There appear to be two different forms. One of these measured 0·026–0·028 mm. in length and shows 6–7 curves in the spiral; it is highly refractile and quite easily seen under a high power. It moves backwards or forwards with equal facility. At times individuals are met with which show a narrow thin portion in the middle of their length, while short individuals having a length of 0·014 mm. and only 3 curves in the spiral are occasionally met with. It appears that these short forms are produced by transverse fission of the larger individuals. The second form of Spirochaete occurs in the rectum and measures 0·014–0·016 mm. in length; it is of a robust type and has two or three wave like bends in the course of its length.

In addition to the above, there is a rich bacterial flora, consisting of diplococci, rod-like bacilli, etc., in both stomach and intestine.

Vivipara bengalensis rarely acts as the *primary* mollusc host for the development of Trematodes. In this respect it forms a marked contrast to other species of the same genus, for *Vivipara fasciata* Müll. has been recorded as the primary host of nine different cercariae, and *V. vivipara* (L.) harbours as many as eleven. Out of a total of 283 examples of *V. bengalensis* I have only succeeded in finding cercariae on two occasions and in both individuals it was the same form that was present. This cercaria belongs to the group of Xiphidiocercariae, and was developing in small oval sporocysts.[1] In both cases the host was a male and development was taking place in the testis.

On the other hand, it is often extremely difficult to find an example that is not acting as an intermediate host. Two kinds of Agamodistomes[2] infect and become encysted in this species and each has a very distinct anatomical distribution. One type of cyst, which is circular in shape, is found in the auricle of the heart. These cysts enclose a stage in the development of an Echinostome. The other cyst is found in the gill-bars, it is oval in shape, and usually of a pale brown colour and enclosed within it is a small Agamodistome, that judging from its structure is derived from a Xiphidiocercaria. I am unable to say whether this Agamodistome represents a further phase of the life-history of the cercaria noted above, but the two are extremely closely related and both possess

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[1] For a description of this Cercaria see Sewell, "Cercariae Indicae," *Indian Journal of Medical Research* (in the press).

[2] Dollfus (*Mem. Soc. Zool. France* XXV, p. 87, Paris, 1912) has introduced the term 'Metacercaria' to describe the stage in the life-history of a Trematode between the free-living cercaria and its final establishment in its definitive host.

exactly the same type of excretory system. Infection with these two cysts appears to occur in different stages of the life-history of the mollusc host. Even in examples of so early a stage as 10 mm. in length, the gills have already become infected with the cysts of this Xiphidiocercaria; and out of 36 examples examined of sizes ranging from 10 mm. to 18 mm. in length only two were apparently free from this parasite. With regard to the Echinostome cysts in the auricle, however, infection appears to occur much later, and further the proportion of infection is extraordinarily different in the two sexes in early life.

TABLE. 2.—*Showing the percentage infection with Echinostome cysts in the two sexes of examples of* 1920 *brood.*

Sex.	No. examined.	No. infected.	Percentage of infection.
♂	39	24	61·5 %
♀	46	15	32·6 %

The table shows that infection is twice as frequent in young males as it is in young females. No case of infection was found in examples that measured less than 14 mm. in shell length. I have already mentioned that sexual maturity is attained in this species when the individuals reach approximately the length of 13 mm. in the ♂ and 16 mm. in the ♀. Manson-Bahr and Fairley (1920, p. 66) have stated, and my own observations on the cercariae of this country have corroborated their statement, that "snails do not become infested with cercariae till they have reached maturity, that is about the third month." I have elsewhere put forward the view that infection by miracidia is probably largely dependent on the establishment of a chemotactic stimulus at the time when sexual maturity is attained in the mollusc host, and it seems possible that we are dealing here with a similar phenomenon. Certainly such an explanation would account for the higher percentage of infection in the males, which become sexually mature at an earlier stage of their life-history than do the females, and would also account for the freedom of infection of young immature examples. On the other hand infection of these molluscs by the Xiphidiocercaria and the production of cysts in the gill-filaments shows no evidence of any such phenomenon.

Turning now to the presence of these cysts and the degree of infection in adult individuals of either sex, I have given in the table below the results obtained from a careful examination of fifty examples, 25 aged 1 year and 25 aged 2 years. The point to which I wish to call attention is the very large percentage of ♂ examples that show a heavy infection with both Xiphidio-

cercaria and Echinostome cysts at the end of the 1st year of life, whereas at the end of the second year there is no such distinction between the two sexes. In cases where infection is heavy the auricle is so packed with cysts that it is a matter for wonder that it is able to perform its function at all, and in the case of the gills their physiological activity must be very seriously interfered with, leading to impaired vitality and a lowered resistance to adverse conditions. It is not improbable that we have here, if not the sole explanation, at least a contributory cause towards the marked progressive reduction in the proportionate numbers of adult males during the period of life succeeding the attainment of sexual maturity that, as we have already seen, occurs in this species.

Table 3.—*Showing the degree of infection present in adult examples aged one and two years.*

Degree of Infection.	Agamodistome Cysts in Gill-Filaments				Echinostome Cysts in Auricle.			
	1st year.		2nd year.		1st year.		2nd year.	
	♂	♀	♂	♀	♂	♀	♂	♀
Absent	8%	13%	...	...	46%	42%	50%	30%
Slight	8%	31%	50%	47%	8%	48%	25%	45%
Heavy	84%	56%	50%	53%	46%	10%	25%	25%

The occurrence of Echinostome cysts in the auricle is by no means restricted to *Vivipara bengalensis*, nor is it confined to any particular district or country. Filippi (1855, p. 345) has recorded the occurrence of similar Echinostome cysts in the auricle of *Vivipara vivipara*, and he has further noted "qu'il ne m'a jamais été possible de voir la moindre trace de ces parasites dans les foetus des Paludines; mais que les jeunes individus, pourvu qu'ils aient vécu quelques mois en liberté dans l'eau du lac en sont déjà enrahis." His results obtained in Europe agree, therefore, closely with the observations made in India. The occurrence of these cysts has also been noted by Moulinié (1886, p. 193).

As regards the geographical distribution in India, I have found these cysts present in examples of *V. bengalensis*, taken from five different areas of water in the Calcutta district. It is worth noting, however, that in examples of the phase *annandalei*, taken from a tank in Baliaghatta, this infection was absent in ten specimens that I examined: other examples from the same source were placed in experimental tanks, and when they were examined about 2 months later in every case cysts were present, so that infection had occurred during their sojourn in the experimental tanks. Extremely similar, if not absolutely identical cysts were found in identically the same situation, namely the auricle,

in two out of six examples of *Vivipara dissimilis* taken from swamps near Bombay, and in nine out of eighteen examples of this species taken from a small ditch at Rambha, Ganjam; but in these latter cases the cysts were degenerating.

Yet another trematode may find a temporary resting place in Indian species of Viviparidae. Examples of *Lecythoconcha lecythis* and *Vivipara oxytropis* brought from the Loktak Lake, and of an undescribed species allied to *V. oxytropis* from Dimapore, Assam, were infected with trematode cysts in the mantle. These cysts were oval in shape, and were situated beneath the external or shell surface just behind the thickened mantle margin. The cyst-wall was thick and gelatinous and appeared to open by a single aperture on the shell surface of the mantle. Contained within these cysts were small examples of a species of *Urogonimus* Mont. [=*Leucochloridium* Carus]. I am elsewhere publishing an account of this species (*vide* Sewell, "Cercariae Indicae," *Ind. Journal Med. Research*); suffice it to say here that these trematodes measure 2–3 mm. in length, are of a deep orange-red colour and have a prominent ventral sucker with a diameter twice that of the oral sucker. Filippi (1855, p. 353, footnote) has recorded finding free distomes, which possess all the above characters, in examples of *Vivipara vivipara* taken from the Lake of Varese, Italy. As regards their distribution in the mollusc host he remarks, "Ils n'ont pas de place fixe, et souvent je les ai vu sur le manteau de l'animal." It is of course impossible to be certain on the point, but it seems by no means unlikely that he was also dealing with an intermediate stage in the development of a species of *Leucochloridium* in the European *Vivipara*.

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EXPLANATION OF PLATE I.

Vivipara bengalensis (Lamarck), *forma typica.*

FIG. 1.—Normal shell from Rajmahal, Bengal.
Actual height 35 mm.

,, 2.—Shell of the elongate type from Calcutta.
Actual height 40 mm.

,, 3.—Shell of the gigantic type from Dinapur, Bihar.
Actual height 48·5 mm.

Vivipara bengalensis mandiensis, Kobelt.

FIG. 4.—Shells from type-series from Mandi State, Kangra valley. W. Himalayas.
Actual height 34·5 mm.

,, 10.—Shell of semi-albino phase from Lahore, Punjab.
Actual height 30 mm.

Vivipara bengalensis colairensis, subsp. nov.

FIG. 5.—Shell of type-specimen from pond at the edge of the Colair Lake, Ellore Dist., Madras Presidency.
Actual height 39 mm.

,, 6.—Shell of elongate type from the same series.
Actual height 48 mm.

Vivipara bengalensis nepalensis, Kobelt.

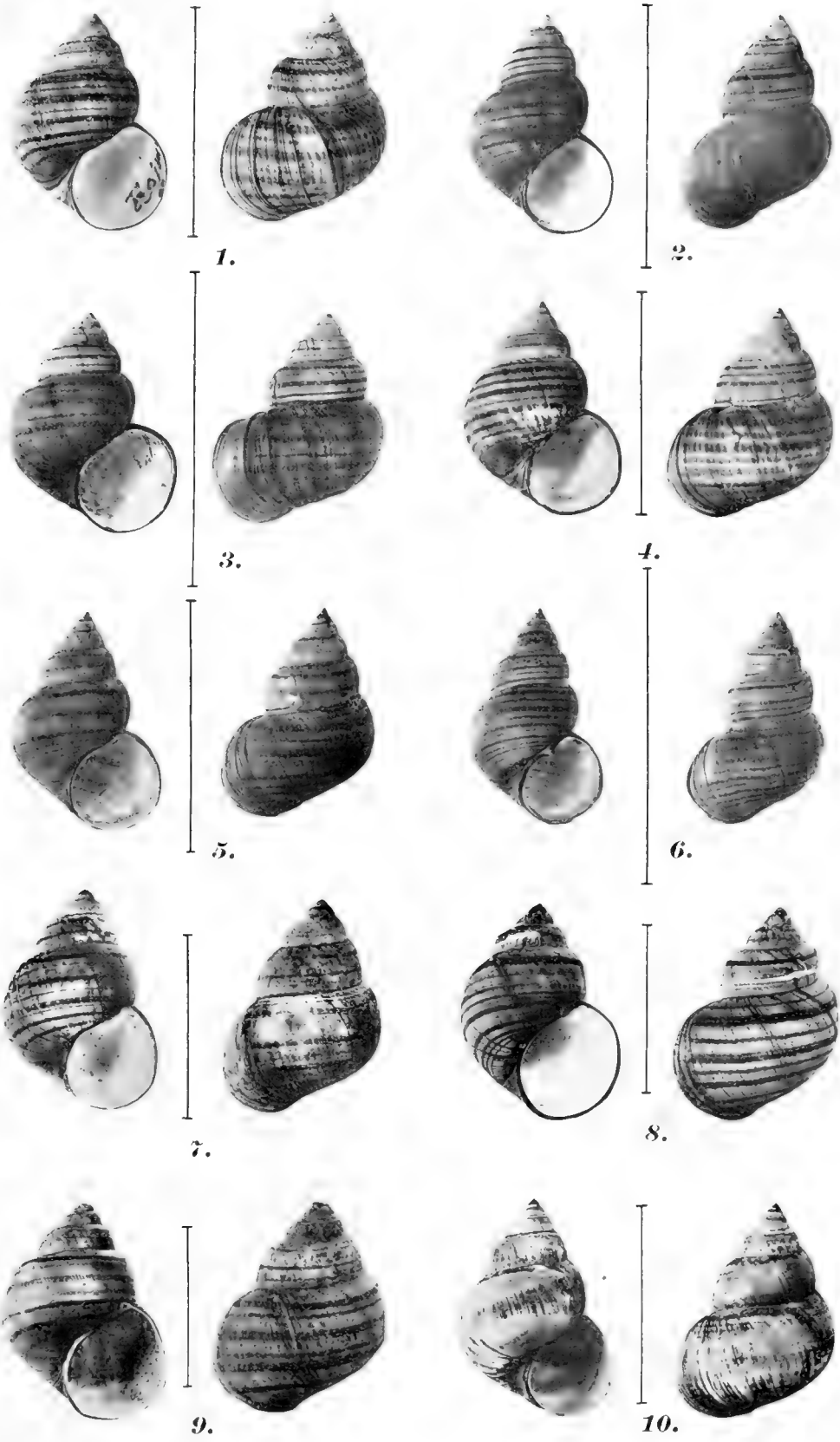
FIG. 7.—Shell from the type-series from Chonebal, Nepal.
Actual height 28·5 mm.

Vivipara bengalensis balteata (Benson).

FIG. 8.—Shell of the obese ("Normal") type from Fenchuganj, Sylhet, Assam.
Actual height 25·6 mm.

Vivipara bengalensis doliaris (Gould).

FIG. 9.—Shell of extreme type from Mandalay, U. Burma.
Actual height 24·5 mm.



S. C. Mondul, photo

Vivipara bengalensis (LAMARCK).

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

EXPLANATION OF PLATE II.

Vivipara bengalensis eburnea, subsp. nov.

FIG. 1.—Shell from type-series from Kotagiri reservoir, Nellore Dist., Madras Presidency.
Actual height 32·5 mm.

,, 2.—Shell of dark phase from a pond in Godavari (town), Madras Presidency.
Actual height 29 mm.

Vivipara bengalensis phase *incrassata*, nov.

FIG. 3.—Type-specimen from Thungabada, Kurnool Dist., Madras Presidency.
Actual height 22·5 mm.

,, 4.—Shell of the elongate type from the same series.
Actual height 30 mm.

Vivipara bengalensis phase *annandalei*, Kobelt.

FIG. 5.—Shell from type-series from Vizagapatam, N.E. Madras Presidency.
Actual height 26·5 mm.

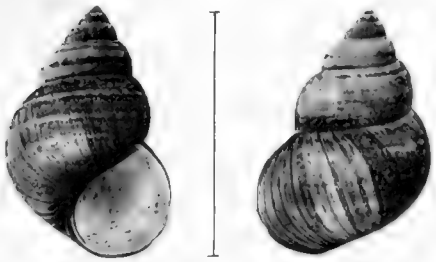
,, 6.—Shell from muddy pool, Secunderabad, Hyderabad.
Actual height 28 mm.

,, 7.—Shell from a dirty pond near the same place.
Actual height 24 mm.

,, 8.—Shell of the elongate type from a dirty pond at Belliaghata, Calcutta.
Actual height 22·5 mm.

Vivipara bengalensis phase *halophila*, Kobelt.

FIGS. 9, 10.—Shells from Calcutta (history unknown).
Actual heights 24 mm. (fig. 9) and 26 mm. (fig. 10).
(The reticulate pattern seen on fig. 10 is due to remains of the polyzoon *Hislopia lacustris*.)



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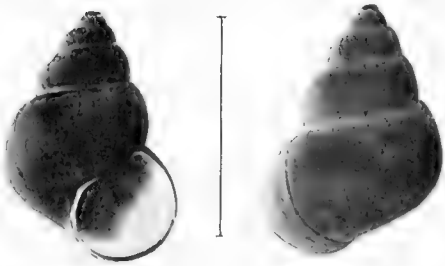

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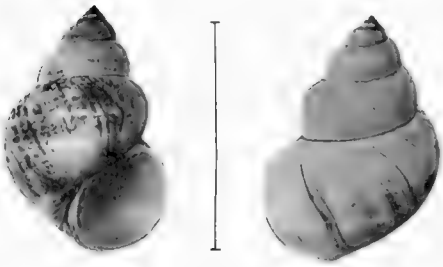

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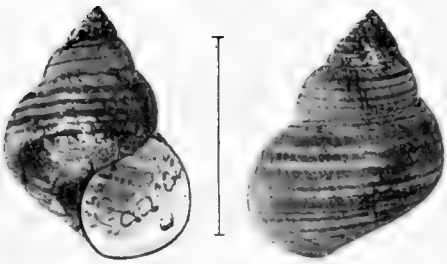

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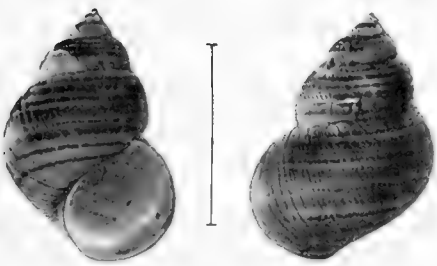

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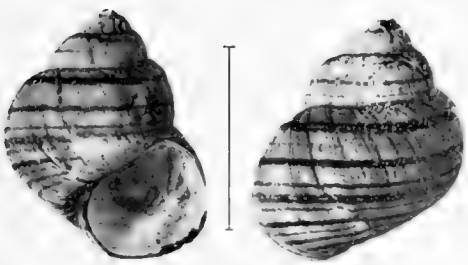

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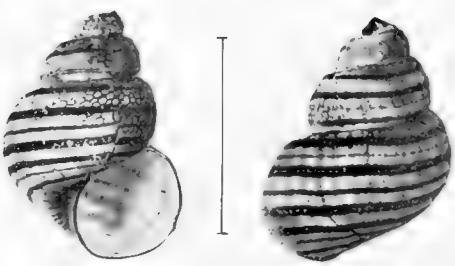


10.

D. Rawat, photo

Vivipara bengalensis (LAMARCK).

Photo-engraved & printed at the Offices of the Survey of India, Calcutta 1921

EXPLANATION OF PLATE III.

Shell-glands of the Viviparidae.

FIG. 1.—Vertical section through the roof of the lower part of the branchial chamber just above the mouth in *Lecythoconcha lecythis* (Benson) at birth, × 75. Stained with Delafield's haematoxylin.

,, 2.—Part of the same section (× 275), including two ducts of the calciferous gland.

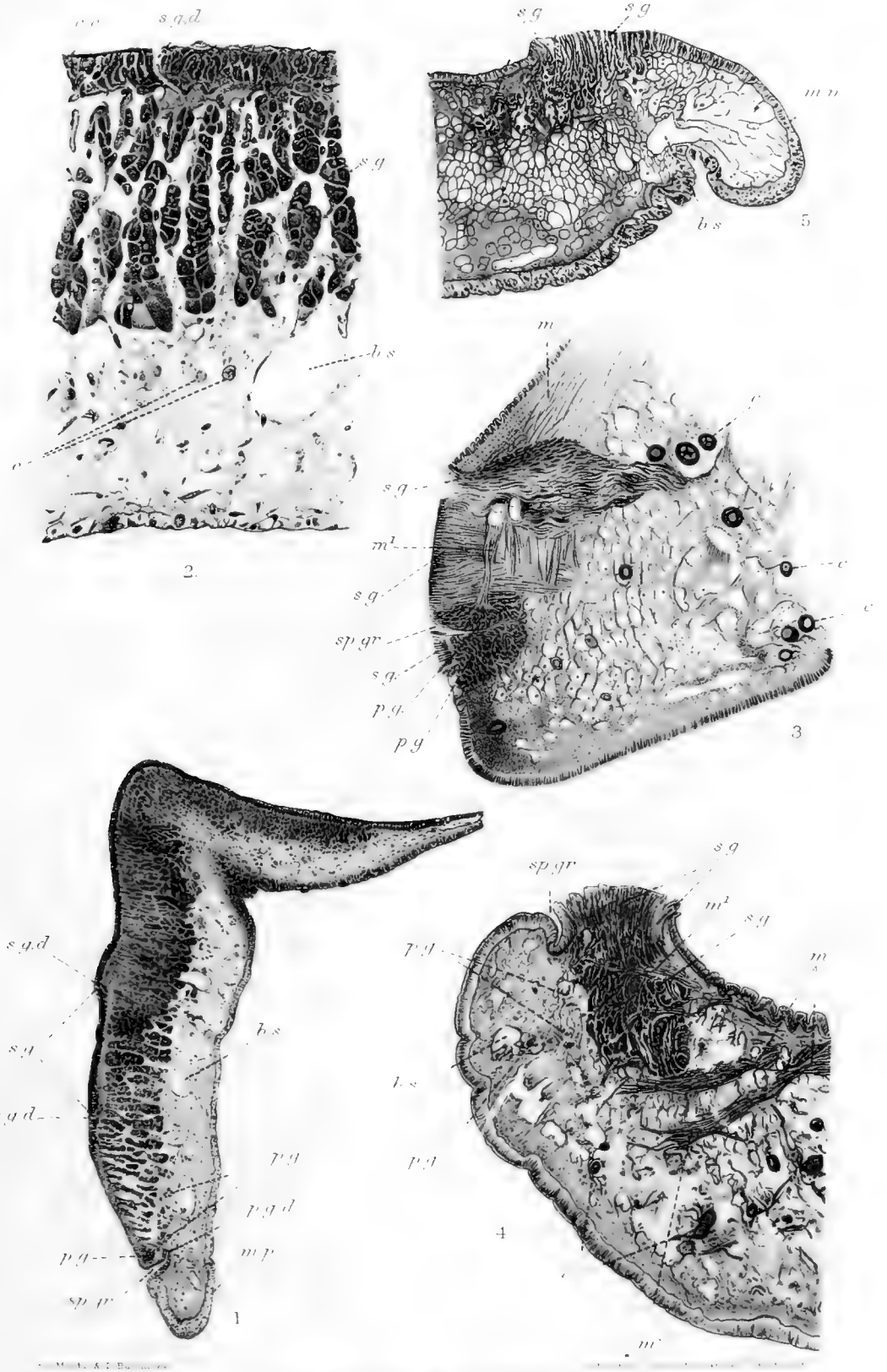
,, 3.—Vertical section through the free edge of the mantle in approximately the same region in an adult of the same species. The mantle was not much contracted and the animal was still growing. Stained with eosin and haematoxylin.

,, 4.—Vertical section of the mantle in the same region in another adult individual of the same species The whole animal was highly contracted and was evidently undergoing a period of arrested growth. The connective tissue of the mantle was markedly degenerate in places owing to the presence of encysted trematode parasites (*Urogonimus*). Stained with Delafield's haematoxylin.

,, 5.—Vertical section through the same region in the adult of *Vivipara oxytropis* (Benson) in a period of arrested growth. Stained with borax carmine.

EXPLANATION OF LETTERING.

b. s., blood-sinus; *c.*, calcareous concretion; *c.e.*, ciliated eipthelium; *m.*, external retractor muscle; *m′.*, sphincter of mantle; *m″.*, muscular network; *m. p.*, peripheral marginal process; *p. g.*, periostracal gland; *p. g. d.*, duct of periostracal gland; *s. g.*, calciferous gland; *s. g. d.*, temporary duct of calciferous gland; *s.p. gr.*, supramarginal groove.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XXI. THE GENUS *TEMNOTAIA* (VIVIPARIDAE).

By N. Annandale, *D.Sc., F.A.S.B., Director, Zoological Survey of India* (on leave).

The genus *Temnotaia* was proposed by myself in 1919 as a subgenus of *Taia*, mihi; but in the following year I gave reasons for considering it distinct. A reference to the collection in the British Museum enables me to throw further light on the genus. I have to thank Mr. G. C. Robson for giving me full facilities for examining the specimens and Mr. J. R. le B. Tomlin for supplying me with the reference to Mabille's description of the allied Indo-Chinese genus *Chlorostracia* and lending me a copy of the scarce work in which it is contained. The Burmese genus may now be more fully described and its relations to *Chlorostracia* discussed.

Temnotaia, Annandale.

1919. *Temnotaia*, Annandale, *Rec. Geol. Sur. Ind.* L, p. 231.
1920. *Temnotaia*, *id.*, *Rec. Ind. Mus.* XIX, p. 115.

The shell is typically Vivipariform in outline, but thick and porcellaneous. It is ovoid, acuminate and imperforate, with $5\frac{1}{2}$ to $7\frac{1}{2}$ whorls, which increase in size gradually and never have the suture deeply impressed. In all the species yet known the umbilicus is imperforate. The body-whorl is never greatly swollen and the aperture is of moderate size, ovoid and slightly oblique. The external surface is smooth and highly polished in fresh shells, with a very thin, closely adherent periostracum. The sculpture consists of incised lines or very fine linear ridges or else is microscopic. Interrupted broad ridges, nodules, scales and spines are entirely absent. The columellar callus is short and broad, convex and highly polished. Dark spiral bands are present or absent.

The operculum resembles that of *Vivipara* and is moderately thick. Nothing is known of the radula or soft parts

Temnotaia differs from *Chlorostracia* [1] mainly in its much more normal outline and in the structure of the operculum. The shell of the latter genus, of which a considerable number of species occur in Siam and French Indo-China, has a curiously *Natica*-like facies owing to its short spire, relatively large penultimate whorl, deep suture, perforate umbilicus, immense body-whorl and large aperture. Its operculum is characterized by the very large internal scar, which bears a curious crateriform process.

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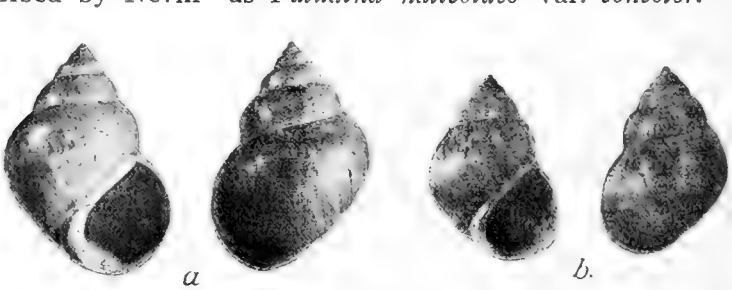
[1] Mabille, *Bull. Soc. Mal. France* VI, p. 309 (1889). The type-species is *C. bocourtei*, Mabille, the shell and operculum of which are figured in the same paper.

My own genus is only known from Upper Burma, Laos and Cambodia. I am now able to distinguish four species as follows:—

I. Shell decorated with well-defined incised spiral lines: $5\frac{1}{2}$ whorls ... ... *T. incisa.*
II. Shell without incised spiral lines, with more than 6 whorls.
A. Shell devoid of prominent linear ridges and not at all angulate ... ... *T. fulva.*
B. Body-whorl of shell bearing linear ridges or distinctly angulate.
i. Shell with more than one linear ridge: $7\frac{1}{2}$ whorls *T. concolor.*
ii. Shell with the body-whorl angulate: $6\frac{1}{2}$ whorls *T. bhamoensis.*

The first of these species is the type-species and is only known from the Chindwin watershed and in a subfossil condition. The second was described by Reeve[1] as *Paludina fulva* from Cambodia and also occurs in Laos. I have examined the type-series of three shells in the British Museum. *T. concolor* was originally described by Nevill[2] as *Paludina naticoides* var. *concolor.* The



TEXT-FIG. 1.—Photographs (nat. size) of
(*a*) *Temnotaia concolor* (Nevill).
(*b*) *Temnotaia bhamoensis* (Nevill).

type-specimens have apparently been lost, but I was[3] perhaps wrong in thinking that Nevill regarded them as identical with the *forma typica* of Theobald's *P. naticoides.* All he inferred was that the series in Calcutta was the type-series of his variety. In the small series in the British Museum there are two specimens from the Upper Salween, included under the name *Vivipara shanensis* (Theobald), which agree exactly with Nevill's brief description of the var. *concolor* except that the colour has faded to a greenish buff. The larger of them is here figured. There are $7\frac{1}{2}$ whorls. *T. bhamoensis* was also briefly described by Nevill,[4] as a variety of *V. dissimilis* (Müller). I have not the type-specimen before me, but have asked Dr. Baini Prashad to add a note upon it.

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[1] Reeve, *Conch. Icon.* XIV, pl. x, fig. 64 (1864).
[2] Nevill, *Hand List Moll. Ind. Mus.* II, p. 25 (1885). Since this was written Col. Godwin Austen has kindly shown me a series of specimens identified by Theobold as *Paludina naticoides.* Apparently he included *T. concolor* in that species as well as nearly smooth specimens of the true *Taia naticoides.*
[3] Annandale, *Rec. Ind. Mus.* XIV, p. 163 (1918).
[4] Nevill, *tom. cit.*, p. 29.

"Of *T. fulva* (Reeve) there is a single specimen in the Indian Museum received in exchange from the late Mr. Sowerby out of the type-series collected by Lombe Taylor in the Laos mountains. It is 23 mm. long and 17 mm. in maximum breadth. I give below a description of the only specimen of *T. bhamoensis* (Nevill); it is labelled as the type of the subvariety *bhamoensis* in Nevill's handwriting and was referred to by Dr. Annandale in his recent paper (*Rec. Ind. Mus.* XIX, p. 115).

The shell is thick, of moderate size and sharply conical; the spire of the unique specimen is greyish, but the body-whorl is of a uniform greyish-brown colour without spiral bands and with a highly polished periostracum. The suture is somewhat oblique and only moderately impressed; the whorls, which are swollen, are subangulate along their upper margin, and $6\frac{1}{2}$ in number. The spire is short and decreases rapidly but irregularly towards the apex; it is about $\frac{3}{4}$ the size of the body-whorl in dorsal view. The body-whorl is distinctly angulate and shows fine, but distinct, vertical and somewhat curved ridges corresponding to the regions of growth. The mouth of the shell is large, suboblique and prominent, somewhat ovoid in shape, with the outer lip sharp and not at all expanded outwards. The columellar callus is of the same type as in *T. incisa*, but is proportionately less broad; it is convex and highly polished.

The unique type measures 26 mm. in length and 17 mm. in breadth, the aperture measures 15 mm. × 13 mm. [*B. Prashad.*]"

XXII. NOTES ON STOMATOPODA.

By STANLEY KEMP, *Sc D., Officiating Director, and* B. CHOPRA, *M.Sc., Research Assistant, Zoological Survey of India.*

Since the memoir on Indo-pacific Stomatopoda was published in 1913[1] 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. oerstedi*, hitherto known only from the Atlantic, thus adding greatly to our knowledge of the geographical range of the species

Calman[2] 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 stylifera* (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. *spinosus* Bigelow, *G. excavatus* Miers, *G. furcicaudatus* (Miers), *G. glaber* (Lenz), *G. glabrous* Brooks, *G. glyptocercus* Wood-Mason, *G. graphurus* Miers, *G. herdmani* Tattersall, *G. nefandus* Kemp, *G. oerstedi* Hansen, *G. proximus* Kemp, *G. pulchellus* Miers and *G. spinosissimus* Pfeffer.

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

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

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

On the first three thoracic limbs in :—

S. dubia, Milne-Edwards.

And on the first two thoracic limbs only in :—

† *S. gibba*, Nobili.
S. supplex, Wood-Mason.
† *S. scorpio*, Latreille.
† ,, var. *immaculata*, 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.

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*, Bouvier [1] 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. Tomo, 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 Neerland.* 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.

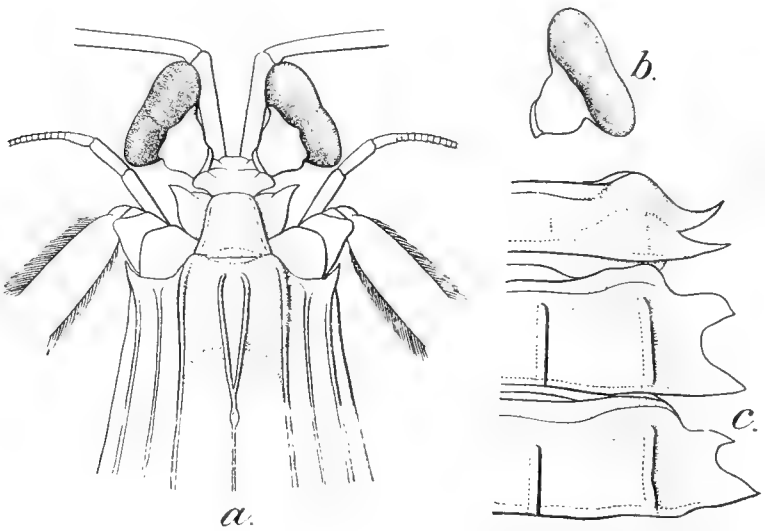
1913. *Squilla stridulans*, Kemp, *loc. cit.*, IV, p. 78 (in part).

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.

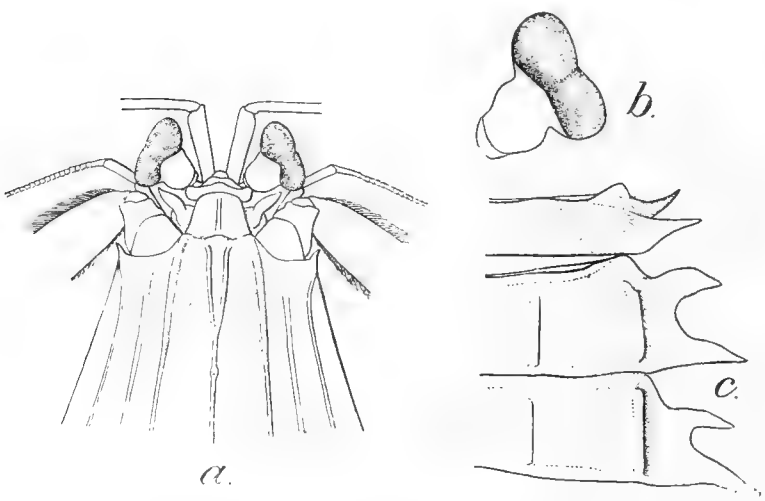
The principal characters in which the two species differ are the following :—

S. stridulans, Wood-Mason.	*S. mikado*, sp. nov.
Undivided portion of mid-dorsal carina of carapace, anterior to dorsal pit, less than one-third as long as bifurcated portion (text-fig. 1*a*).	Undivided portion of mid-dorsal carina of carapace, anterior to dorsal pit about half as long as bifurcated portion (text-fig. 2*a*).
Rostrum with an obscure mid-dorsal tubercle (text-fig 1*a*).	Rostrum with a well defined median carina (text-fig. 2*a*).
Cornea much dilated and set very obliquely on eyestalk (text-fig. 1*b*).	Cornea less dilated and set much less obliquely on eyestalk (text-fig. 2*b*).
Lateral processes of sixth and seventh thoracic somites shorter and broader (text-fig. 1*c*).	Lateral processes of sixth and seventh thoracic somites longer and more slender (text-fig. 2*c*).
Surface of abdominal somites finely rugose.	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 coll.). 1 ♂, 122 mm.

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.

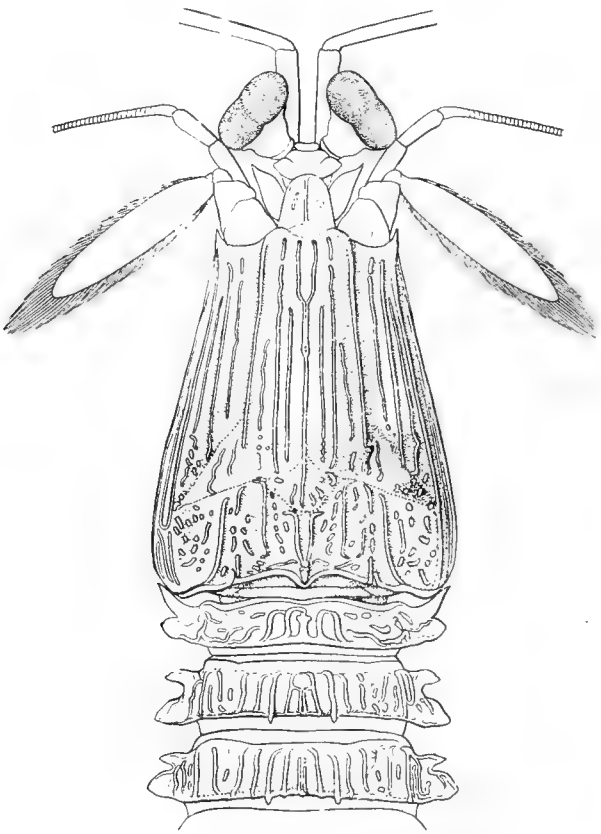
C 332/1. 4 miles N.N.E. of Kabusa Is., Mergui Archipelago. 'Investigator.' 1 ♀, 35 mm.

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:—

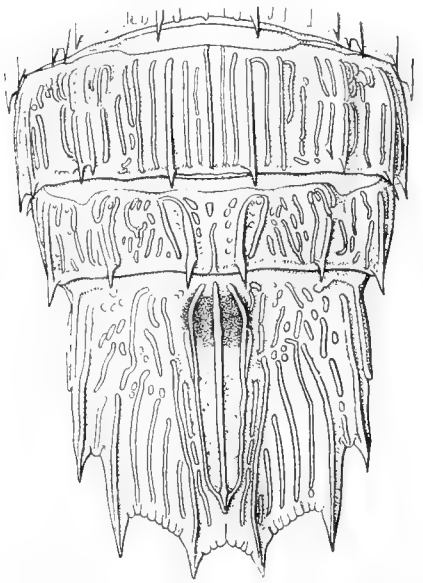
Carinae.	*Abdominal somites.*
Submedian ..	.. 1, 2, 3, 4, 5, 6.
Intermediate ..	.. 1, 2, 3, 4, 5, 6.
Lateral ..	.. 1, 2, 3, 4, 5, 6.
Marginal ..	.. 1, 2, 3, 4, 5.

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 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.



Text-fig. 4.—*Squilla lirata*, sp. nov. Last two abdominal somites and telson.

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. 80, 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.).	*O. cultrifer* (White).
Rostrum broadly cordiform; apex pointed and lateral margins strongly convex.	Rostrum quadrangular with convergent sides; apex broadly rounded and lateral margins slightly concave.
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]	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 about 3 times as long as wide.	Second segment of antennular peduncle scarcely 1½ times as long as wide.
Dactylus of raptorial claw strongly inflated at base.	Dactylus of raptorial claw slightly inflated at base.
A carina present on last abdominal somite between submedians and intermediates.	No carina 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.	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 nearly twice as long as ultimate segment, with 11 or 12 movable spines on outer edge.	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 oerstedi, 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. Zeeproduct. 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. Diguet 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. oerstedi* 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. oerstedi* 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 Miers [1] from Panama and of Nobili [2] 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. oerstedi* 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 oerstedi 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. oerstedi* 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. 108–111.
1921. *Gonodactylus demani*, Tattersall, *Journ. 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.

Contents of Part I.

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 Austen [1] has already published notes on the land molluscs and Lt.-Col J. Stephenson [2] on the Oligochaete worms, while the late Mr. C. A. Paiva [3] 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 mungooses (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-fauna[1]) 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 *Acanthoclisis 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 (*Ennallagma 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 *Kalotermes* has been found in this situation. A *Capritermes* 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 heimii*, 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 purpura*). On the evenings of October 7th to 12th, 1920, the "Green-Fly" (*Nephottetix 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. neriifolia*) 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. Wooly Coccidae are by no means scarce on the young shoots of *Taphrosia purpura* 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 Bombylidae (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 instalment 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. Gravely[2] 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 *Fasc. 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. Chilton [1] 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 to 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 Polyzoon, 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 waterworks 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.

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[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 ignominous 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 *Neptunus 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 *Neptunus* 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 ichythaetus, 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 disused 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 cyanophlyctis*, 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 Khasi 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*.

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[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 subtropical 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 Panagéides, *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 striole 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. chinnada*.

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

Bombay: Satara, Medha 1 ex., Ratnagiri, Pimpli, 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 *Hypolimnas 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 imagine 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 *Danais 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" *Danais 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.						
Danais chrysippus	15♂5♀	....	2♂, 1♀	1♀	13♂, 3♀	....
Euploea core ..	1♂, 10♀	1♀	....	....	1♂, 9♀	....
Hypolimnas bolina	6♂, 8♀	1♂, 1♀	1♂, 2♀	1♀	4♂, 4♀	The females seem to be more attacked than the male in spite of the "mimicry."
Junonia lemonias	8♂, 4♀	....	2♂	....	6♂, 4♀	....
Telchinia violae .	12♂, 4♀	....	....	....	12♂, 4♀	....
PAPILIONIDAE.						
Papilio hector ..	3♂, 1♀	....	2♀	....	1♂, 1♀	One of the perfect specimens was bred from the larva.
Papilio aristolochiae ..	3♂, 4♀	2♀	....	....	3♂, 2♀	....
Papilio demoleus	4♂, 3♀	....	1♀	....	4♂, 2♀	This butterfly is very common at certain seasons, but damaged specimens have seldom been observed.
Papilio polytes romulus, ♂ ..	33	1	1	1	30	The males seem to possess the greatest protection.
Papilio polytes romulus, ♀ f. cyrus, ..	2	....	....	....	■	....
Papilio polytes romulus ♀ 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.
Papilio polytes romulus, ♀ f. romulus, ..	11	1	....	....	10	Appears to be better protected than the preceeding ♀ form.
PIERIDAE.						
Leptosia xiphia ..	8♂, 2♀	....	....	....	8♂, 2♀	....
Ixias pyrene pirenassa ..	7♂, 4♀	1♂	2♂	....	4♂, 4♀	....
Pareronia valeria hippia ..	12♂	....	2	....	10	....
Colotis calais amatus ..	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 *Hypolimnas 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*, *Danais 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*, *Danais 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. Agricul. 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.

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[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
Ashamboo Hills, 6 to 40 miles N.W. of Cape Comorin.	Pusa,[1] p. 904 ..	The *romulus* ♀ apparently nearly twice as common as the *polytes* ♀, and *cyrus* ♀ extremely rare.
Bangalore district .	J.B.N.H.S. XXI, p. 699, Ent. Month Mag. 1920, p. 201.	The *polytes* ♀ the prevailing form.
Benares...	J.B.N.H.S. XXVI, p. 690.	The *cyrus* ♀ and the *polytes* female not uncommon. Only one damaged *romulus* ♀ taken.
Burma		Col. Evans informs us that the *romulus* ♀ does not occur in Burma.
Dehra Dun ...	...	The *romulus* ♀ not common. The *cyrus* ♀ is not as common as the *polytes* ♀.
Hong Kong and Macao districts.	Pusa, p. 905 ...	The male-like ♀ commonest, *polytes* ♀ rare, *romulus* ♀ unknown.
Johore, Malay Peninsula.	Pusa, p. 905	The *polytes* ♀ apparently nearly twice as common as *cyrus*. Dr. Seitz only remembers the *polytes* ♀ in this locality.
North Kanara ...	P.E.S. 1914, p. 99 ...	The *cyrus* ♀ exceedingly rare, *polytes* and *romulus* ♀ ♀ about equally common, the latter perhaps slightly the commoner.
The Konkan ...	J.B.N.H.S. XV, p. 52.	The commonest female is *polytes*, *romulus* ♀ is not rare, and *cyrus* entirely (?) absent.
Kumaon ...	J.B.N.H.S. XX, p. 361.	The *romulus* ♀ seems to occur only in the Terai; *cyrus* ♀ never seen.
Lucknow district ...	J.B.N.H.S. XIV, p. 492.	The *cyrus* ♀ absent, *polytes* ♀ common, and *romulus* ♀ rare. "Its (*romulus* ♀) 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 *cyrus* ♀ absent, *polytes* and *romulus* ♀ ♀ about equally common.
Singapore Island ...	Pusa, p. 905.	The *polytes* ♀ commoner than *cyrus* ♀.
Tavoy district ...	J.B.N.H.S. XXVII, p. 805.	Only two forms of ♀ have been taken; the *cyrus* and *stichius*.
Tharawaddy and the Pegu Yoma.	J.B.N.H.S. XXV, p. 111.	The *aristolochiae* like ♀ (*polytes*) 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.

Danais limniace, Cram.
Danais plexippus, Linn.
Danais 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 pyrene 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.

Family Lycaenidae.

Neopithecops zalmora, But.
Chilades laius, Cram.
Zizera lysimon karsandra, Moore
Catachrysops strabo, Fab.
Catachrysops cnejus, Fab.
Azanus ubaldus, Cram.
Castalius rosimon, Fab.
Lampides bochus, 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 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, 1-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, 11 and 24-viii-19; 11 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; 1–29-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. 118*b*.

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. 11, sect. 11, p. 34, pl. 15*a*.

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).

1907. *Papilio aristolochiae*, Bing., *tom. cit.*, p. 20, text-figs. 3*a* and 3*c*.
1909. *Papilio aristolochiae*, Jordan, *tom. cit.*, p. 38, pl. 16*a*.

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 ⅔ 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. 3*a* and 32*a*.

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. 26*a*.

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. 33*a* and 33*b*.
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 synonomy 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. 62*f*.

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 n April, 1920.

Anaphaeis mesentina, Cram. (975).

1907. *Anaphaeis mesentina*, Bing., *tom. cit.*, p. 155, text.-fig. 30.
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. 58*a*.

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. 72*a*.

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. 69*b*.

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 60*b*; pl. xvi, fig. 106.
1910. *Terias hecabe*, Fruh., *tom. cit.*, p. 166–167, pl. 73*f*.

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. 65*a* and 65*b*.
1910. *Terias blanda silhetana*, Fruh., *tom. cit.*, p. 169, pl. 73*c*.

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. 66*a* and 66*b*.

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, ♂, 2*a*, ♀, 2*b*, ♂ (*wet-seas. brood*); 2*c*, ♂, 2*d*, ♀ (*dry-seas. brood*); 2*e*, ♂ (*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, ♂, 3*a*, ♀, 3*b*, ♀ (*wet-seas. brood*); 3*c*, ♂, 3*d*, ♀, 3*e*, ♂, 3*f*, ♀ (*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, ♂, 3*a*, ♀, 3*b*, ♂ (*wet-seas. brood*); 3*c*, ♂, 3*d*, ♀ (*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, ♂, 3*a*, ♀, 2*b*, ♀ (*wet-seas. brood*); 3*c*, ♂, 3*d*, ♀ (*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, 2*a*, ♀, 2*b*, ♂ (*wet-seas. brood*); 2*c*, ♂ 2*d*, ♀ (*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, 2*a*, ♀, 2*b*, ♂.

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, 230, pl. 630, figs. 1, ♂, 1*a*, ♀, 1*b*, ♂ (*wet-seas. brood*); 1*c*, ♂, 1*d*, ♀ (*dry-seas. brood*) 1*f*, ♂, 1*g*, ♀ (*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, ♂, 3*a*, ♀, 3*b*, ♀.

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, ♂, 1*a*, ♀, 1*b*, ♂ (*wet-seas. brood*); 1*c*, ♂, 1*d*, ♀, 1*e*, ♂ (*dry-seas. brood*); 1*f*, *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, ♂, 2*a*, ♀, 2*b*, ♂.

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. 93*a* and 93*b*.
1910–11. *Curetis thetys*, Swin., *tom. cit.*, p. 239, pl. 698, figs. 1, ♂, 1*a*, ♀, 1*b*, ♂, 1*c*, *larva and pupa* (nat. size), 1*d*, *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 (*Gravely*); 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. ♂, 2*a*, ♀, 2*b*, ♂ (*bulis* form); 3, ♂, 3*a*, ♀, 3*b*, ♂ (*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 (*Gravely*).

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*) 3e, *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. *Caltoris 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.

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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 (*Gravely*); 14-viii-20 (*Dover*). A common Indian species not rare on Barkuda.

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

Lymantria rhodina Wlk. 4 ex., 3–19-viii-19 (*Gravely*); 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 (*Gravely*). A widely distributed species rather rare on the island.

Hyblaea puera Cram. 10 ex., 15–22-vii-16 (*Annandale and Gravely*); 3–19-viii-19 (*Gravely*); 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 alcuca Gueu. 1 ex., 3–19-viii-19 (*Gravely*). 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 (*Gravely*); 29-iv-20 (*Dover*). Not an uncommon moth during the rains.

Ophiusa dotata 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 (*Gravely*); 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 (*Gravely*); 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 (*Gravely*). 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 (*Gravely*); 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 (*Gravely*).

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

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

Phycodes minor Moore. 1 ex., 3–19-viii-19 (*Gravely*). 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.
Family Mutillidae.
Mutilla ruficrus Rad. M.S.
Mutilla nr. *pondicherensis* Rad. and Sich.
Mutilla sexmaculata Swed.
Mutilla nr. *sexmaculata* Swed.
Mutilla indostana Smith.
Mutilla sp.
Family Scoliidae.
Elis thoracica (Fab.)
Family Pompilidae.
Macromeris violaceae Lepel.
Salius perplexus (Smith).
Salius madraspatanum (Smith).
Pompilus analis (Fab.).
Pompilus rothneyi Cam.
Family Sphegidae.
Tachytes modesta Smith.
Ammophila atripes Smith.
Ammophila laevigata Smith.
Sceliphron madraspatanum (Fab.).
Sceliphron violaceum (Fab.)
Sphex luteipennis Mocs.
Sphex aurulentus (Fab.).
Ampulex compressa (Fab.).
Stizus vespiformis (Fab.).
Cerceris vigilans Smith.
Cerceris sp.

Tribe Diploptera.
Family Eumenidae.
Eumenes brevirostrata Sauss.
Eumenes petiolata (Fab.).
Eumenes esuriens (Fab.).
Eumenes conica (Fab.).
Rhynchium brunneum (Fab.).
Odynerus punctum (Fab.).
Family Vespidae.
Polistes stigma (Fab.).
Vespa cincta Fab.
Tribe Anthophila.
Family Apidae.
Nomia westwoodi Grib.
Nomia oxybeloides Smith.
Steganomus nodicornis Smith.
Megachile disjuncta (Fab.).
Megachile lanata (Fab.).
Megachile coeliox sides Bing.
Ceratina viridissima Guer.
Coelioxys fuscipennis Smith.
Coelioxys capitatus Smith.
Xylocopa tenuiscapa Westw.
Xylocopa fenestrata (Fab.).
Xylocopa nr. *fenestrata* (Fab.).
Xylocopa aestuans (Linn.).
Xylocopa rufescens Smith.
Tribe Tubulifera.
Family Chrysididae.
Stilbum cyanorum var. *splendidum* (Fab.)
Chrysis lusca Fab.

Tribe FOSSORES.

Family Mutillidae.

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

Barkuda, 2 ex., 15–22-xii-16 (*Gravely*); 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 (*Gravely*).

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. Gravely (*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 (*Chilka 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 *Gravely*).

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 (*Gravely*).

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 (*Gravely*).

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.

Salius 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.

Salius 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 (*Gravely*); 25-vii–4-viii-17 (*Annandale*); 3–19-v-19 (*Gravely*); 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 (*Gravely*); 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 (*Gravely*).

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 (*Gravely*); 3–19-viii-19 (*Gravely*).

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 (*Gravely*); 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 (*Gravely*); 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 *Gravely*). A rather widely distributed species not common on the island.

Family VESPIDAE.

Polistes stigma (Fab.), p. 396.

Barkuda, 16 ex., 15–22-vii-16 (*Gravely*); 16–20-ix-19 (*Brunetti*); 25-vii–4-viii-17 (*Annandale*); 3–19-vii-19 (*Gravely*); 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 (*Gravely*); 3–19-viii-19 (*Gravely*); 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 (*Gravely*); 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., *Journ. 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 Bangaloie, 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* Sich. 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 aufgelost 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 (*Gravely*); 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 (*Gravely*); 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, *Annandale*), and of a new genus of Pachygastrinae.

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[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.

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[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 Sarcophagidae.

Two or three species of *Sarcophaga*, not represented in the collection of the Indian Museum, are not uncommon on Barkuda.

Family Muscidae.

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 *Idiellopsis similis* Towns. (3-19-viii-19), a recently described species, was taken by Dr. Gravely on Barkuda.

Family Hippoboscidae.

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 *Acanthoclisis* 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* Needham[1]. 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.

Acanthoclisis horridus Wlk.

Barkuda, 2 examples, 13–19-ix-19 (*Gravely*).

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*).

Acanthoclisis edax Wlk.

Barkuda, 1 example, viii-19 (*Gravely*).

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[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, *Journ. 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. 1*a*). 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. 1*e*) 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. 1*c*) 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. 1*e*). 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 10½ mm. long by 8½ 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*f*; 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 6⅓ 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. 1*f*) 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 arthrapophysis, Gravely.

Pl. xviii, fig. 12.

Sasonichus arthrapophysis, 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. 49–50*b*) 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. 2*e*.

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.

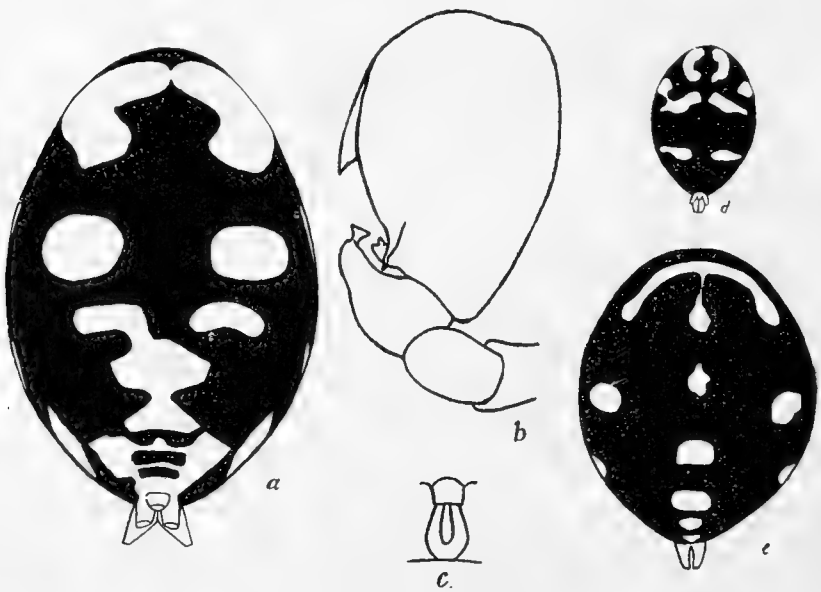
The cephalothorax is blackish brown, with a white margin ventrally. The sternum and labium are brown. The appendages and spinnerettes are pale yellowish, except the tarsus of the palp which is brown. The abdomen (text-fig. 2 *e*) is black with five whitish longitudinal lines or rows of spots. The mid-dorsal 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 ventro-lateral 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. 2*a*) 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. 2*c*.

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. 2*b*. 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. 2*d*.

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 2½ 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).

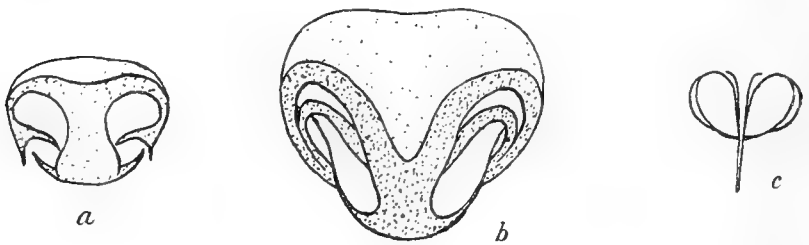
Argyroepeira celebesiana, Pocock, 1900, p. 216.[1]

A few specimens which probably belonged to this species were once seen on their horizontal webs among bushes.

Leucauge fastigata (Simon).

Argyroepeira 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. 3*a*, *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. 3*a*, *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 (1915*b*, 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.
Cycosa 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. rumphi* 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. 3*c*.

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 7½ 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. 3*c*.

♂. 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

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 Thomisidae.

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 Clubionidae.

Sparassus lamarcki, Latreille.

Sparassus lamarcki, Pocock, 1900, p. 267.

A large spider of a somewhat rich brown colour, with densely scopulate tarsi and metatasi. 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-existant. 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 Lycosidae.

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 spiney 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.

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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.

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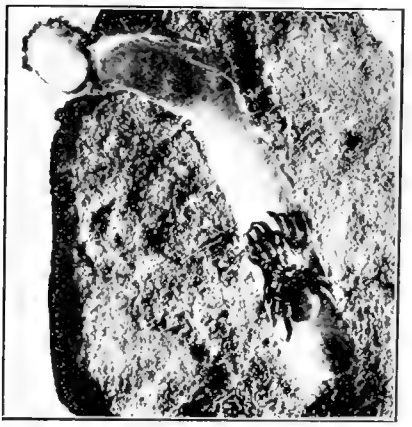

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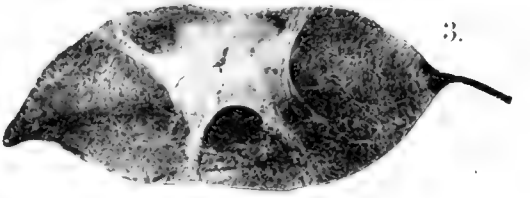


3.

5.

6.

S. C. Mondul and D. Bacchi, photo.

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. ,, ,, ,, ,, ,, *Nemesiellus* sp.

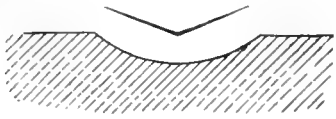
,, 9. ,, ,, ,, ,, ,, *Acanthodon barkudensis*.[1]

,, 10. ,, ,, ,, ,, ,, *Sason* sp. from Ceylon.

,, 11. ,, ,, ,, ,, ,, *Diplothele walshi*.

,, 12. ,, ,, ,, ,, ,, *Sasonichus arthrapophysis*.

[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.



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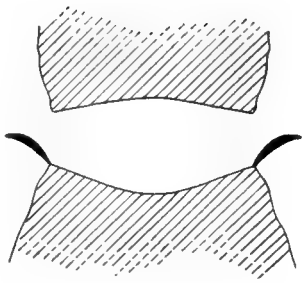

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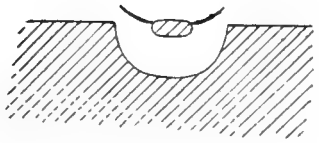

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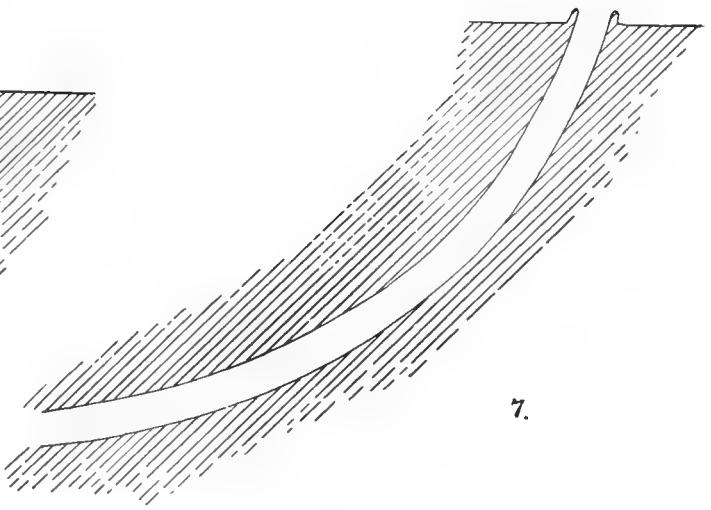

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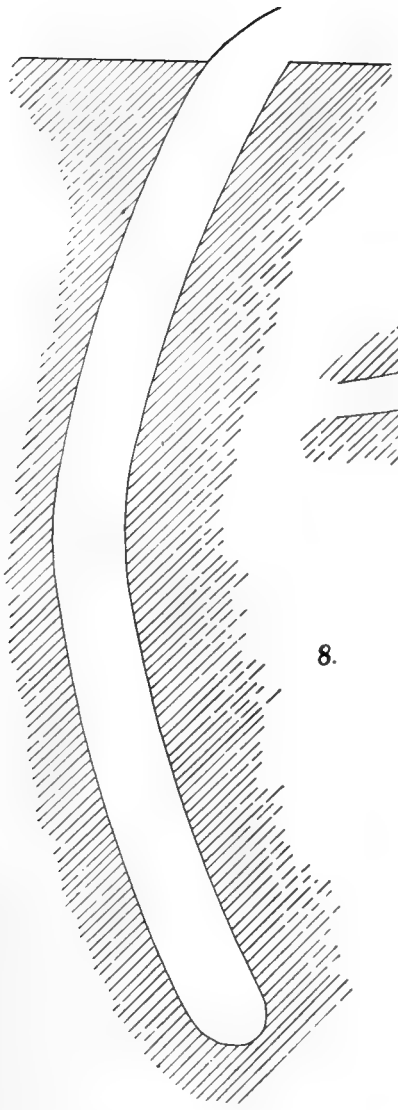

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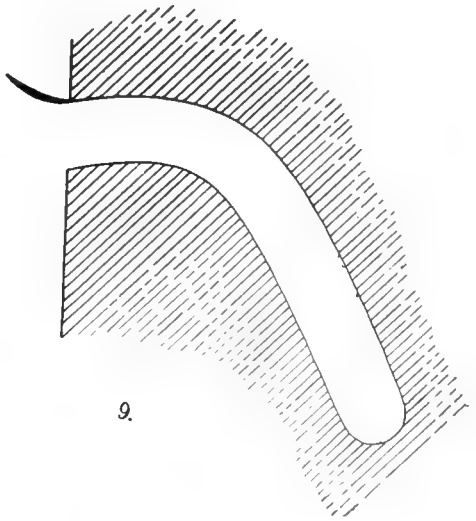


9.

D. Bagchi del.

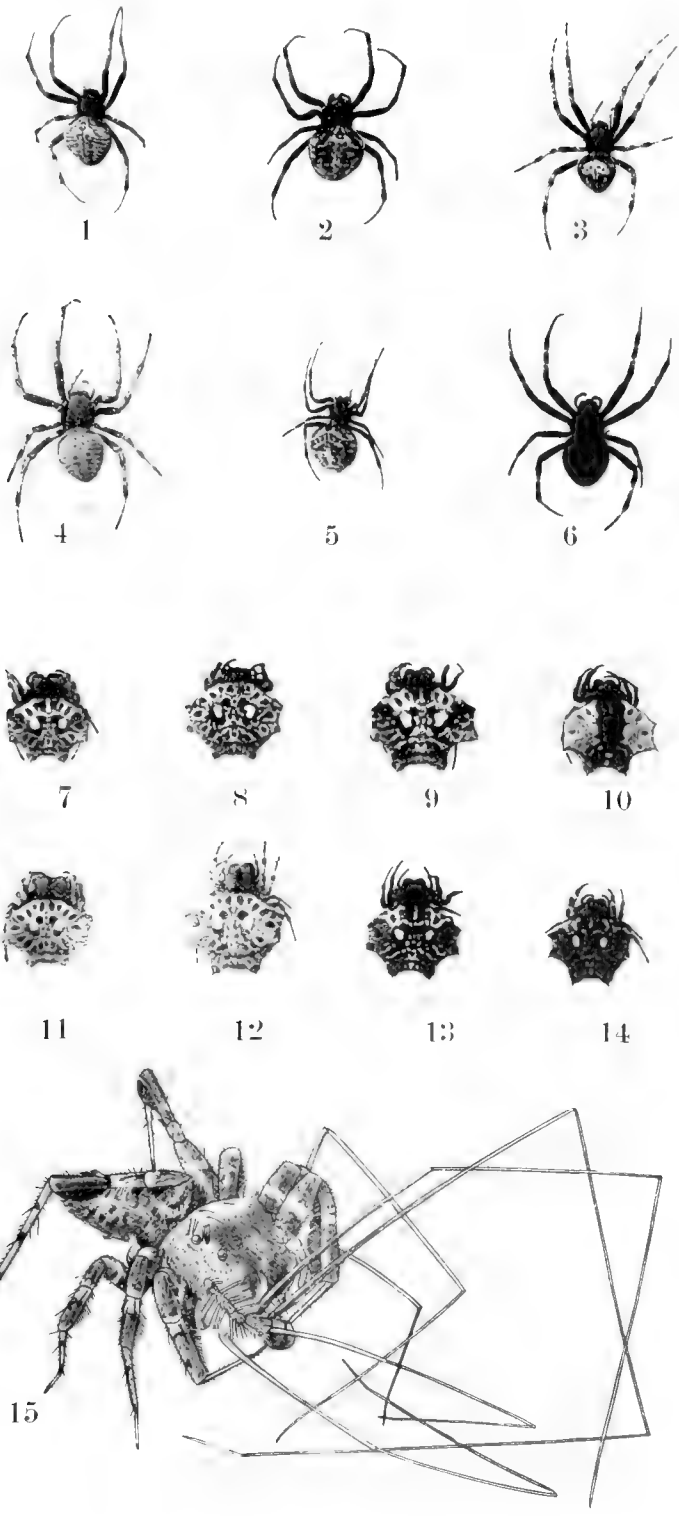
Burrows of Spiders on Barkuda I.

EXPLANATION OF PLATE XIX

FIGS. 1–6.—Colour variation in *Araneus 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* (=*Argyroepeira*). 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 *Atclidea*, *Atimiosa*, *Dolichognatha*, *Dyschiriognatha*, *Eucta*, *Meta*, *Mitoscelis*, *Orsinome*, *Pachygnatta*, *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. 265*a-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, Gravely, 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 hasselti*, 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. 3-3*b*.

From the neighbourhood of Calcutta. Relatively short spiders having the general build of *T. hasseltii* and *T. mackenzici*. 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, Gravely, 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

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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. 1–1*b*.

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. 2–2*c*.
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. 1*a*)	*T. gracilis*, p. 436.
	Ocular quadrangle little or no narrower in front than behind	2.
2	Lateral eyes somewhat more widely separated than medians (fig 1*g*,) [1]	3.
	Lateral eyes not more widely separated than medians, usually more or less closely approximate or contiguous (fig. 1*d*) ...	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. 1*g*)	*T. mackenziei*, p. 438.
	Abdomen slender, parallel-sided; anterior and posterior rows of eyes strongly recurved, anterior laterals small	*T. moulmeinensis*, p. 439.
	Females	5.
	Males	11.
5	Fang with a more or less distinct tooth situated ventrally on outer side of basal bend (figs. 2*a*, *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. 3*a*)	*T. Fletcheri*, p. 440.
	Fang armed on inner side with a strong tooth about a third of the way from base to tip (fig. 3*b*) or first ventral tooth (or teeth) very large (figs. 3*c-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	*T. geniculata*, p. 441.
	First ventral tooth very large, directed forwards below fang which is slightly geniculate with fully developed teeth ...	*T. mandibulata*, p. 441.
8	Fang much swollen towards the middle, where it is armed dorsally with a stout and more or less rectangular tooth (fig. 4*a*); abdomen very slender	*T. cochinensis*, 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. 4*c*) ...	*T. listeri*, 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. 5*a*)	*T. sutherlandi*, p. 444.
	Chelicerae very long and slender; first tooth of both dorsal and ventral rows much larger than second (fig. 6*a*) ...	*T. viridorufa*, 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. 3*e*)	*T. geniculata*, p. 441. *T. mandibulata*, p. 441.
	First dorsal tooth not the largest; or a strong tooth on inner side of basal curve of fang	12.
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. 4*b* 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. 5*b* and 6*b*)	14.
13	First dorsal tooth much smaller than second; subapical spine very slender distally, truncate at apex (fig. 4*b*)	*T. cochinensis*, p. 442.
	First dorsal tooth about equal in size to second, subapical spine broader distally, more or less bifid at apex (fig. 4*d*) ...	*T. listeri*, p. 443.
14	Subapical spine short and stout; first dorsal tooth acuminate, slightly smaller than second ventral (fig. 5*b*)	*T. sutherlandi*, p. 444.
	Subapical spine long and slender, first dorsal tooth almost equally long, but stouter; second ventral tooth small (fig. 6*b*) ...	*T. viridorufa*, p. 445.

Tetragnatha gracilis (Stoliczka)

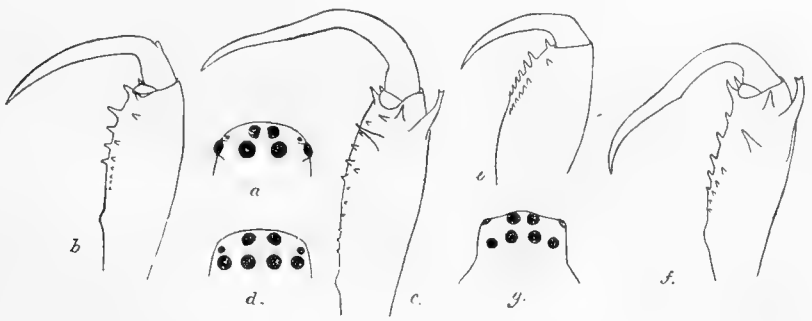
Figs. 1*a–c*.

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. 1*e–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 Inlè Lake, Fort Stedman, Yawnghwe 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. pucilla*, 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. 1g 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.

Text-fig. 2.

Tetragnatha moulmeinensis ♀, chelicera from above.

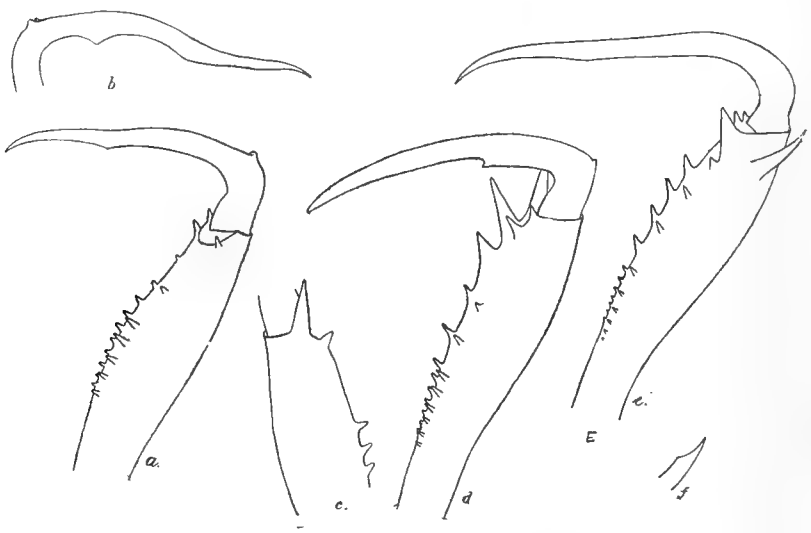
The chelicerae are about as long as the carapace, with a minute denticle on a low obtuse swelling on the outer side below. The first dorsal tooth is slightly smaller than the first ventral; both these teeth are situated at the base of the fang and are followed after an interval, which is longer in the 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.

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. 3*a*.

Locality,—Shillong. Four females collected by Mr. T. Bainbrigge 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*, *c*.

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, Birbhum 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. 3*c*, *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.

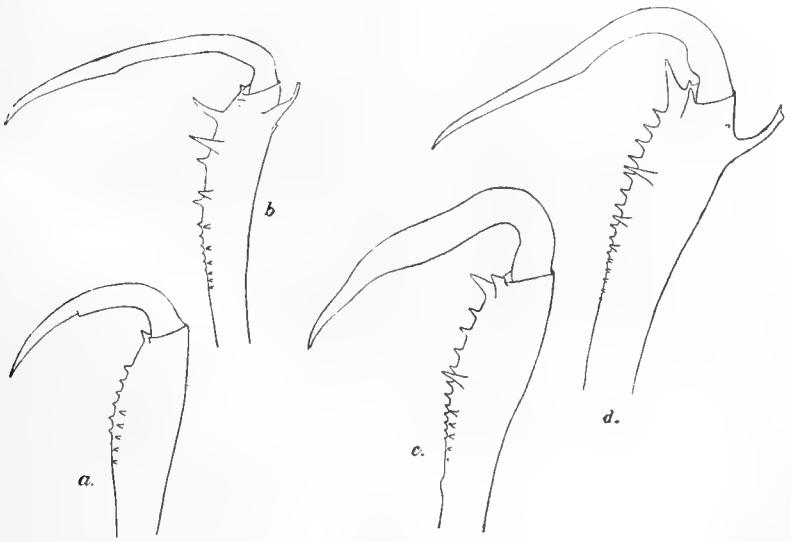
Figs. 4*a*, *b*.

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.—*Tetragnatha cochinensis* ♀, chelicera from above.
b.— ,, ,, ♂, ,, ,, ,,
c.—*Tetragnatha listeri* ♀, ,, ,, ,,
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.

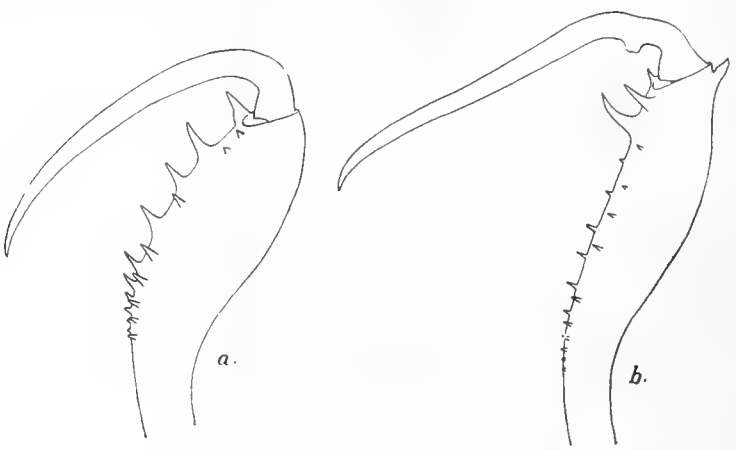
Figs. 4*c*, *d*.

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.

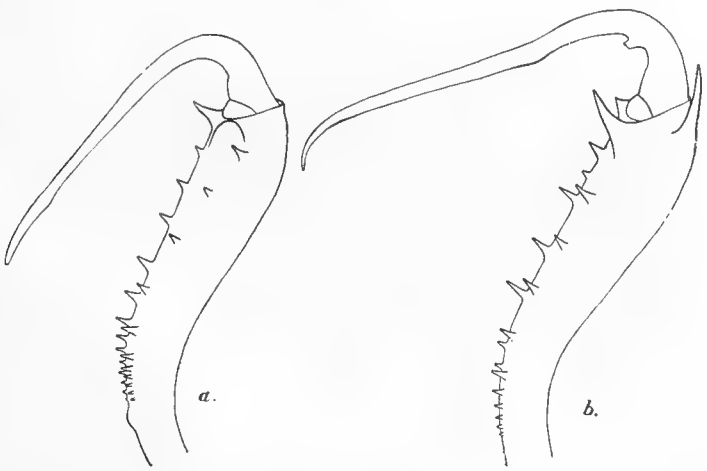
Figs. 5*a*, *b*.

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, Gravely.

Fig. 6*a*, *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. 4–4*b*), 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, Yawnghwe 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. 7*a*, *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. 7*a*. 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 Shillong.

Orsinome listeri, sp. nov.

Fig. 7*c*.

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. 7*c*). 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. *Argyroepeira*, 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).

Argyroepeira 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), 1890*a*, 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 Mahè.

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. emertoni (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. 39, 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), 1890*a*, 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), 1890*a*, 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), 1901*b*, 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 infuscate; abdomen in spirit (said to be greenish in life) brownish, finely specked with silver; anterior median eyes unusually prominent, especially in the male; palpal organ of male dark brown ... ... *L. ventralis* 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.
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. 8*a*) ... *L. culta* p. 453.
Black (or grey) markings linear and more extensive (fig. 8*b*) ... ... 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. 8*b*, *c*); male with relatively short palps and globular palpal organs with only the inner tarsal apophysis present ... *L. celebesiana* p. 454.
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. 8*d-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. 8*d*); abdomen of male much less strongly marked than that of female, oblique stripes absent ... ... *L. decorata* p. 454.
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. 8*g*); abdomen of male as strongly marked as that of female, oblique black stripes present between the longitudinal ones dorsally .. .. *L. bengalensis* p. 455.

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.
Adomen 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.

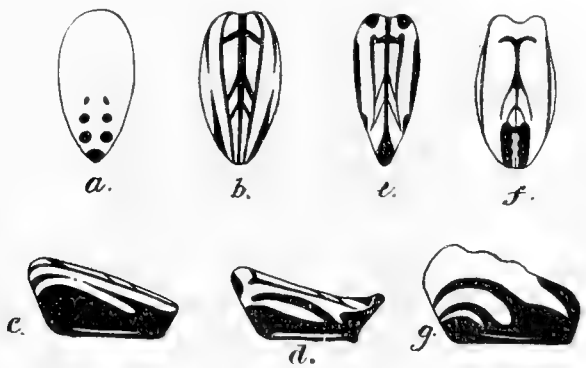
Leucauge ventralis (Thorell).

Meta ventralis, Thorell, 1877, pp. 423–427.
Argyroepeira ventralis, Workman, 1896, pl. lv.
Argyroepeira 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. 8*a*.

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. 8*b*, *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. 8*d*, *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.
Argyroepeira celebesiana, Workman, 1896, pl. lii.
Argyroepeira 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 erronoeus 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. 8*f*, *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).

Argyroepeira tessellata, Thorell, 1887, pp. 135–138.
Argyroepeira 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).

Argyroepeira 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.
Argyroepeira 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 spiney chelicerae. Both the inner and outer tarsal apophyses are present on the palps.

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XXV. REPORT ON A COLLECTION OF SUMATRAN MOLLUSCS FROM FRESH AND BRACKISH WATER.

By B. Prashad, *D.Sc., Assistant Superintendent, Zoological Survey of India, with an Introductory Note by* N. Annandale, *D.Sc., F.A.S.B., Director, Zoological Survey of India.*

(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 mollusca [1] made by Mr. J. E. A. den Doop in Sumatra [2] 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 Viviparidae. 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 Susswasser Schnecken aus Sumatra." *Nachr. Deutsch. Malakozool. Ges.* XXXII, pp. 3–14.

1903. Martens, E. von. "Die beschalten 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.
GASTROPODA.			
PULMONATA.			
AURICULIDAE.			
Pythia ...	*pantherina, undata*	*scarabeus, imperforata.*	*trigona, plicata, undata.*
Cassidula ...	*auris-felis, multiplicata, mustelina.*	... ...	*auris-felis.*
Auricula ...	*midae, judae, scheepmakeri.*	... ...	*midae, judae, limnaeiformis* (sp nov.).
Melampus ...	... ...	*fasciatus* ...	*percha* (sp. nov.).
LIMNAEIDAE.			
Limnaea ...	*javanica, brevispira*[1]	*javanica* var. *angustior, excavata, bongsonensis.*	*javanica* and vars. *intumuscens, subteres, angustior, porrecta, costulata* and *turgidula.*
PLANORBIDAE.			
Planorbis (in part) = *Indoplanorbis.*	*indicus* = *exustus*...	... ...	*exustus.*
Planorbis (in part) = *Gyraulus.*	*sumatranus, proclivis.*	*sagoensis* (probably a *Gyraulus*).	*convexiusculus, sumatranus, proclivis.*
Segmentina ...	... ...	*kennardi* ...	*calathus.*
Isidora = *Physastra*	*sumatrensis, stagnalis.*	... ...	*doopi* (sp. nov.).
PROSOBRANCHIA.			
AMPULLARIIDAE.			
Ampullaria (in part)= *Pachylabra.*	*ampullacea, involuta, scutata*=*conica.*	*ampullacea* var. *sumatrensis.*	*conica, ampullacea* vars. *typica* (= *celebensis*), *sumatrensis* and *magnifica.*
VIVIPARIDAE.			
Vivipara ...	*grassicosta, sumatrensis, hamiltoni, ingalsiana.*	*javanica, javanica* var. *sumatrana, sumatrensis, deliensis.*	*sumatrensis, hendrici,* (sp. nov.), *javanica* with vars. *laevior, saleyerica, moussoni, scalaris, borneensis.*

[1] Dr. Annandale and I have recently established (*Proc. As. Soc. Bengal*, XIV, pp. 460—462, pl. xii, figs. 4, 4*a* 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.			
Bithynia ...	... ..	... ...	*truncata.*
Pachydrobia ...	*lacustris.*		
Stenothyra ...	... ...	*weyersi.*	
ASSIMINEIDAE.			
Assiminea ...	... ...		
Subg. *Cyclotropis.*	*carinata, banka, lirata.*		
LITTORINIDAE.			
Littorina.			
Subg. *Littorinopsis.*	*scabra, intermedia, carinifera, undulata.*		*scabra, intermedia, carinifera, conica.*
Subg. *Nodilittorina*	*vilis.*		
Subg. *Melarraphe.*	*ventricosa* var. *subgranosa, biangulata.*		
MELANIIDAE.			
Protia = *Acrostoma*...	*sumatrensis, episcopalis, curvicosta, subplicata, verbecki, papillosa, stricticosta, zollingeri.*[1]	*indragirica, curvicosta* var. *prestoniana.*	*variabile*, vars. *sumatrensis, infracostata, binodulifera, pseudospinosa* and *menkeana.*
Melania (*Stenomelania, Melanoides, Plotia, Tarebia* and *? Sermyla*, all = *Melanoides*).	*bisinuata, laevigata?, crepidinata, tuberculata, pulchella, scabra, granum, datura, spectabilis, granifera, lineata, flavida, dissimulans, riqueti, pinguiuncula.*	*mucronata, arctecava, javanica, rustica, perplicata, sobria, rudis, pagoda* var. *costulata, savinieri, javanica, acanthica, distinguenda, livata* (= *semigranosa*), *palembangensis, datura, unifasciata, sykesi, kobelti.*	*aspirans, plicaria, acutissima, turris, monile, crenulata, uniformis, litigosa, tuberculata*, vars. *seminuda, virgulata, angularis* and *truncatula*; *scabra*, vars. *nodosocostata, angulifera* and *mutica*; *semigranosa, sluiteri* (sp. nov).
Melania, s.s. ...	*cybele* (*amara*), *setosa?, bocki, snellmani.*	*setosa, mitra* (probably same as *cybele*), *rudis, winteri, berkoltzi.*	
Faunus ..	...	*ater.*	
Paludomus? .	*olivacea.*		
CERITHIIDAE.			
Potamides ...	... . .		
Subg. *Terebralia* .	*palustris, sulcatus.*		
Subg. *Telescopium.*	... .	... ...	*telescopium.*
Subg. *Tympanotonos.*	*cingulatus* (*fluviatilis*).	... ...	*cingulatus, micropterum.*
Subg. *Cerithidae* ..	*ornatus, charbonnieri*	*cornea, weyersi* ...	*obtusum, quadratum.*
NASSIDAE.			
Canidia ...	... ...	*theminckiana* ...	*helena, theminckiana.*
Clea ...	*bocki* ...	... ...	*bocki.*

[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.			
Neritina.			
Subg. *Auriculatae* = *Neripteron.*	*auriculata* ...	... ...	*simoni* (sp. nov.).
Subg. *Mitrulae* = *Dostia.*	*crepidularia* ...	... ...	*crepidularia* with vars. *melanostoma* and *exaltata*; *weberi* (sp. nov.).
Subg. *Hemispheri-cae*=*Clypeolum.*	*iris, pennata* ...	*pulligera.*	
Subg. *Sulculosae* . .	*guerini,*		
Subg. *Aculeatae* ...	*aculeata.*		
Subg. *Serratae* = *Neritae.*	*gagates?, variegata, zizac, communis?, turrita.*	*turrita* var. *semicostata.*	*zizac, variegata.*
Subg. *Neritodryas*	*cornea* ...	...	*cornea.*
Subg. *Clithon* ...	*brevispira, subpunctata, solium, ualensis.*	*cliadema*	*brevispina, squarrosa.* *lineata, planospira.*
Nerita	*lineata, planospira*	*tessellata* with vars.	*tessellata* with vars.
Septaria ...	*sculpta, suborbicularis, tessellata.*	*clypeolum, insignis, compressa, lineata.*	*clypeolum, compressa* and *lineata.*
PELECYPODA.			
OSTREIDAE.			
Ostrea s.s. ...	...	... ...	*gryphoides.*
Subg. *Alectryonia*	*cucullata* ...	...	*folium, cuculata.*
ARCIDAE.			
Arca	*granosa.*		
UNIONIDAE.			
Unio (genus doubtful).	*macropterus* ...	*stolatus.*	
Schizocleitherium. ...		*hajakomboensis.*	
Pilsbryoconcha ...		*exilis, expressa.*	
Contradens ...	*hageni, dimotus* (= *Unio sumatrensis*, Lea), *verbecki.*	*laticeps* ...	*dimotus* var. *lugens.*
Rectidens ...	*sumatrensis* (=*Unio sumatrensis*, Dnkr.) *palembangensis.*	*gracilis, pressirostris.*	
Physunio ...	*superbus.*		
Monodontina ...	... ...	*vondembuschianus*...	*vondembuschiana*, var. *chaperi.*
Pseudodon ...	...	*bicristatus.*	
Trapezoideus ...	*peninsularis* (=*Unio sumatrensis*, Sow.)		
Diplodon ...	*novo-Hollandiae* (= *Unio cucumoides*, Lea).		
LUCINIDAE.			
Lucina (*Anodontia*)...	*phillipinarum.*		
CYRENIIDAE.			
Cyrnae ...	*sumatrensis* ...	... ...	*sumatrensis.*
Batissa ...	*jayensis*	*sphaericula, violacea* var. *discoidea.*	

	von. Marten's list (1897).	Species described or recorded since von Marten's paper in 1897.	Mr. den Doop's collection.
Corbicula ..	*moltkeana, tumida, ducalis, trapezoidea, angulifera, pullata, lacustris, gibba.*	*gustairana, tobae, sulcata, moussoni, subrostrata.*	*moltkeana, trapezoidea, angulifera, pullata.*
Sphaerium ...	... ...	... ...	*ceciliae* (sp. nov.).
Pisidium ...	*sumatranum.*		
GLAUCOMYIDAE.			
Glaucomya ...	*sumatrensis.*		
PSAMOBIIDAE.			
Elizia ...	*orbicularis.*		
Psmamotellina ...	*palleus.*		
Asaphis ...	*rugosa.*		
SOLENIDAE.			
Siliqua ..	*radiata, winteriana.*		
Cultellus, s.s. ..	*attenuatus.*		
Subg. *Pharella* ..	*javanicus* ...	... ...	*javanicus.*
PHOLADIDAE.			
Teredo ..	...		
Subg. *Cuphus* ...	*arenaria* ...	...	*arenaria.*

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 pematang [1] 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 connoidal, 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. lutcola*, 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:—*intumuscens*, *subteres*, *angustior*, *porrecta*, *costulata* and *turgidula*. Besides the above there are a few individuals which it is not possible to assign to varietal rank.

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[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. **intumuscens**, v. Martens.

1881. *Limnaea Javanica* var. *intumuscens*, v. Martens, *Conch. Mitth.* I, p. 88, pl. xvi, figs. 2-4.
1897. *Limnaea javanica* var. *intumuscens*, v. Martens, *op. cit.*, p. 3, pl. i, fig. 5.
1898. *Limnaea javanica* var. *intumuscens*, Sarasin, P. and F., *Süssw. Moll. Celebes*, p. 89.
1900. *Limnaea javanica* var. *intumuscens*, v. Martens, *Nachr. Malakozool. Ges.* XXXII, p. 10.
1912–13. *Limnaea javanica* var. *intumuscens*, 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-bosschen) pass gradually into fresh-water swamps (moreas-bosschen). 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 Goemba[1] (Karo-Batak High-Plain) near Brastagei and from the stream Soengei Landak (Upper Langkat).

Family PLANORBIDAE.

Genus **Indoplanorbis**, Annandale and Prashad.

Recently Dr. Annandale[2] 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, *Journ. 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*, 40*a*, *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 Planorbidae[1] 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 Lamarck[2] 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 Dooϕ 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 Annandale[1] 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, 1*a* (1918).

1919. *Gyraulus convexiusculus*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, pp. 52–54, figs. 6*c*, 7*b*, 8*b*.
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 E) 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 Annandale [1] has discussed the question of the synonymy of the genus *Bullinus*. Shortly before this Hedley [2]

[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 Cook[2] 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 *Pyhsastra* 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-spired forms known from Australia and the adjoining islands and catalogued by Tate and Brazier,[7] Smith,[8] Cooke, 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*.

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[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] *Journ. 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] *Journ. 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 $\frac{1}{5}$ 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. viii, 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, *Journ. 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 (*Journ. As. Soc. Bengal*, L. pt. ii, p. 155, pl. vi, figs. 11, 11A) 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*, Kruimel, *Bijdr. Dierkunde Amsterdam*, p. 220.
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 monograph,[2] doubtfully considered *A. ampullacea* as synonymous with *A. celebensis* and considered the various species, which later Reeve rightly considered as synonymous, as distinct. Reeve[3] 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*, Mousson[4] (not Quoy and Gaimard[5]) 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. Java*, 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. 65*a*, *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 sumairensis*, 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'eune 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 Sarasins [1] 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.

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[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 Medan (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, 11*b*.

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 figures[1] 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 MELANIIDAE.

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 "Paleomelanien," 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. 1*a-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 1*a* (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 Lepan ...	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 Lepan (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. 3*a* (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 Deli Medan	1.	60·2	22·9	21·3	14·4	$6\frac{1}{2}$
	2.	51	18·2	17·6	10	8
	3.	49	17·9	17·1	9·8	$7\frac{1}{2}$
Soengei Kalau	1.	36	14·1	14	8·4	$6\frac{1}{2}$
	2.	32·3	12·8	12·2	6·7	$6\frac{1}{2}$

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 $2\frac{1}{2}$–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 *binodulifera*.

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 Lepan 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	$5\frac{1}{2}$	
30	13·3	12·4	7·2	$4\frac{1}{2}$	Apex greatly eroded.
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. 4*a–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, 2*a*.
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, 5*a*.

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. 9*a*.
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, 3*a*, 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, 5*a*, *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 *M. 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 Toentoengan, 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.* XVIII, 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 (Sabang).

Subgenus **Tarebia,** H. and A. Adams

Melanoides semigranosa (Busch).

1842. *Melania semigranosa*, V. D. Busch, *Philippi Abbild.* I, p. 2, pl. i, fig. 13.
1874. *Melania lirata* var. 2, Brot, *op. cit.*, p. 329, pl. xxxiii, figs. 6, 6*a*.
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. 11, pl. ii, figs. 9, 9*a–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 Lepan, 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 *Pyrazus*, Montf., which is also known from Sumatra.

Subgenus **Telescopium,** Montf.

Potamides telescopium (Linn.).

1855. *Cerithium telsecopium*, Sowerby, *Theasaurus Conchyliorum*, II, p. 890, 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. Niederl. 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 Berkley[1] 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]

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[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 micropterum (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*) *obtusus*, 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 Pelawan (Deli) collected at different times, and from the mouth of the Soengei Bataug 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, *Journ. 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 referrable 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 Brot [1] 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, *Journ. Conchyliol.* IV, pp. 255, 256, pl. vii, fig. 11.
1876. *Canidia Theminckiana*, Brot, *Journ. 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] *Journ. Conchyliol.* XXIV, pp. 343–351, pl. xii (1876).

There is a single specimen in the Sumatran collection which is referrable 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*, I., 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, *Journ. 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 transluscent 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, 7*a*.

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, 11*a* 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, 14*a*, 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 papers[1] 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.* XLV, 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 Simpson[2] 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 Lepan (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 cecilae, 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.

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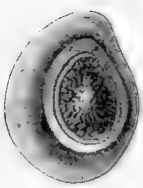

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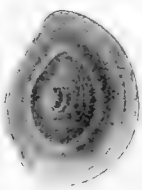

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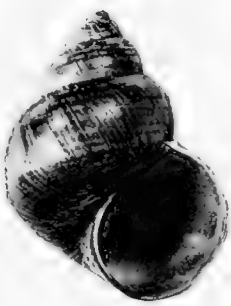

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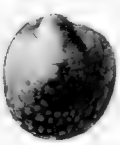

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S. C. Mondul, photo

NEW SUMATRAN MOLLUSCA.

Photo-engraved & Printed at the Offices of the Survey of India, Calcutta, 1921

XXVI. TWO NEW SPECIES OF RAGMUS[1] 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*), Cholam (*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 ∩-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.

1 2. 3.

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 translucid 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 Yawnghwe, 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. Meso- 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, subacute 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 inermous, 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 equalling 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 whitish[1] ... ... 8.

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. gravelyi*, 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 Yawnghwe), 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, Yawnghwe State, S. Shan States, *ca.* 4000 ft. (F. H. Gravely, 1·iii·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. 2-3-4-1-7-5-2-5-7-4-6-5-**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 carvernicolous 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. 215. 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, *Atti 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 metanotum similar to pronotum, the former with posterior margin subangulate 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, × 6.

,, 2. *Id.* Face, front view, × 14.

,, 3. *Id.* Basal joints of right antenna, × 28.

,, 4. *Id.* Joints of the middle part of antenna, × 28.

,, 5. *Id.* Maxilla, × 28.

,, 6. *Id.* Apex of maxilla, × 56.

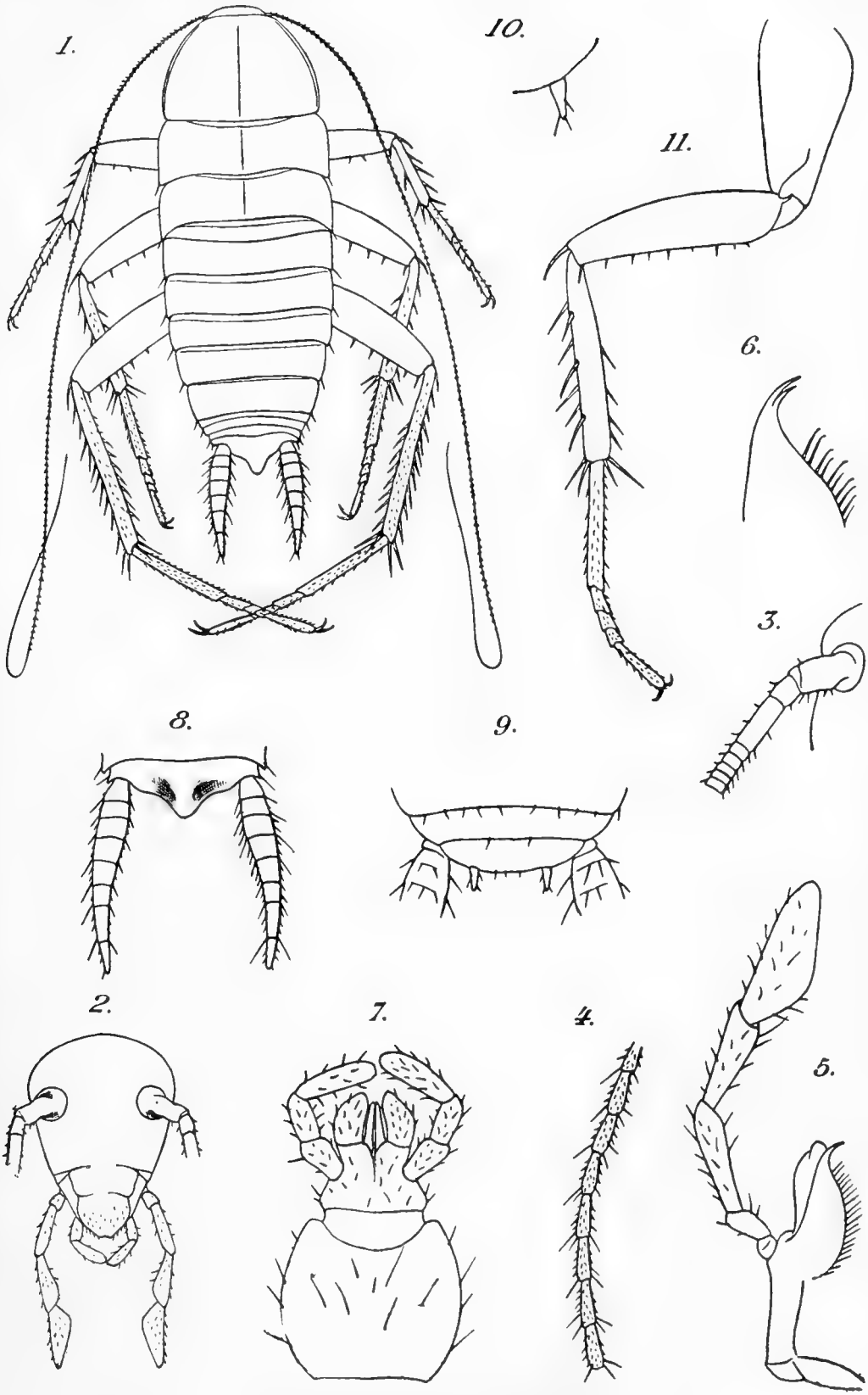
,, 7. *Id.* Labium, × 28.

,, 8. *Id.* Supra-anal plate and cerci, × 14.

,, 9. *Id.* Subgenital plate, × 19.

,, 10. *Id.* Styles, × 28.

,, 11. *Id.* Intermediate leg, × 17.



CAVERNICOLOUS ORTHOPTERA.

EXPLANATION OF PLATE XXII.

FIG. 12. *Spelaeoblatta* (?) *caeca*, sp. nov.—Anterior leg, × 14.

,, 13. *Id.* Internal inferior margin of anterior femur, × 19.

,, 14. *Id.* Posterior leg, × 14.

,, 15. *Rhaphidophora rufobrunnea*, sp. nov.—Lateral view of head and thorax, × 6.

,, 16. *Id.* Frontal rostrum, dorsal view, × 14.

,, 17. *Id.* Posterior tarsus and spurs of tibia, internal view, × 7.

,, 18. *Diestrammena indica*, sp. nov.—Head and thorax, dorsal view, × 4·5.

,, 19. *Id.* Head and thorax, lateral view, × 4·5.

,, 20. *Id.* Frontal rostrum, dorsal view, × 14.

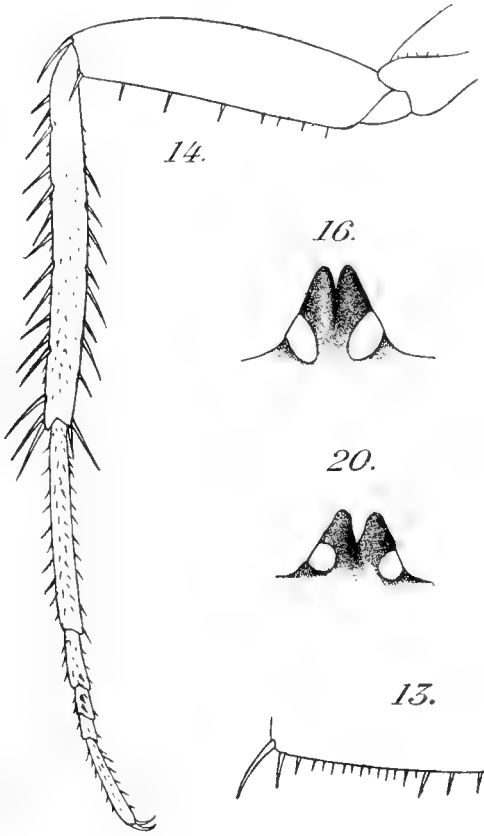
,, 21. *Diestrammena vitalisi*, Chop.—Genitalia, dorsal view, × 14.

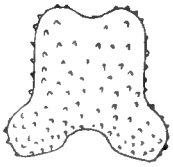
,, 22. *Id.* Epiphallus isolated, × 28.

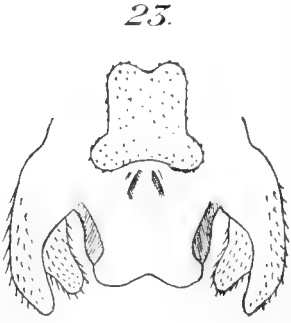
,, 23. *Tachycines adelungi*, sp. nov.—Genitalia, dorsal view, × 14.

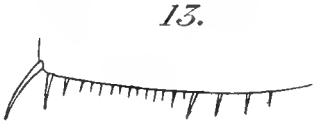
,, 24. *Id.* Epiphallus isolated, × 28.

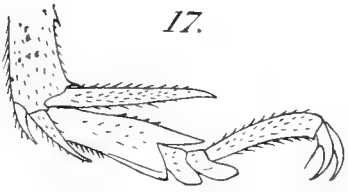
,, 25. *Id.* Frontal rostrum, dorsal view, × 14.

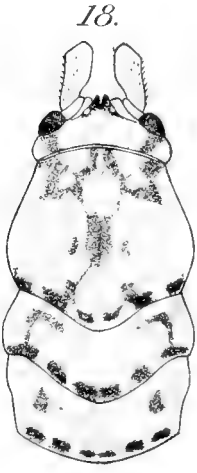












CAVERNICOLOUS ORTHOPTERA.

EXPLANATION OF PLATE XXIII.

FIG. 26. *Tachycines adelungi*, sp. nov.—Head and thorax, dorsal view, ×4·5.

,, 27. *Id.* Head and thorax, lateral view, ×4·5.

,, 28. *Id.* Subgenital plate of male, ×6.

,, 29. *Tachycines cryptopygius*, Chop.—Frontal rostrum, dorsal view, ×6.

,, 30. *Id.* A few joints of the antenna, from the 10th to the 17th, × 14.

,, 31. *Id.* Apex of abdomen of male, showing the process of the 7th tergite, ×6.

,, 32. *Id.* Apex of abdomen of male, lateral view, ×6.

,, 33. *Id.* Anal valves of male, dorsal view, ×6.

,, 34. Outlines of head and thorax, of : A. *Tachycines validus*, sp. nov., B. *Tachycines cryptopygius*, sp. nov., ×4.

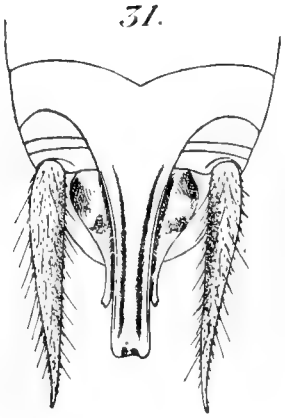
,, 35. *Tachycines validus*, sp. nov.—Apex of abdomen and ovipositor of female, lateral view, ×3.

,, 36. *Id.* Same as the preceding with the cercus cut off to show the anal valves, ×4.

,, 37. *Id.* Subgenital plate of female, ×4.

,, 38. *Id.* Disposition of spines of posterior femur, ×6.


27.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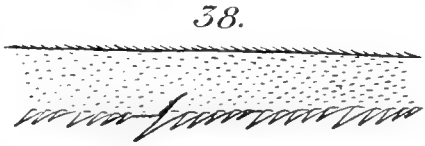
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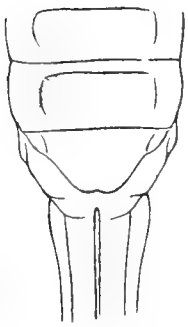
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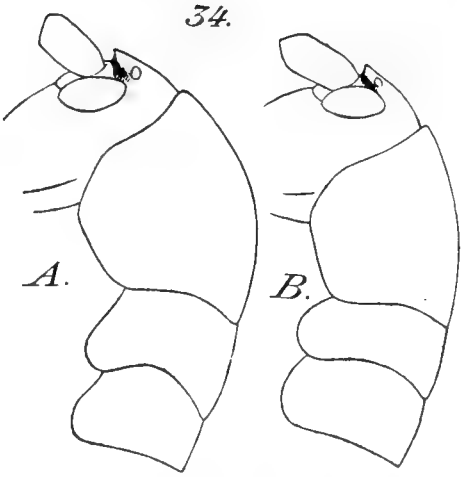
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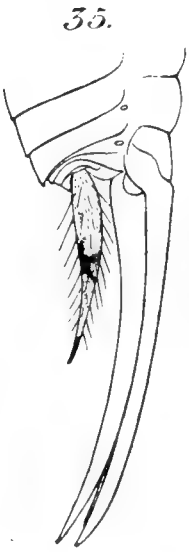
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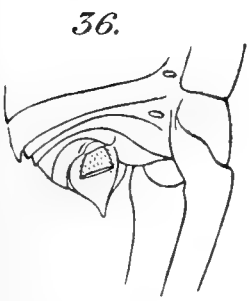
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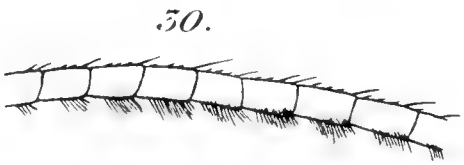
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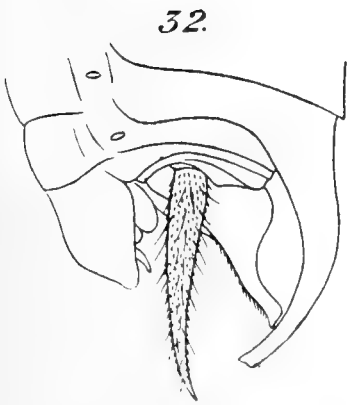
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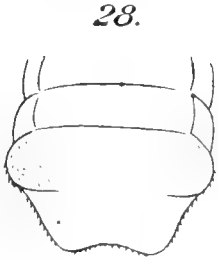
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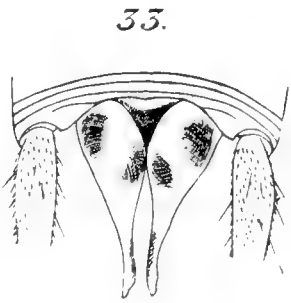
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XXVIII. THE AQUATIC AND AMPHIBIOUS MOLLUSCA OF MANIPUR.

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.

CONTENTS.

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° 50′ and 25° 41′ N. and 93° 2′ and 94° 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.

Hill-streams of Manipur.

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.

Fauna of Oriental Hill-streams.

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

(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.

Manipur Valley.

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.

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.

The Loktak Lake.

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.

Water of the Lake.

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., Directer 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 channel s. of Thanga I., Manipur. Total amount received 554 c.c.; solid suspended matter found therein ·0148 gm.	Water from open part of Loktak Lake. Total amount received 1107 c.c.; solid suspended matter found therein ·0189 gm.	Water from stream flowing into Loktak 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 (Cl) ,,	·0028	·0023—·0024	·0039—·0042
Silicia (SiO_2) ,,	·0027	·0020—·0062	·0030—·0035
$Fe_2O_3Al_2O_3$,,	*nil*	·0075	*nil*
Calcium (Ca) ,,	·0049	·0148	·0118
Magnesium (Mg) ,,	·0053	·0068—·0134	·0110—·0105

Comparison between the Loktak Lake and the Inlé Lake.

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.

Origin of the Loktak Lake.

It is impossible to consider the origin of the Loktak Lake without considering also that of the Manipur valley 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.

Vegetation of the Loktak Lake.

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 doutbless 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.

General characters of the fauna of the Loktak Lake.

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. Periostome 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. ceramcopoma* (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.

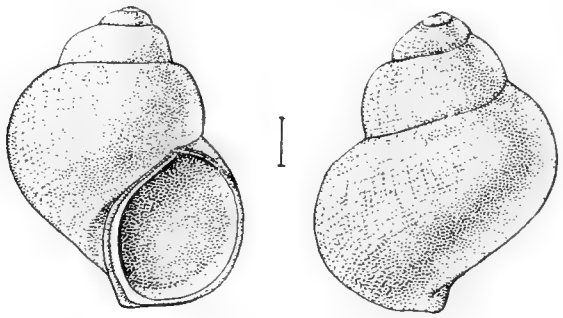

Fig. 1.—Type-shell of *Digoniostoma textum*.

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.

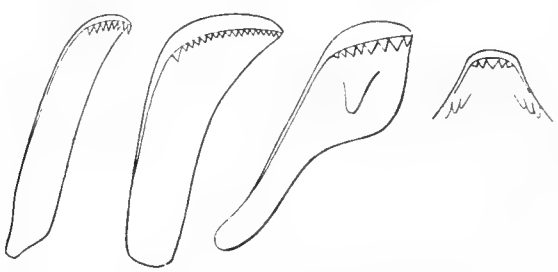

Fig. 2.—Radular teeth of *Digoniostoma textum*.

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 *Digoniostoma* 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

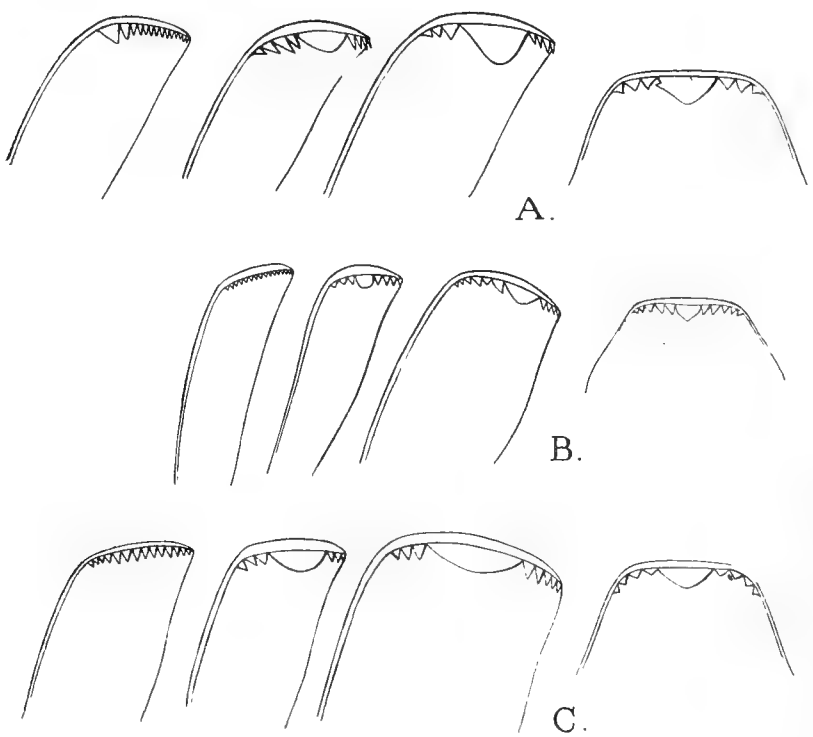

Fig. 3.—Radular teeth of Viviparidae.
A.—*Vivipara crassispiralis.*
B.—*V. oxytropis*
C.—*Lecythoconcha lecythis.*

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

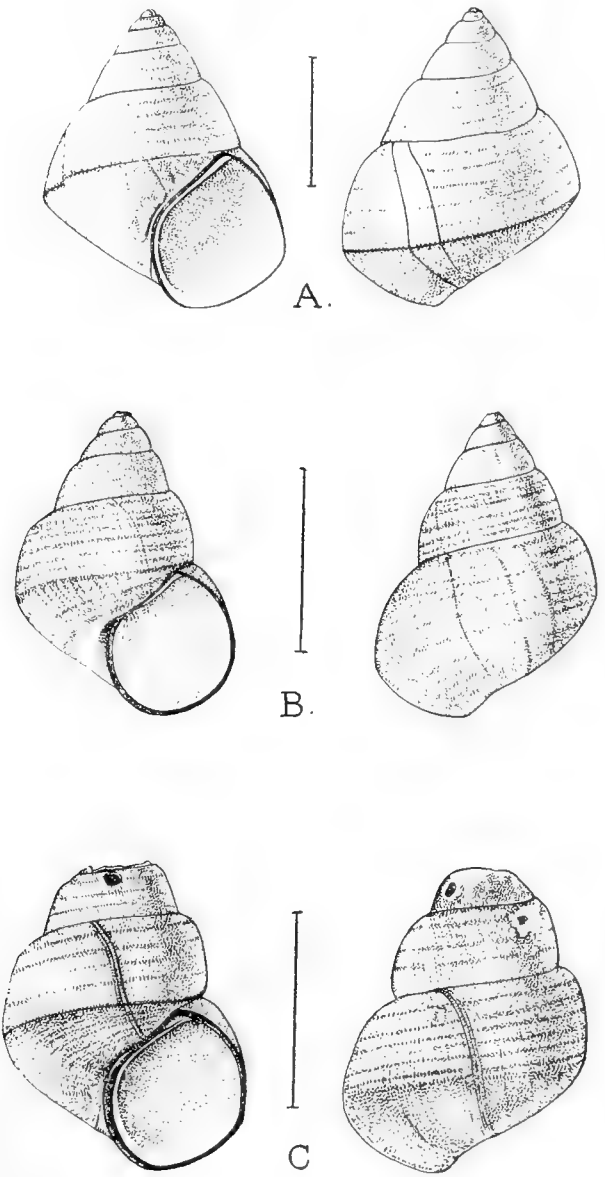

FIG. 4.—Shells of *Vivipara microchaetophora*.
A.—Young shell. B.—Shell of young adult.
C.—Old shell.

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 5½ 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 $1\frac{1}{6}$ 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

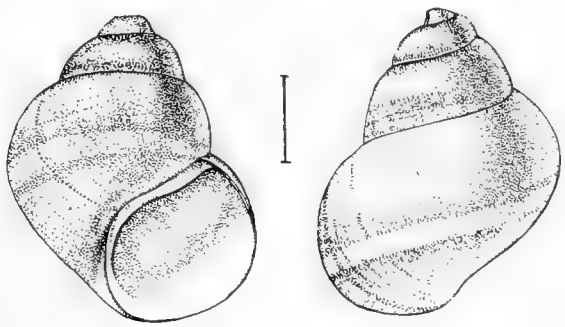

Fig. 5.—Type-specimen of *Vivipara micron*.

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.

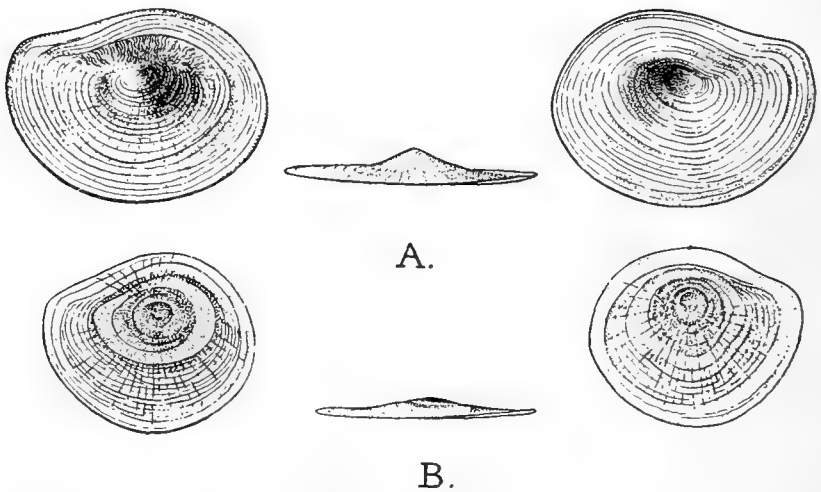

Fig. 6.—Opercula of *Lecythoconcha* and *Vivipara*. A.—*L. lecythis* (nat. size). B.—*V. oxytropis* (nat. size).

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 4½ 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

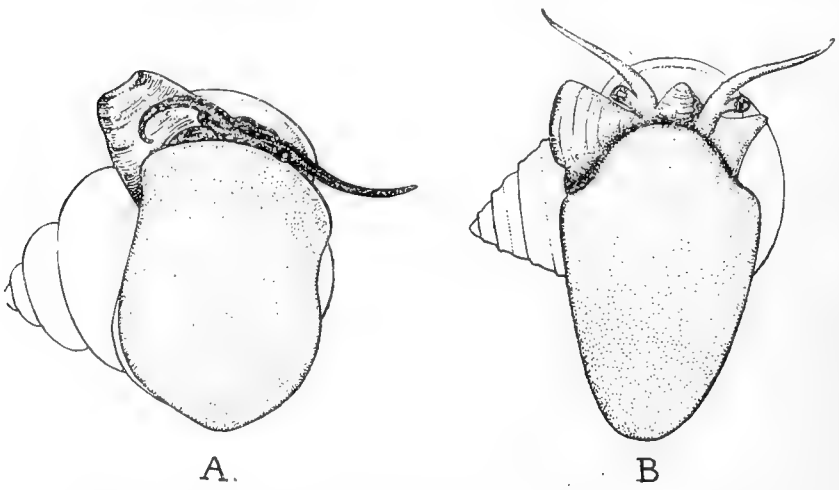

FIG. 7.—Living animals of *Lecythoconcha lecythis* ♂ (A) and *Vivipara oxytropis* ♀ (B). Nat. size.

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 Lake[1] 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 accidently 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. *putcicola*. 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, 1*a*.
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.

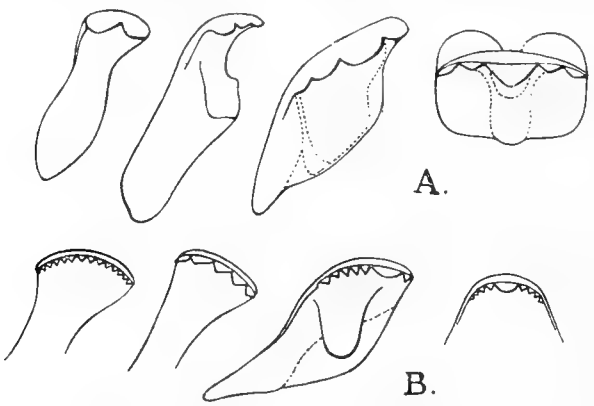

Fig. 9.—Radular teeth of Melaniidae.
A. *Acrostoma variabile.* B. *Paludomus pustulosa.*

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 Benson 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*.

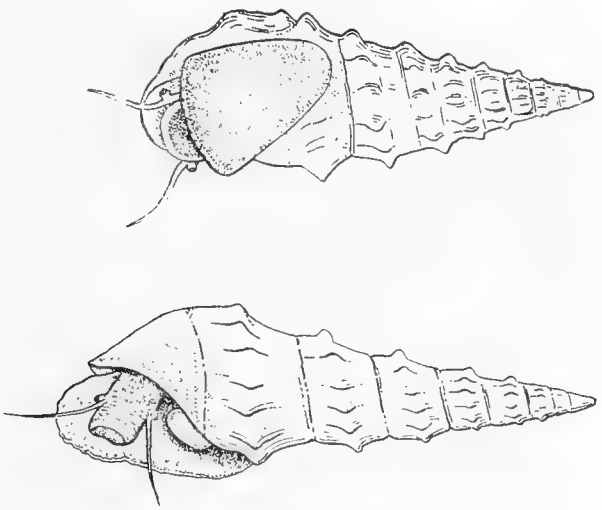

FIG. 10.—Living animal of *Acrostoma variabilis* var. *subspinata*, nov., from Dimapur, Assam.

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-

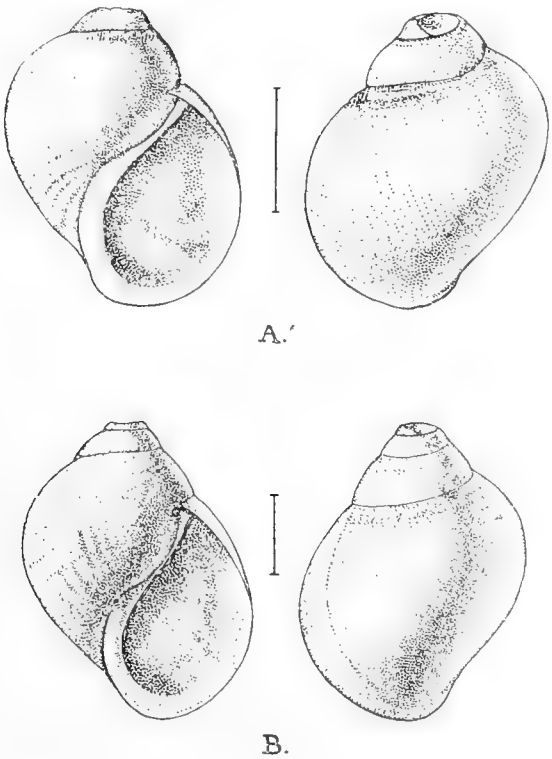

FIG. 11.—Shells of *Paludomus pustulosa*.
A. Adult shell. B. Half-grown shell.

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 crassispiralis* 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 Ancylidae, the first by four species of *Limnaea*; the second by the unique species of *Indoplanorbis* and by species of *Gyraulus*, *Segmentina*, *Hippeutis* (?) 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 Ancylidae. 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 homogeniety 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 Ancylidae.

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 Martens[2] 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 volume [1] 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 Baker[1] 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 idiosyncracy, 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

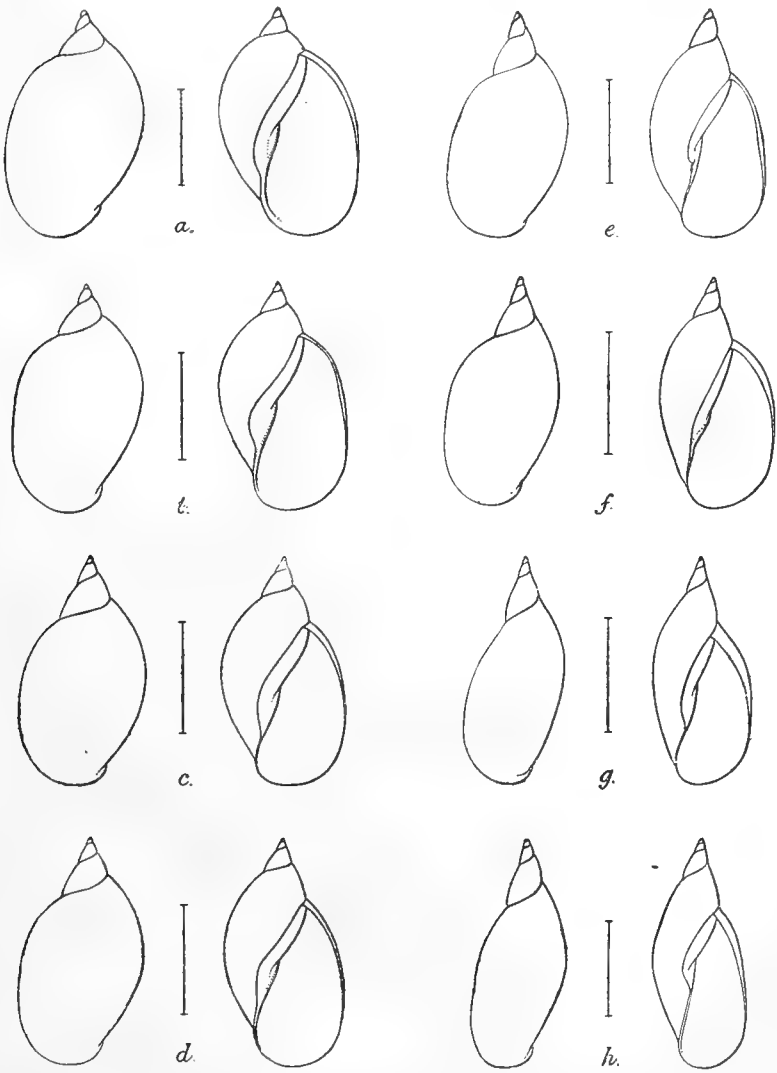

FIG. 12.—Series of shells of *Limnaea acuminata* from Manbhum, Bengal. FIG. *a* may be taken to represent var. *patula*, Troschel and figs. *g* and *h* the var. *gracilior*, von Martens.

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 averge 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 ...	31·2	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	11·4	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-spired 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.

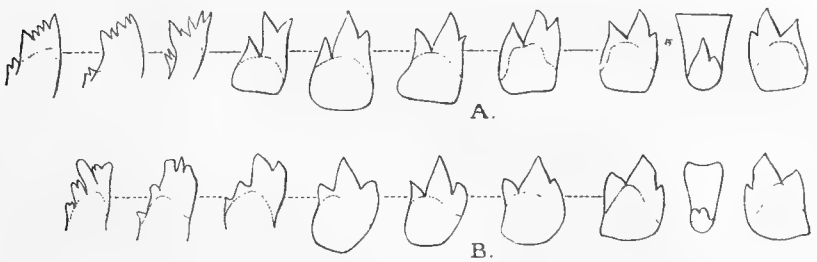

Fig. 13.—Radular teeth of *Limnaea*.
A. *L. ovalior*, Annandale and Prashad.
B. *L. andersoniana*, Nevill.

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. 4*a*, 4*b*.

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 1¼ 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 Yawnghwe 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 Yawnghwe 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 Yawnghwe 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 Yawnghwe 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 Walker [1] was right in assigning it to the Planorbidae and that its resemblances to the Ancylidae, on which we previously [2] 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.

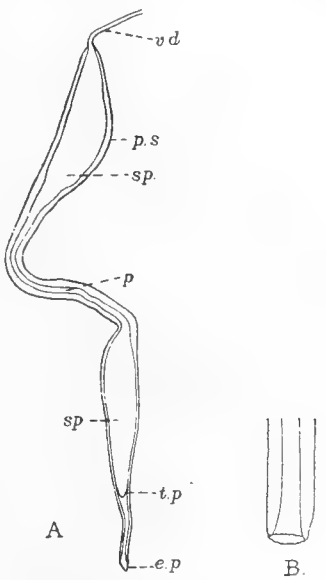

FIG. 14.—*A*. Penis and end of vas deferens of *Indoplanorbis exustus* (Deshayes).

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*.

Type-species. — Planorbis exustus, Deshayes.

This genus differs from the true *Planorbis* of Müller (with the European *P. corneus*, 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-

[1] Pelseneer, *Mollusca*, in Lankester's *Treatise on Zoology*, p. 186, fig. 175 (1906).

[2] P. and F. Sarasin, *Susszv. 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, 1*a*.

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 × 11 × 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 × 9·5 × 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 × 16·5 × 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 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.

Fig. 15.—Longitudinal section of the secondary branchial process of *Indoplanorbis exustus* (Deshayes).

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, 7*a*, 8*b*.

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 umbilicalis*) 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.

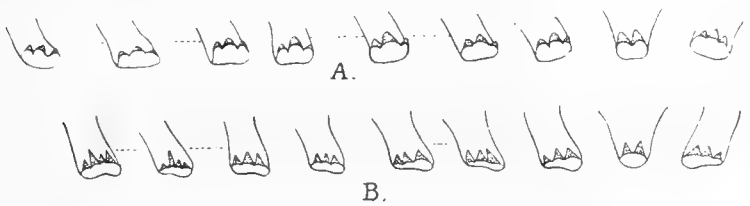

Fig. 16.—Radular teeth of Planorbidae.
A. *Gyraulus cantori* (Benson).
B. *Hippeutis* (?) *umbilicalis* (Benson).

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.

Fig. 17.—Penial stylet of *Gyraulus cantori* (Benson).

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

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 sindicus* 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*

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[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 Planorbid, 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. sindicus* 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.

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[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 chitinized. The internal anatomy is of the Planorbid 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 "Ferrissiinae" 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	*A. ceylanicus.*
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 ..	*A. verruca.*
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	*A. baconi.*
ii.	Sides parallel; altitude more than $\frac{1}{3}$ of length.	
a.	Shell deep violet internally with minute radiating striae	*A. viola.*
b.	Shell dull yellowish internally, without distinct microscopic sculpture	*A. tenuis.*

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

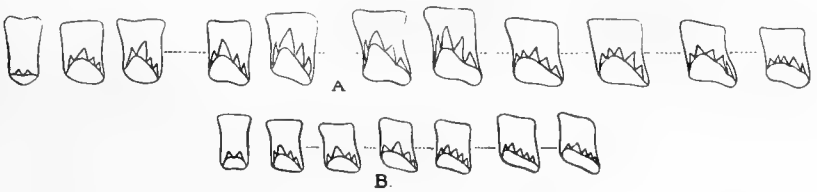

FIG. 18.—Radular teeth of *Ancylus*.
A. *A. viola*, Annandale and Prashad.
B. *A. verruca*, Benson.

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 $1\frac{3}{4}$ 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.

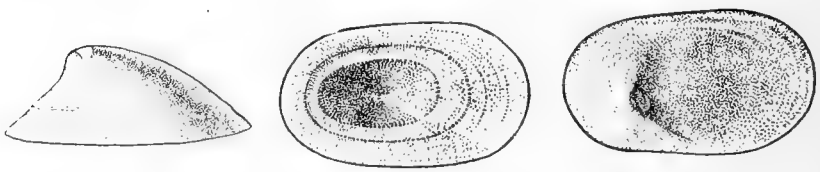

Fig. 19.—Shell of *Ancylus viola*, Annandale and Prashad.

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. lxxxi, 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 Rieper[1] has given a full description of the genitalia and physiology of *S. putris*, while Ihering[2] gives a general account of the genitalia of the same species. Jacobi in his paper on Japanese Pulmonates[3] 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] *Jahrb. Deut. Malakozool. Ges.* IV, pp. 136–142 (1877).
[3] *Journ. 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.

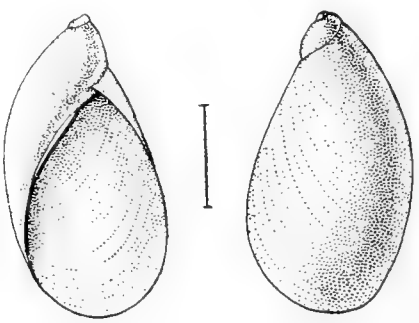

Fig. 20.—Shell of *Succinea elegantior*, Annandale, from Manipur.

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

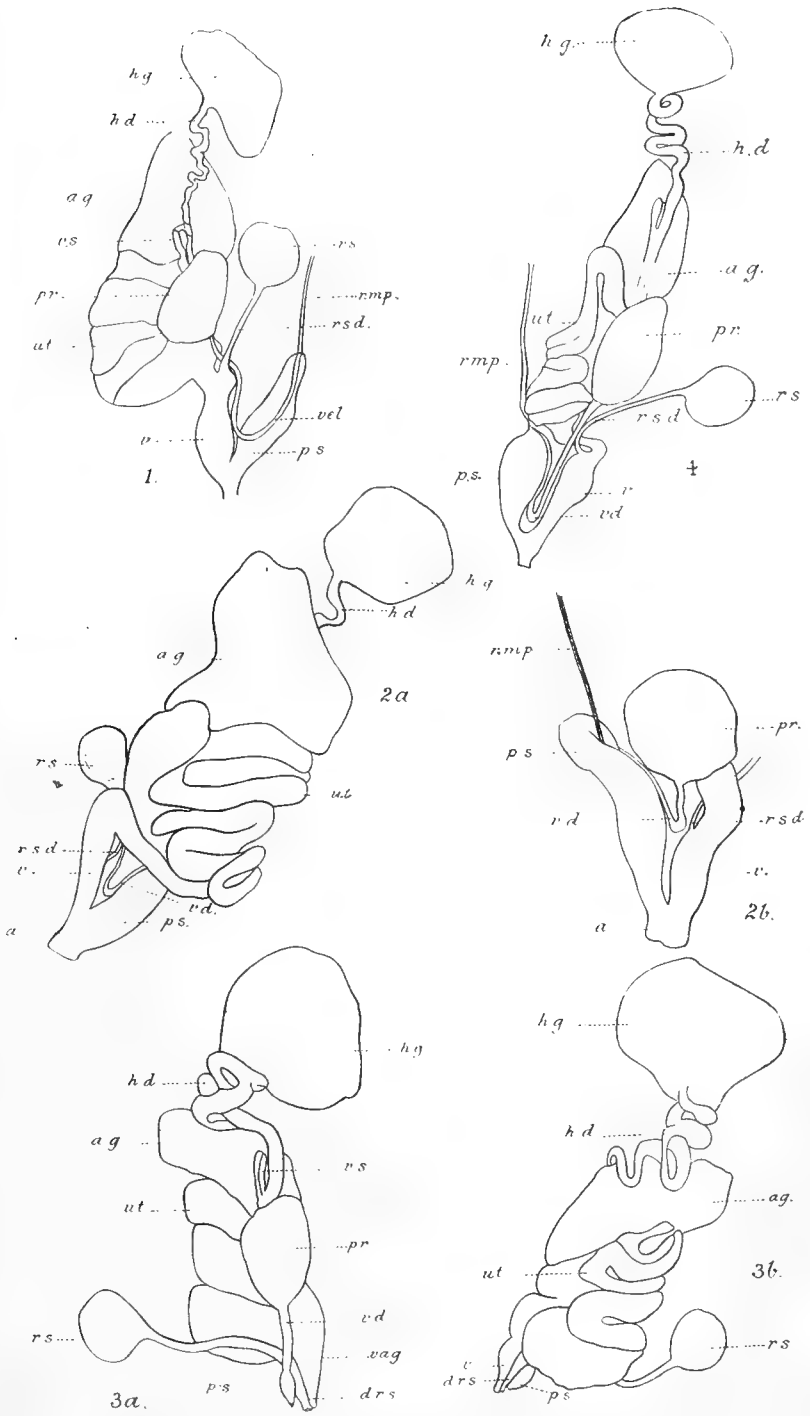

FIG. 21.—Genitalia of different species of *Succinea*.

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

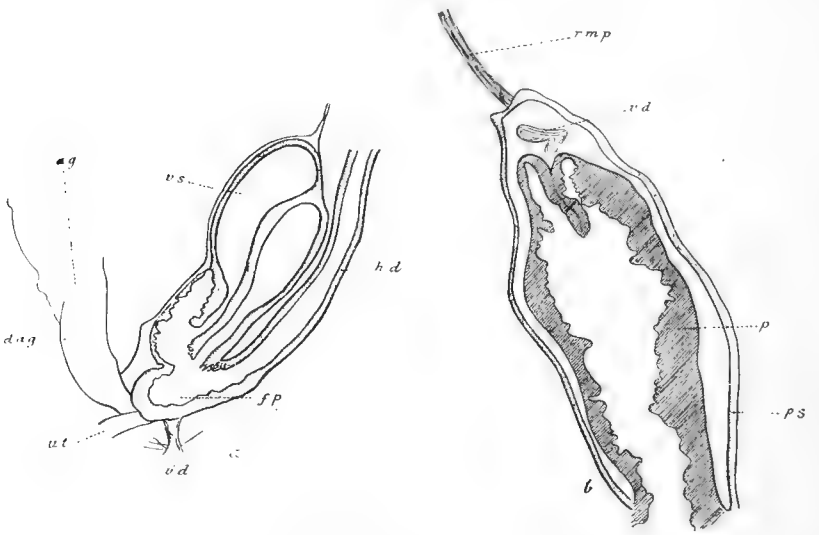

Fig. 22.—*Succinea elegantior*, Annandale.

(*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.

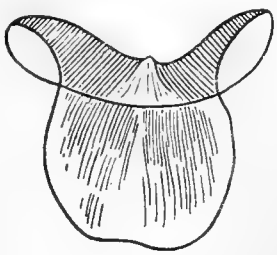

Fig. 23.—Jaws of *Succinea elegantior*, Annandale.

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.

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 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.

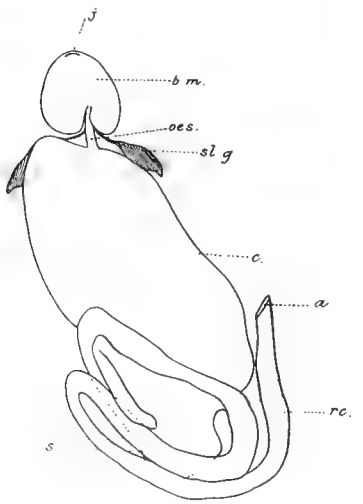

Fig. 24.—Alimentary canal of *Succinea elegantior*, Annandale.

a. anus; *b.m*. buccal mass; *c*. crop; *j*. jaw; *oes*. oesophagus; *r*. rectum; *s*. stomach.

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.

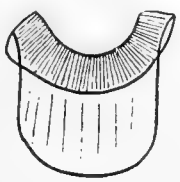

FIG. 25.—Jaw of *Succinea rutilans*, Blanford.

The radula is a long narrow ribbon with only about 35 teeth in a transverse row. The dental formula is 6.11.1.11.6. 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.

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 mangoe, 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.

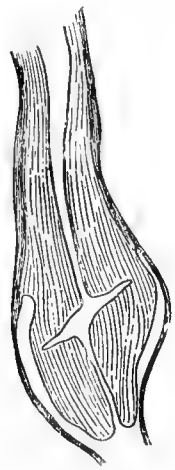

FIG. 26.—Penis of *Succinea semiserica*, Gould.

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

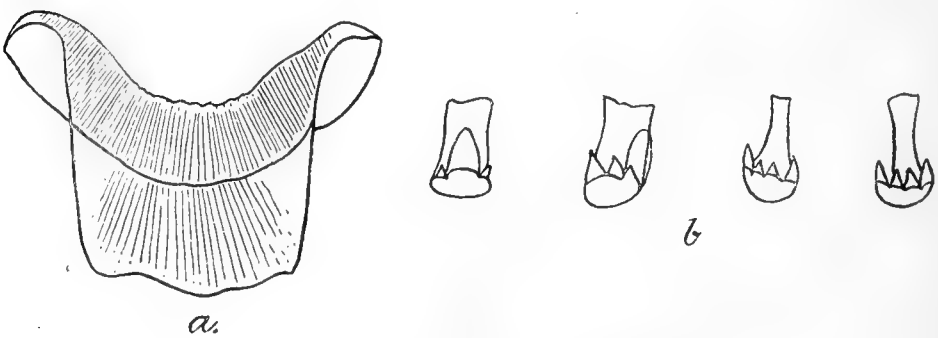

FIG. 27.—*Succinea semiserica*, Gould.
(*a*) Jaw. (*b*) Radular teeth.

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

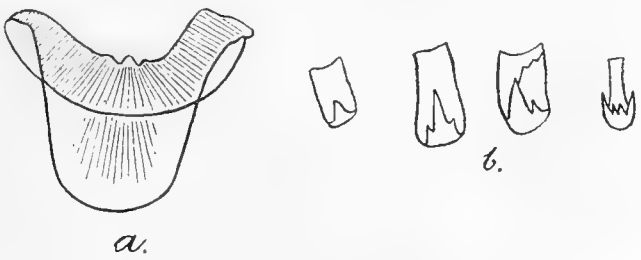

FIG. 28.—*Succinea indica*, Pfeiffer.
(*a*) Jaw. (*b*) Radular teeth.

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.

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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 Thoba! 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. xlvi, 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. xlvi, 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 *siliguricnsis*, 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.

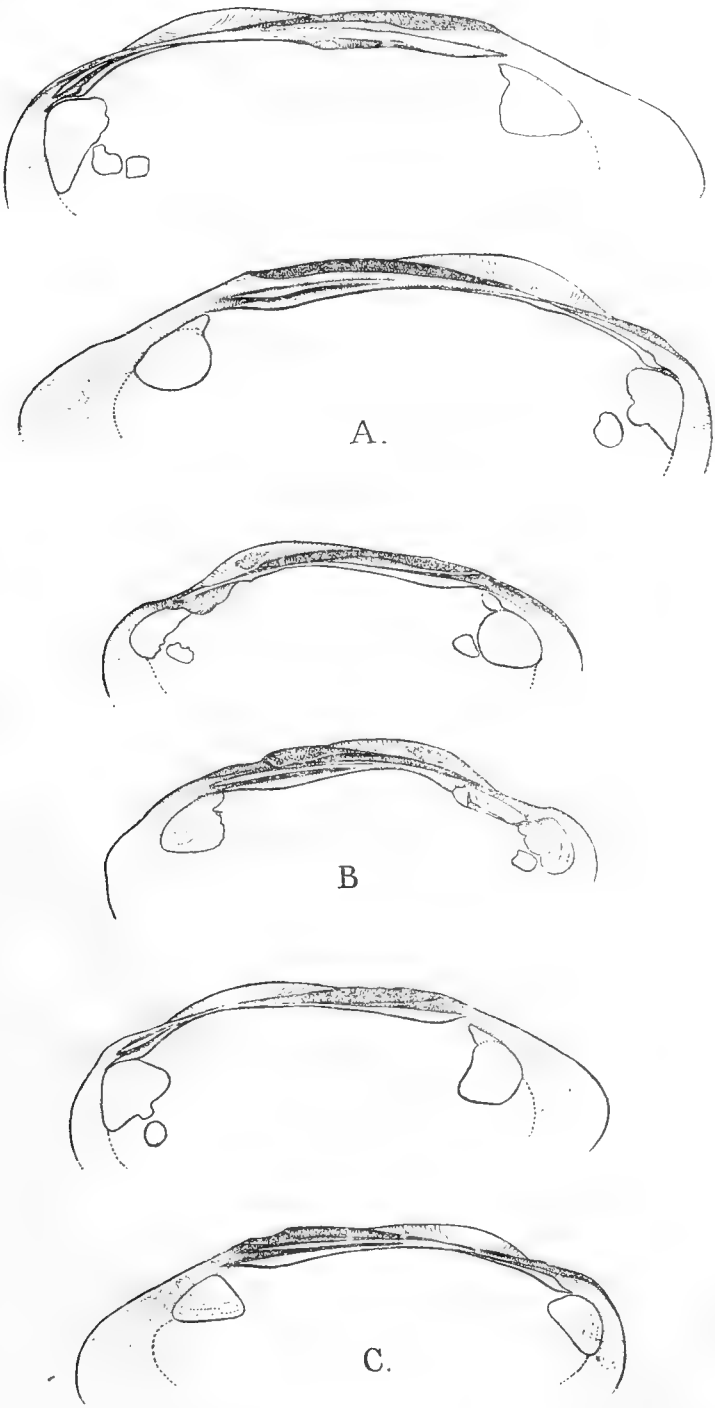

FIG. 29.—Hinge-teeth of *Lamellidens*.
A. *L. marginalis* (Lam.). B. *L. consobrinus* (Lea). C. *L. corrianus* (Lea).

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

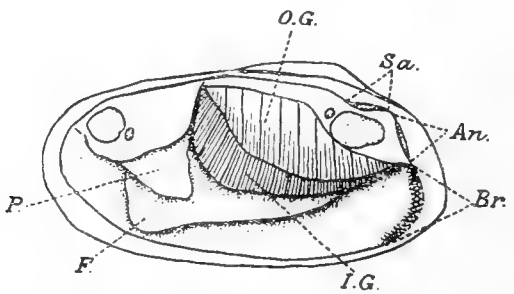

Fig. 30.—Soft parts of *Trapezoideus dhanushori*, Prashad.

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

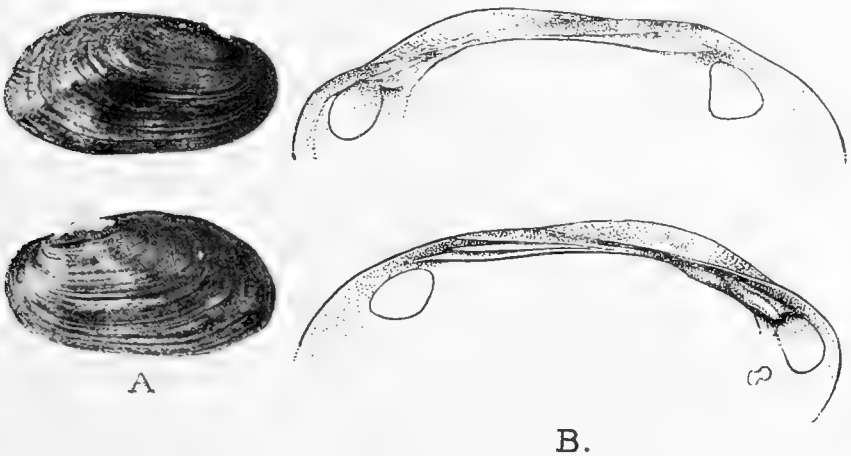

FIG. 31.—*Trapezoideus dhanushori*, Prashad.
A. Photographs of the two valves of the type-shell.
B. Hinge-teeth.

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 paper[1] 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. 210.

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 Prime[2] 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)

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[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.

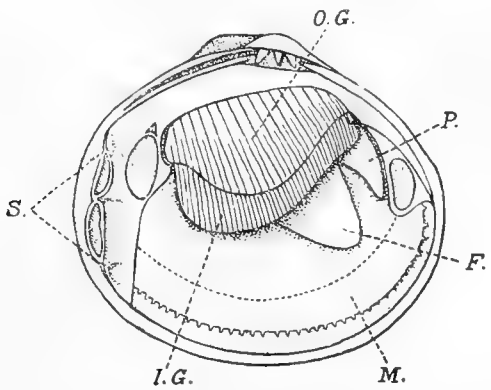

FIG. 32.—Soft parts of *Corbicula occidens*, Deshayes.
F. foot ; *I.G.* inner gill ; *M.* mantle ; *O.G.* outer gill ; *P.* palp ; *S.* siphons.

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. agrensis* 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.

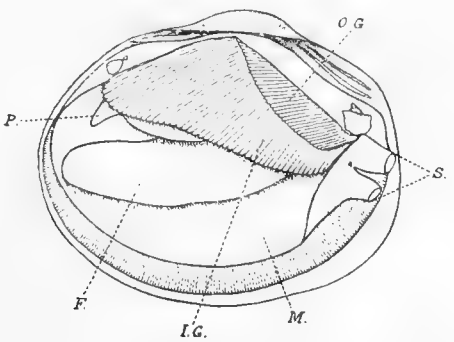

FIG. 34.—Soft parts of *Sphaerium indicum*.
F. foot; *I.G.* inner gill; *O.G.* outer gill; *M.* mantle; *P.* palp; *S.* siphons.

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. Jacobsen[1] 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] Fischer[3] 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's[4] and Oscar Schmidt's[5] papers contain very little on the structure of the gills of the European species dealt with by them. I have not seen Drew's paper[6] 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 Conchyliol.*, 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. 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.

FIG. 35.—Shell of *Sphaerium austeni*, sp. nov.

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, *Journ. As. Soc. Bengal* XL, p. 9, pl. i, figs. 4, 4*a–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, *Journ. 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.

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[1] *Journ. 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. *Gyralus 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. *Trapezoideus 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 *Trapezoideus*. 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 :—

Amnicola orcula.	*Hippeutis* (?) *umbilicalis.*
Acrostoma variabilis.	*Segmentina calathus.*
Limnaea acuminata.	*Ancylus verruca.*
Limnaea ovalis.	*Ancylus ceylanicus.*

Gyraulus cantori.

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 Planorbid 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 Northeastern 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 crassispiralis*, *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 section[1] 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*, *Trapezoideus*, *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 *Trapezoideus* 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 Assamese 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—

Vivipara oxytropis.
Lecythoconcha lecythis.
Limnaea acuminata.
Indoplanorbis exustus.
Gyraulus cantori.
Hippeutis (?) umbilicalis.
Lamellidens corrianus.
Sphaerium indicum.
Pisidium clarkeanum.

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 ..	*Taia*, *Lecythoconcha*.	*Vivipara*, *Lecythoconcha*.
Predominant genera ..	*Taia*.	*Vivipara*.
Number of living species	*Taia* 5, *Lecythoconcha* 1.	*Vivipara* 3, *Lecythoconcha* 1.
Fossil forms known ..	Four (*Taia*).	None.
Number of species with highly sculptured shells	5 recent, 4 fossil (*Taia*).	2 recent (*Vivipara*).
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 paper[1] 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).

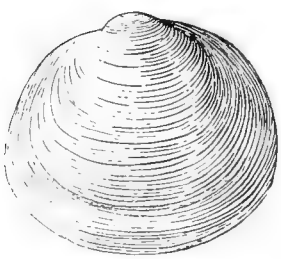
this species have been found—a broad form in ponds and a narrow form in a small stream. In the Manipur Valley and at Dimapur no less than four such phases occur. Two of these are almost identical with the two from the Shan States and inhabit similar types of environment. A third phase, still narrower 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.

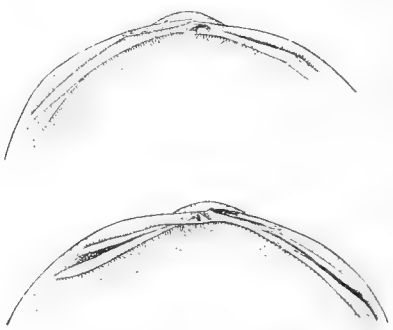
ADDENDUM.

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 referrable 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.

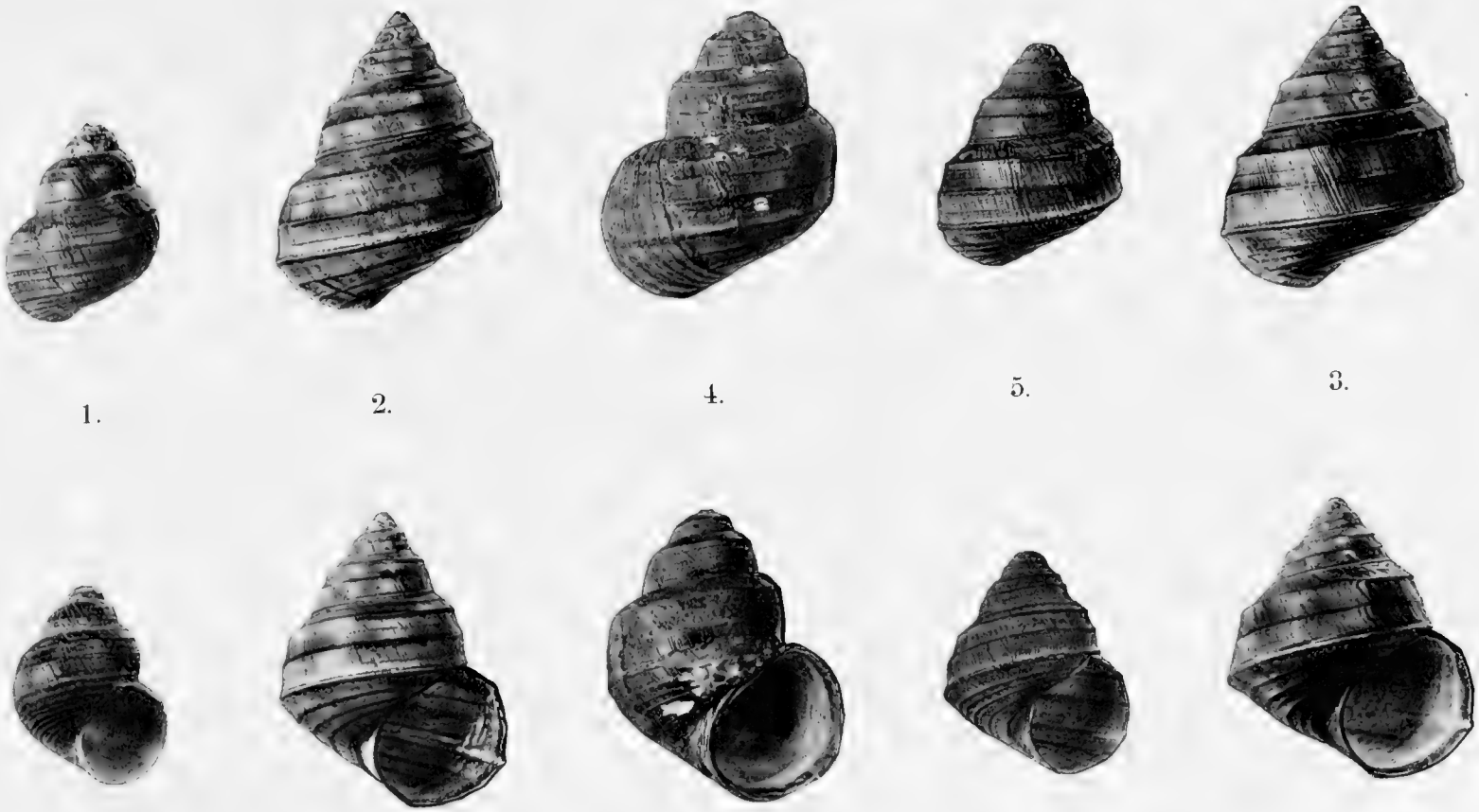
Vivipara oxytropis (Benson).

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.



S. C. Mondal, photo

FIG. 1. VIVIPARA CRASSISPIRALIS. FIGS. 2-5. V. OXYTROPIS.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921

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.

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3.

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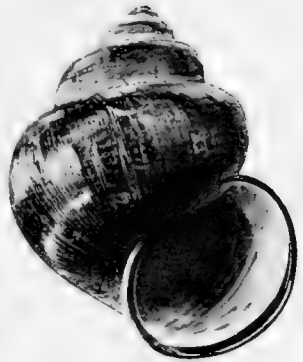

S. C. Mondal, photo

LECYTHOCONCHA LECYTHIS.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta 1921

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.

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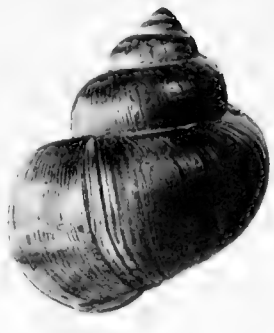


3.

S. C. Mondal, photo.

4.

5.

6.

Figs. 1, 2. LECYTHOCONCHA LECYTHIS. Figs. 3-6. ACROSTOMA VARIABILE.

Photo-engraved & printed at the Offices of the Survey of India, Calcutta, 1921.

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.

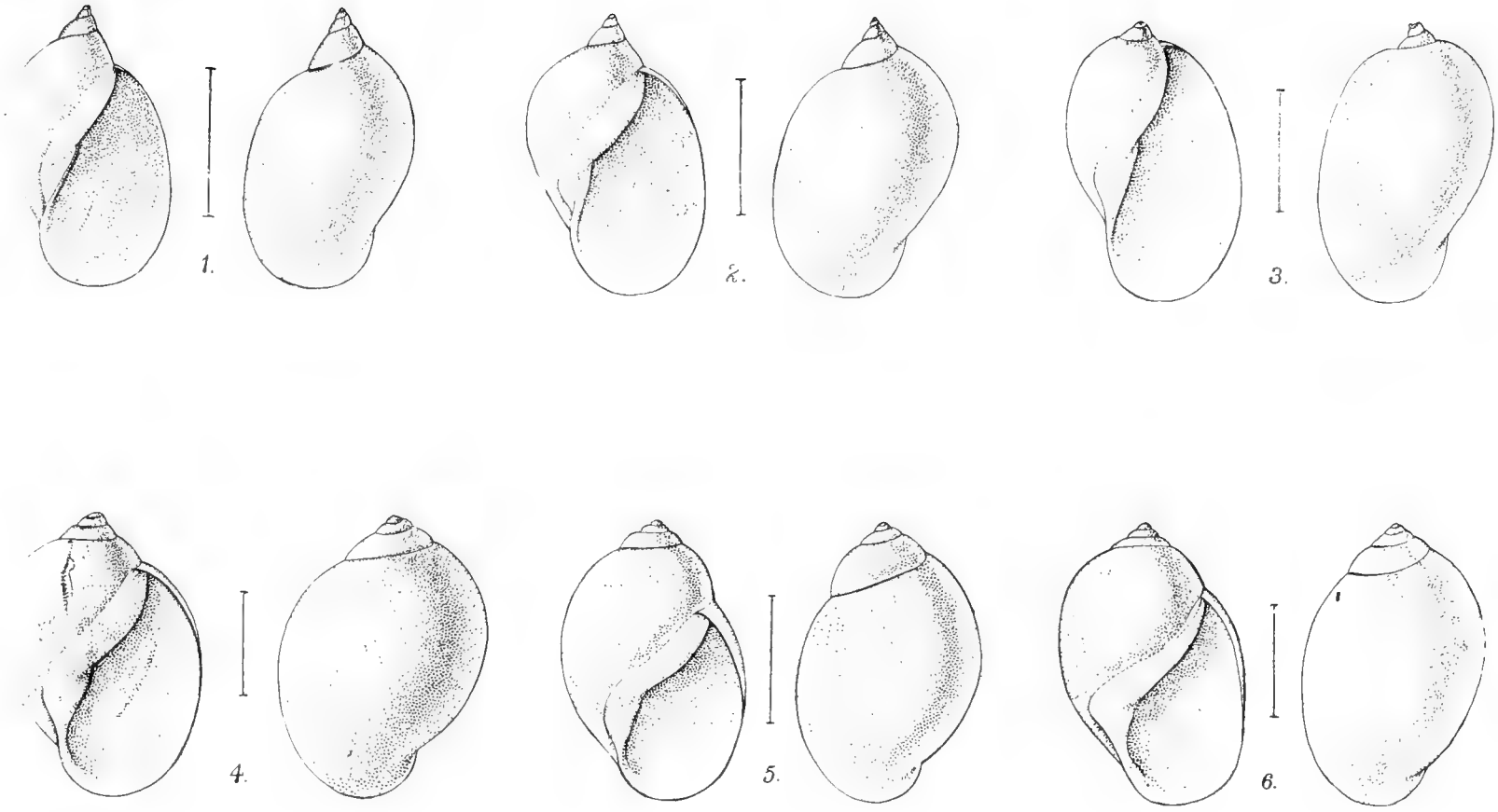
,, 2.—Normal shell from a patch of *Potamogeton* near the outflow of the same lake.

,, 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.



A. C. Chowdhary del.

Figs. 1—3. LIMNAEA ACUMINATA, Lam. Figs. 4—6. L. OVALIOR, sp. nov.

EXPLANATION OF PLATE VIII.

The line beween the two views of each shell shows the actual height of the specimen.

Limnaea andersoniana, Nevill.

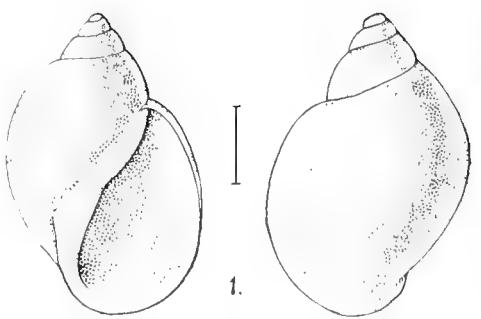
FIG. 1.—Type-specimen (pond-phase) from Nantin, Yunnan (*Anderson*).

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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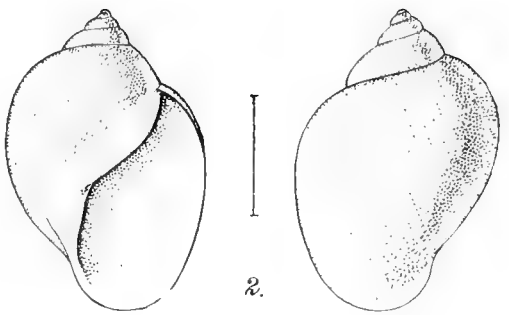

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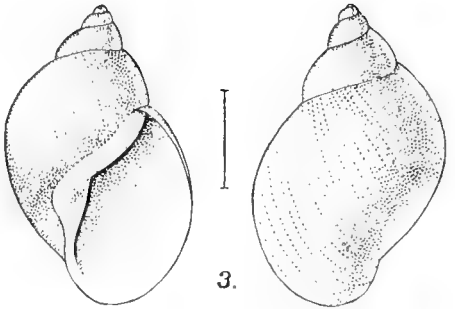

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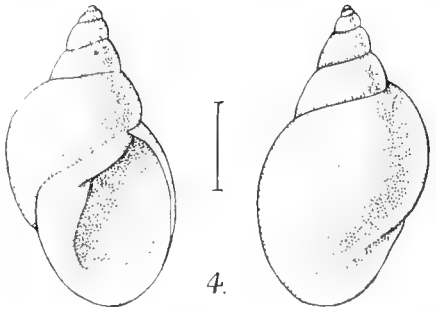

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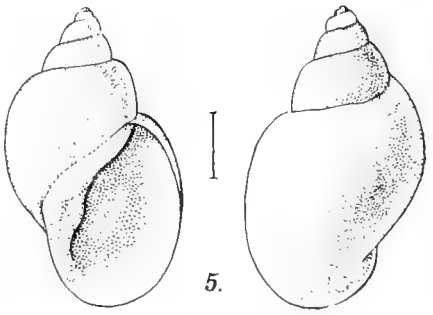

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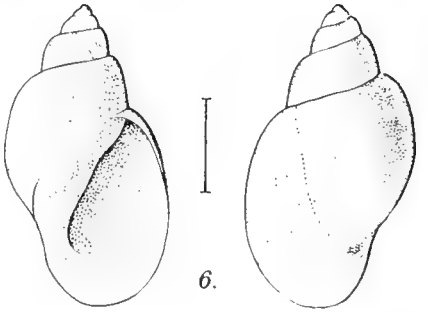

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LIMNAEA ANDERSONIANA. Nevill.

XXIX. INDIAN CYPRINOID FISHES BELONGING TO THE GENUS *GARRA*, WITH NOTES ON RELATED SPECIES FROM OTHER COUNTRIES.

By SUNDER LAL HORA, *M.Sc., Assistant Superintendent, Zoological Survey of India.*

(Plates XXIV—XXVI).

CONTENTS.

INTRODUCTION.

Among the Indian fresh-water fishes few have greater interest in the study of evolution than those belonging to the genus *Garra*. Great confusion has prevailed in the taxonomy of this genus, partly because many of the species exhibit considerable individual variability, and partly because ichthyologists have attempted to apply to them specific standards unsuitable for forms apparently still in the process of adaptation to their environment. Scale-counts, number of fin-rays and proportions are all important diagnostic characters in most Cyprinid genera; but in *Garra*, at any rate, they have much less significance than the structure of certain organs and appliances modified or produced in correlation with the peculiar mode of life adopted, apparently not very long ago, by the members of the genus. Before expressing an opinion as to how this has come about it is necessary that the genus should be investigated as completely as possible on anatomical and taxonomic lines. This Annandale attempted to do, so far as the taxonomy of the Indian species is concerned, in two recent papers (1919*a*, *b*), while Narayan Rao (1920) has still more recently published a third paper on the same subject and Annandale and I have discussed the generic position of the fish in a fourth (1920).

The great difficulty under which we have laboured hitherto has been that the type-specimens of older species were not available and that the figures and descriptions previously published were inadequate. This difficulty has now been overcome to a great extent, firstly because the old collection of the Indian Museum, including types of the species described by Day, which was sent to Dr. V. Pietschmann before the beginning of war, has been returned to Calcutta, and secondly because I have been able to visit and obtain specimens from the same localities in which Hamilton Buchanan found his specimens of *Cyprinus* (*Garra*) *lamta*, the genotype of *Garra*. The collection of the Zoological Survey of India has also been very largely augmented by the addition of specimens from many parts of the Indian Empire, and we have in particular received from Mr. Narayan Rao and Mr. G. E. Shaw, to whom our best thanks are due, valuable series from Coorg and the Darjiling Himalayas respectively. The Bombay Natural History Society has also lent us some interesting forms, and practically all the Indian districts whence specimens of the genus have been described are now well represented in our collection.

My sincere thanks are due to Dr. N. Annandale for placing the valuable material in my hands for investigation and description and for allowing me to visit some hill-streams to study these fishes in nature. I am indebted to Dr. S. W. Kemp for going through the manuscript with me and also for some valuable suggestions. I have also to express my obligations to Mr. Tate Regan for the courtesy he has shown me in sending at my request a copy of Heckel's original description of the genus *Discognathus*.

HISTORY.

Hamilton Buchanan, in his classical work entitled "*An account of the Fishes of the Ganges*," published in 1822, was the first to describe a species—*Cyprinus lamta*—with a disc behind the lower jaw, which he "found in rivulets, with rocky bottoms, in the province of Behar, and in the Rapti River of the Gorakhpur District." This characteristic form he referred to his ninth division of *Cyprinus* which he termed *Garra*. A decade after this Gray (1832) figured a similar species, *Cyprinus gotyla*, also with a disc on the lower jaw, from "Mountain Stream, India"; while McClelland (1838, 1839, 1842) recorded a number of species with the same character from streams in the Eastern Himalayas. The latter, however, described his specimens under two genera, *Gonorhynchus* and *Platycara*, and seems to have attached no importance to the character of the disc. Sykes (1841) also paid little attention to this well-marked structure in *Chondrostoma mullya* from South India and it was left to Heckel to recognise its value as a generic distinction when he referred his Syrian specimens (1843) to the new genus *Discognathus*. Heckel refers to Gray's species and also to those described by McClelland, but seems to have been unaware of the existence of *Cyprinus lamta* and *Chondrostoma*

mullya. In 1844 he described *Discognathus fusiformis* from Bombay and two years later he recorded similar forms from Abyssinia. Jerdon (1849) recorded *Gonorhynchus gotyla* and described two new species in the same genus from South India; while Blyth (1860) adopted *Platycara* of McClelland in describing a new species from Burma. Bleeker (1863*a*) recognised Buchanan's *Garra* as a distinct genus and gave the name of *Garra ceylonensis* to a new species from Ceylon. In the *Atlas Ichthyologique*, III, p. 24, 1863, Bleeker described two subgenera of *Garra*, Ham. Buch., *Garra* and *Discognathus*, distinguishing them merely by the number of barbels, which are four in the former and two in the latter. Day (1865, 1867) in a series of papers on the Fishes of South India gave an account of some new species of *Garra*, and in 1869 erected a new genus *Mayoa* for two specimens he found in the Calcutta Museum which probably came from Northern India. After the publication of Günther's catalogue (1868) Day, when writing a "Monograph of Indian Cyprinidae" (1871), evidently recognised only one Indian species of *Discognathus*, for he places all the then known species, with the exception of *D. variabilis*, under the synonymy of *D. lamta*; at the same time he allowed his new genus, *Mayoa*, to stand with a single species, *M. modesta*. Next year he recorded a peculiar specimen from the Salt Range, Punjab, which he referred to *D. lamta*. In his later works Day (1878, 1889) abolished his new genus and recognised three species, viz. *D. lamta*, *D. jerdoni* and *D. modestus*. Steindachner (1867) recorded *Garra gotyla* from Simla and added a few notes on the characters of *G. lamta*. Günther (1868) recognised *Discognathus variabilis* and *D. nasutus* and described *D. macrochir* as a new species; all the remaining known forms he regarded as synonymous with *D. lamta*. In 1889 he also referred specimens collected in Afghanistan to *D. lamta*, while Playfair (1870) and Blanford (1870) gave on his authority the same name to their Arabian and Abyssinian specimens. Sauvage (1874) obtained a new species, *D. prochilus*, in China, while Lortet (1883) and Tristram (1884) referred their Palestine examples to *D. lamta*, the latter author pointing out, however, that they might represent the species—*D. rufus*—which Günther had considered to be a synonym of the former. Vinciguerra (1883) recorded *D. lamta* from Africa and described a new species, *D. chiarinii*, from the same continent. Later on, in 1889, while writing an account of the fishes of Burma, he named another new species *D. imberbis* and recorded *D. lamta*. Nikolsky (1897, 1899) recorded *D. variabilis* and *D. lamta* from Persia and its vicinity, but later on (1900) described the specimens which he had previously referred to *D. variabilis* as a new species, *D. rossicus*, while those referred to *D. lamta* were made the type of another new species, *Garra persica*, by Berg (1913). Boulenger in a series of papers (1901, 1903, 1905) and in his two works (1907, 1909) on the fishes of Africa stimulated research in this genus and himself described and figured as many as seven species of *Discognathus*, while quite recently another species has

been described from the same continent by Nichols and Griscom (1917). Vaillant (1902) described a new species, *D. borneensis*, from Borneo; this was referred to the genus *Garra* by Fowler (1905) and again placed in the genus *Discognathus* by Weber and Beaufort (1916). Pellegrin in 1905 gave the name of *D. rothschildi* to a species from Abyssinia; this Boulenger in 1909 regarded as doubtfully synonymous with *D. dembeensis*. Regan in 1909 and 1914 described two new species, one from Yunnan and the other from Waziristan respectively. Jenkins (1909), after having examined the specimens in the Indian Museum, preferred to call all of them *D. lamta* and in 1910 he also referred a fish from Baluchistan to the same species. In 1912 Garman described a new species, *G. imberba*, from Western Syechuan, China. He referred it to a new subgenus of *Garra*, which he termed *Ageneiogarra*. This subgenus he distinguished from the two others recognised by Bleeker (1863) by the absence of barbels. Zugmayer (1913) hesitatingly referred his examples from Pishin in Baluchistan to two species, *D. lamta* and *D. variabilis*; while Chaudhuri in the same year recorded *D. lamta* from the Abor Hills. Annandale (1913), when writing notes on the fishes of the Lake of Tiberias, recognised at least four races of *D. lamta* and in Chaudhuri's paper he pointed out that the Abor examples might represent the Assamese race *nasutus* of McClelland; in two more recent papers (1919) he recognised many Indian forms to be specifically distinct. Jordan and Evermann (1917), when urging the revival of old names, pointed out that *Garra* is a valid genus, and Rao (1920) has quite recently described certain fishes from Mysore under this generic name. Still more recently Annandale and myself (1920) discussed the advisability of recognising both *Garra* and *Discognathus* on certain anatomical grounds. Prashad (1919) described a new species from the Kangra Valley, Punjab, and in 1920 I outlined the evolution of *Garra* from the allied Cyprinid genera.

The chequered history of the genus *Garra*, characterised by the presence of a mental disc behind the lower jaw, has resulted from various causes. The greatest confusion has, however, centred round *Garra lamta* of which a short and inadequate description without a figure was given in *An account of the Fishes of the Ganges* by Hamilton Buchanan. An illustration of a species with the disc-character well marked occurs among the manuscript drawings of this author, now preserved in the library of the Asiatic Society of Bengal; it is labelled *Cyprinus godyari*. Both *godyari* and *lamta* are local names of the same fish in the Bhagalpur and Gorakhpur districts respectively, and it is clear from a remark on page 103 of Day's volume on the fisheries and botany of Bengal (in Hunter's *Statistical Account of Bengal*, 1877) that the two names refer to the same species. Day, who is quoting from a manuscript of Hamilton Buchanan, says, "The Godiyari of the Bhagalpur list is here called lamta."

There has also been some confusion as to the exact localities

whence Buchanan obtained his specimens of *godyari* and *lamta*. On page 81 of the volume cited above the habitat of the *godyari*, cited under the name *sahari*, is given as, "small streams among rocks south of Monghir"; the *lamta* has been stated to occur "in the Rapti River of the Gorakhpur District." Nowadays Monghyr is not included in the Bhagalpur District but is in a district of its own; the hills towards its south, to which Buchanan referred, are the well-known Kharagpur Hills. While gathering information for a tour in these hills my attention was drawn to a significant passage in the *District Gazetteer of Monghyr* (1909) where the author, dealing with the fishes of the Man River, observes that, "The pools below the waterfalls along the latter river are tenanted by a little fish which the woodmen declare to be the young *tengra*. When flood comes this little fish finds it very difficult to hold its own against the stream; but nature has provided it with a sucker, which enables it to fasten itself to the rocks and wait securely until the flood has passed." This passage proved of great assistance in determining the habitat of *Garra lamta* recorded by Hamilton Buchanan from the then known Bhagalpur District and in October 1920 a series of specimens was obtained in the Man River. The fish were fairly abundant in small pools below the *Katin* waterfall, but it was very difficult to net them as on the slightest provocation they would hide themselves underneath stones. By bailing the water from an isolated pool in the course of the *Katin nallah* eight specimens were obtained, one was found in the Bhaura Stream, a tributary of the Man River, and another near the *Uttar band*, the canal outlet on the eastern side. From the passage quoted from the *Gazetteer*, it would be inferred that the local name of *Garra lamta* is "*tengra*" in these parts. I have not been able to verify this, but found two local names instead current among the fishermen, *Gudar*[1] and *Patharchat*; in the former reference is made to the rounded subcylindrical form of the fish and in the latter to its habit of adhering to stones. The fish was said to be very common during the rains and it is stated that at this season a large number climb up the artificial waterfall known as *Katin*. After having made collections at Kharagpur, I went to Gorakhpur to see the fishes of the Rapti River, but failed to find a single specimen of *Garra*. Moreover the name *lamta* was strange in the town of Gorakhpur and its vicinity. Even enquiries from old fishermen elicited no information as to the occurrence of a fish with this name in the district, nor did they recognise as local fish some specimens of *Garra* which I had brought with me. It may here be remarked that the Rapti River near Gorakhpur is a muddy channel and its bed is nowhere rocky within a few miles of the town.

In giving a synopsis of the species of a genus of fish a good

[1] *Gudar* is also the vernacular name given to all species of *Nemachilus* in the Kumaon Hills.

deal of importance is generally attached to the number of fin-rays and scales, but in *Garra* these characters are variable and it is impossible to use them in separating one species from another. Jenkins (1909) relied on these very characters and came to the conclusion that, "there are no specimens of *Discognathus* in the Indian Museum which justify me in considering that there is more than one Indian species of this genus." In both the Indian and African species the general rule is that there are seven to eight branched and two to three unbranched rays in the dorsal, while in the anal there are five branched besides one or two that are unbranched. The number of scales along the lateral line varies from 33 to 44. Marked deviations from these numbers occur only as abnormalities and minor differences are always bridged over when a large series of specimens are examined from the same locality.

In the absence of any well-marked characters, in the number of scales and fin-rays, Günther (1868) attributed to *G. lamta* a very wide range extending from "Syria to Assam," and ever since this statement was made, authors in general have attributed any species of this genus from any part of this region to *G. lamta*. In particular Day, who had previously recognised several species from South India, subsequently (1871) referred them all to *G. lamta*, but later on (1878) insisted on the specific validity of *G. jerdoni*.

No less confusion has been caused by a black spot that is present in many species behind the angle of the operculum. Also there is often a series of black spots at the base of the fin-rays of the dorsal fin.

In certain species of *Garra* a proboscis is present on the snout and this has been regarded as a secondary sexual character restricted to males; in *G. stenorhynchus* and *G. bicornuta*, however, the proboscis is known to be common to both sexes. Very little is known about the variation of the proboscis or the conditions which influence its formation. I have found after examination and dissection of a large series of specimens from all parts of India that wherever a well-developed proboscis is present it is always common to both sexes except in the classical species *G. lamta*, in which a peculiar proboscis is present in the male sex only.

The credit of stimulating research in this genus belongs to Boulenger, who recognised many species of *Garra* from Oriental Africa and pointed out in 1907 that the Asiatic species of the genus were much in need of revision. Annandale (1913, 1919) attempted to revise the Indian species in a series of valuable papers, but unfortunately the old collection of the Indian Museum containing Day's types was at that time interned in Austria, having been sent to Dr. V. Pietschmann before the outbreak of war.

PROBABLE EVOLUTION OF THE DISC IN *GARRA*, AS REPRESENTED BY A SERIES OF SPECIMENS COLLECTED IN MANIPUR, ASSAM.

The young specimens on which the following observations were made, were collected in various hill-streams that flow into the Manipur Valley from the surrounding Naga Hills. I have figured eight stages in the text, seven of which are drawn from the Manipur specimens while stage 2 is a copy of the illustration previously published by Annandale and myself (1920). The original of the figure was then referred to *Garra nasutus*, but I am unable to assign it to any species now on account of the immaturity of the specimen, which is only 7·4 mm. in length. The Manipur examples are, however, much larger and I have been able to identify them as *Garra rupeculus*. This is one of the smallest known species of the genus and is extremely well-adapted for life in rapid running streams. The following are the localities and measurements of these examples :—

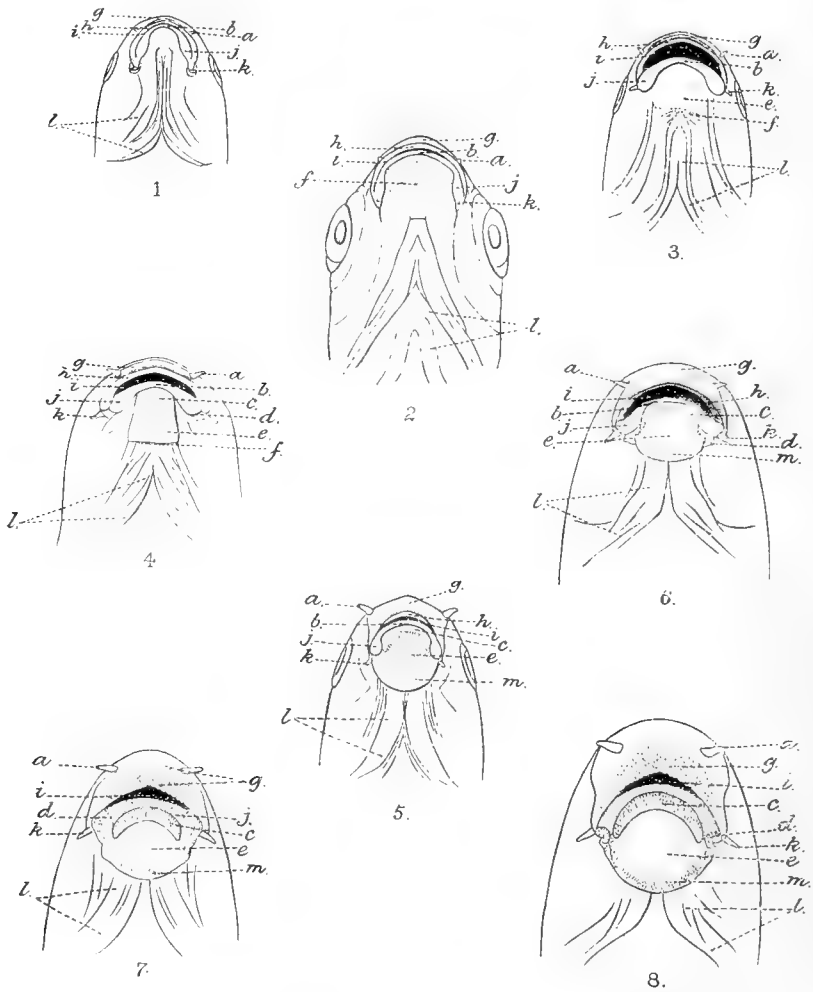
Stage No.	Locality.	Length without caudal.
		mm.
1	Small stream, 3 miles N.W. of Potsengbaum	13·4
3	Small stream near Kangpokpi	18·5
4	Thaubal stream near Yaribuk	20·0
5	Sikmai stream near Palel	18·5
6	Thaubal stream near Yaribuk	21·0
7	,, ,, ,, ,, ...	19·0
8	,, ,, ,, ,, ...	25·0

It is unfortunate that very little attention was paid to the preservation of these specimens in the field; I was not aware at the time that these young examples would yield such interesting results. The region of the head, however, is well preserved in all the specimens, but the opening of the mouth, which in some examples gapes widely, while in others it is completely closed, considerably alters the ventral aspect, especially the extent of the labial folds and the lips. It is clear from the measurements given above that the stages in the development of the disc are not necessarily correlated with size, but that they may depend upon the age of the fish. We are as yet ignorant of the stimuli that hasten or retard the development of this interesting organ in a particular environment.

The figures are semi-diagrammatic and are drawn with the help of a camera lucida.

Great difficulty has been experienced in the terminology of the disc and its associated structures. The mouth in this genus is situated on the under surface and hence the so-called upper and lower lips are really anterior and posterior in relation to the mouth. Moreover the true lips are only visible either in the less advanced species or in the younger stages of the more advanced forms; with

the growth of the fish they are in the latter case covered by secondary folds. These, the anterior and the posterior labial folds, have hitherto been termed the upper and the lower lips.



Text-fig. 1.—Development of mental disc in *Garra*.

1—8 represent successive developmental stages of the disc in *Garra*.

a = rostral barbel; *b* = median portion of posterior lip; *c* = posterior labial fold; *d* = connective; *e* = callous portion of disc; *f* = papillate disc rudiment; *g* = anterior labial fold; *h* = anterior lip; *i* = mouth; *j* = lateral swollen portions of posterior lip; *k* = maxillary barbels; *l* = branchiostegal rays; *m* = posterior free margin of disc.

Although the development is gradual I have thought it convenient to select a number of representative stages and to describe each in detail.

In stage 1 the mouth is situated slightly behind the tip of the snout and is bordered by the true lips. In front of the ante-

rior lip (*h*) is a narrow groove which separates it from the fold (*g*) covering the tip of the snout. Both the lips are continuous near the angle of the mouth. The anterior lip is of almost uniform thickness throughout and is partially covered by a flap of the posterior lip (*j*) near the angle of the mouth. The posterior lip can be divided for description into three parts, the median narrow part (*b*) and the two swollen bulb-like lateral portions (*j*). The bony elements of the jaws are not visible. There are two pairs of short barbels and the eyes are distinctly visible from below. There is as yet no indication of the disc and the branchiostegal membranes which meet at an acute angle are continued forwards for a considerable distance.

A slightly more advanced stage is shown in figure 2, the only noteworthy feature being the presence of an almost circular area (represented by dotting in fig. 2) immediately behind the posterior lip. This area I consider to be the rudiment of the disc organ.

In stage 3 the disc rudiment (*f*) is restricted and is represented by a few papillate concentric lines, the squarish area between these and the posterior lip may now be called the disc proper (*e*). At this stage the branchiostegal membranes are slightly separated and the branchial isthmus has become wide.

A marked change is shown in stage 4. The disc rudiment is now represented by a transverse line of papillae (*f*) just behind the disc proper (*e*); the anterior portion of the latter is indistinctly demarcated as a somewhat prominent lobe which ultimately develops into the posterior labial fold (*c*). Changes have also taken place in the lateral bulb-like portions of the posterior lip (*j*). A small area on each side is separated off just at the angle of the mouth and is represented in the figure as a connective (*d*) between the anterior and the posterior lips. The branchial isthmus is still further widened and the branchiostegal rays are slightly reduced with their membranes somewhat separated. By a careful comparison of the four stages it can readily be seen that the mouth has shifted backwards and that the anterior labial fold is coming into prominence.

Between the fourth and the fifth stage there is a lack of continuity. The disc rudiment is entirely absent and the anterior labial fold is more extensive; it has almost covered the anterior lip (*h*), of which only the median portion is visible. The mouth opening has shifted still further backwards and the disc is well marked with lunate anterior (*c*) and semicircular posterior (*m*) borders. In the development of the branchial isthmus, the branchiostegal membranes and rays and the posterior lip, the specimen from which this stage is described is less advanced than that shown in stage 4. The connectives have not yet been separated, though near the angle of the mouth the lip is greatly swollen.

In stage 6 the features of the disc and the anterior labial fold (*c*) are well pronounced, and the connective (*d*) is a distinct structure. Changes have also taken place in the posterior lip and

the branchial region. The antero-median portion of the posterior lip (*h*) has become very thin and in its place the anterior border of the disc is coming into prominence. In the branchial region the isthmus is wider, and the rays much reduced.

In stage 7 we are approaching the definitive form. The anterior lip is entirely hidden underneath the labial fold which is now distinctly fringed and tuberculate, and the median portion of the posterior lip is represented by small prominences in front of its posterior swollen region. The connective is well-marked and forms an anterior continuation of the posterior border of the disc on either side. The posterior jaw is now visible in the middle. The branchiostegal membranes no longer meet behind the disc and their rays are greatly reduced.

In the final stage all traces of the posterior lip are gone except for the connective (*d*) near the angle of the mouth ; the mouth is now surrounded by secondary folds both anteriorly and posteriorly. The isthmus is much wider and the rays in the branchiostegal membranes greatly reduced. From this stage it is but a small step to reach the condition found in the adults of the most advanced species. The only change is that the isthmus is still wider and the rays further reduced.

It will be advantageous at this point to enumerate the lines along which the development of the under surface of head has taken place in *Garra* :—

(i) The anterior labial fold develops considerably and ultimately covers the anterior lip.

(ii) The anterior lip, though prominent in the younger stages, is much reduced in the older and is covered by the anterior labial fold.

(iii) The mouth, which at first occupies a position near the tip of the snout, becomes shifted backwards and in all the older stages is clearly ventral in position.

(iv) The posterior lip in younger stages is narrow in the middle, but greatly thickened near the angle of the mouth. During the development of the fish the median part is replaced by a posterior labial fold ; but the thickened portions near the angles separate off and form definite connectives on either side between the upper labial fold and the posterior border of the disc.

(v) The disc begins as a finely papillate squarish area just behind the posterior lip. Its anterior portion is early marked off into the disc proper and the papillae (which are probably the disc rudiments) are pushed backwards. They ultimately vanish and their place is taken by the posterior border of the disc. The anterior border of the disc is marked off as a posterior labial fold having a callous circular portion in the middle.

(vi) The branchial membranes containing the branchiostegal rays meet for a considerable distance in young individuals, but with the growth of the fish they are widely separated and the rays in them greatly reduced.

(vii) The eyes in the adult are usually invisible from below though visible in the first few stages on the under surface.

It seems quite probable that the various changes enumerated above have been brought about by the rolling of the skin covering the snout towards the under surface and that the mouth changes its position and is being gradually shifted backwards. By this process the anterior labial fold is formed and the divergence and reduction of the branchiostegal membranes and the rays brought about. How the true lips are replaced by secondary folds is a matter of detail. The disc develops from the papillate disc rudiment.

In adults of certain less specialised species of the genus, the structure of the disc and the associated organs resembles a stage in the development of typical species of the genus. Thus *G. chaudhurii* and *G. quadrimaculatus* are similar to stage 4, while *G. vinciguerrae* shows a considerable resemblance to stage 5. In almost all the species that occur in Persia, Syria and Africa the mental disc is less specialised and the true lips are usually present. The new species from Darjiling is represented by three specimens, two of which are mature males and the other a ripe female. The mental disc in the three specimens shows progressive specialisation beginning with stage 4 of the developmental series described above. It is not uncommon to find one or two specimens in a big collection of typical *Garra* in which the branchiostegal rays meet at an acute angle behind the disc and the branchial isthmus is narrow. It is still more common to meet with examples in which the posterior and the anterior borders of the disc are poorly developed, but it is always possible, after examining a large number of individuals from the same locality, to refer them along with normal specimens to their proper species.

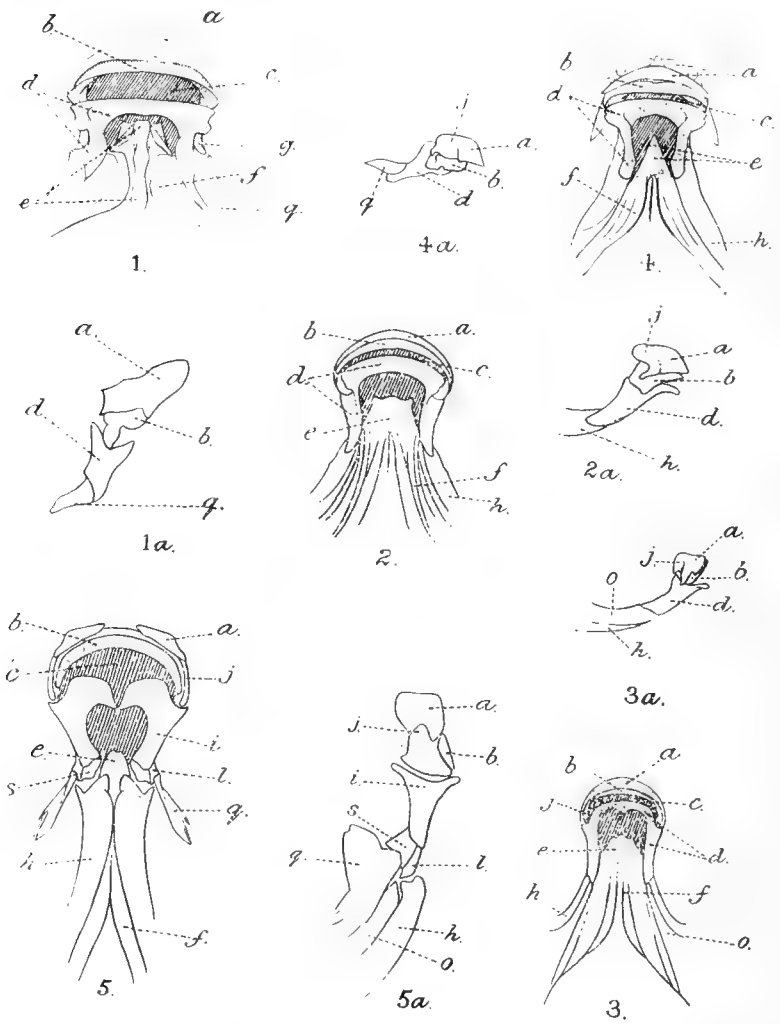
In the collection of the Zoological Survey of India there is a series of young specimens from Madras collected by Major Sewell. Of these I have been able to determine only four stages which are separated from each other by fairly wide gaps.

SKELETON OF THE MOUTH-PARTS.

Boulenger (1907), when defining the genus *Discognathus*, gave the following short account of its skeleton:—"The skeleton is very similar to that of *Labeo*, but the premaxillaries emit short ascending processes, the posterior edge of the mandible is raised into a process at the symphysis, and the clavicles do not form a diaphragm." So far as the skeleton of the mouth-parts is concerned, I find great dissimilarity between that of *Labeo* and that of *Garra*. The nearest approach to *Garra* is made by *Cirrhina* and *Crossochilus*. The following are some of the salient points in which the mouth-parts of *Labeo* (fig. 2, 5, 5*a*) differ from those of the other genera enumerated above:—

(i) The bones are distinct and separate and have not coalesced to form a rigid structure.

(ii) The maxillae of the two sides are widely separated in the middle.



TEXT-FIG. 2.—Skeleton of mouth-parts of *Garra* and allied genera.

1. *Garra mullya* (Sykes), ventral view.
1*a*. Same, lateral view of upper and lower jaws.
2. *Garra rossicus* (Nikolsky), ventral view.
2*a*. Same, lateral view of upper and lower jaws.
3. *Cirrihina mrigala* (Ham. Buch.), ventral view.
3*a*. Same, lateral view of upper and lower jaws.
4. *Crossochilus latia* (Ham. Buch.), ventral view.
4*a*. Same, lateral view of upper and lower jaws.
5. *Labeo rohita* (Ham. Buch.), ventral view.
5*a*. Same, lateral view of upper and lower jaws.

a = maxilla ; *b* = premaxilla ; *c* = mouth cavity ; *d* = lower jaw ; *e* = urohyal ; *f* = branchiostegal rays ; *g* = portion of skull ; *h* = preoperculum ; *i* = dentary *j* = jugal ; *l* = splenial ; *o* = interoperculum ; *q* = quadrate ; *s* = articular.

(iii) The articular and dentary bones on each side have fused to form a single piece, but those of the two sides are distinctly separate.

(iv) The preopercular bones meet or slightly overlap just behind the lower jaw, presenting an articular surface anteriorly.

(v) The branchiostegeal rays are concealed under the opercular borders anteriorly and are not visible for a considerable distance behind the mouth.

(vi) The mouth points anteriorly and is considerably nearer to the dorsal than to the ventral profile of the fish.

From the points enumerated above it is clear that *Labeo* represents a skeletal structure of the mouth-parts, which is at a low stage of organisation; but at the same time we must remember that in *Labeo* the mouth is suctorial and this probably accounts for the mobility of its component parts.

Now let us examine more closely the condition found in a specialised member of the genus *Garra* (fig. 2, 1, 1*a*). The sutures between the various bones are absent and the skeleton presents a solid structure. The mouth having been shifted backwards, the maxillae and the premaxillae are well developed and are fairly broad. The backwardly directed process of the posterior jaw (corresponding to the articular bone, etc., of other bony fishes) is short and curved instead of being straight as in *Labeo*; those of the two sides are widely separated and articulate with the quadrate of each side respectively. The basihyal is very prominent in the middle behind the lower jaw and is distinctly separate from other structures throughout its length posteriorly. Anteriorly it is flattened out laterally on the dorsal surface and to this are attached the anterior ends of the branchiostegal rays which are greatly reduced and are represented by two or three short bony elements. The rays of the two sides are widely separated in the middle. On account of the position of the mouth, both the jaws have to be accommodated in a short space.

In a less specialised form of the same genus (fig. 2, 2, 2*a*) the fusion of the bony elements is not complete and the position of the mouth near the tip of the snout considerably alters the whole arrangement. The jugal is visible as a separate bone and a faint line of demarcation can be made out between the dentary and the articular bones. The articular is almost straight and meets the opercular border behind; it is visible on the ventral surface. The basihyal is seen as a rounded process behind the posterior jaw, but is covered for a greater part of its length by the branchiostegal rays, which are but slightly reduced. The rays of the two sides meet for a considerable distance on the ventral surface.

The structure met with in *Cirrhina* (fig. 2, 3, 3*a*) is not very different from that described above, the only difference being that more of the opercular elements are visible on the under surface, the visible portion of the basihyal is further reduced and the branchiostegal rays and the articular bones have become more marked.

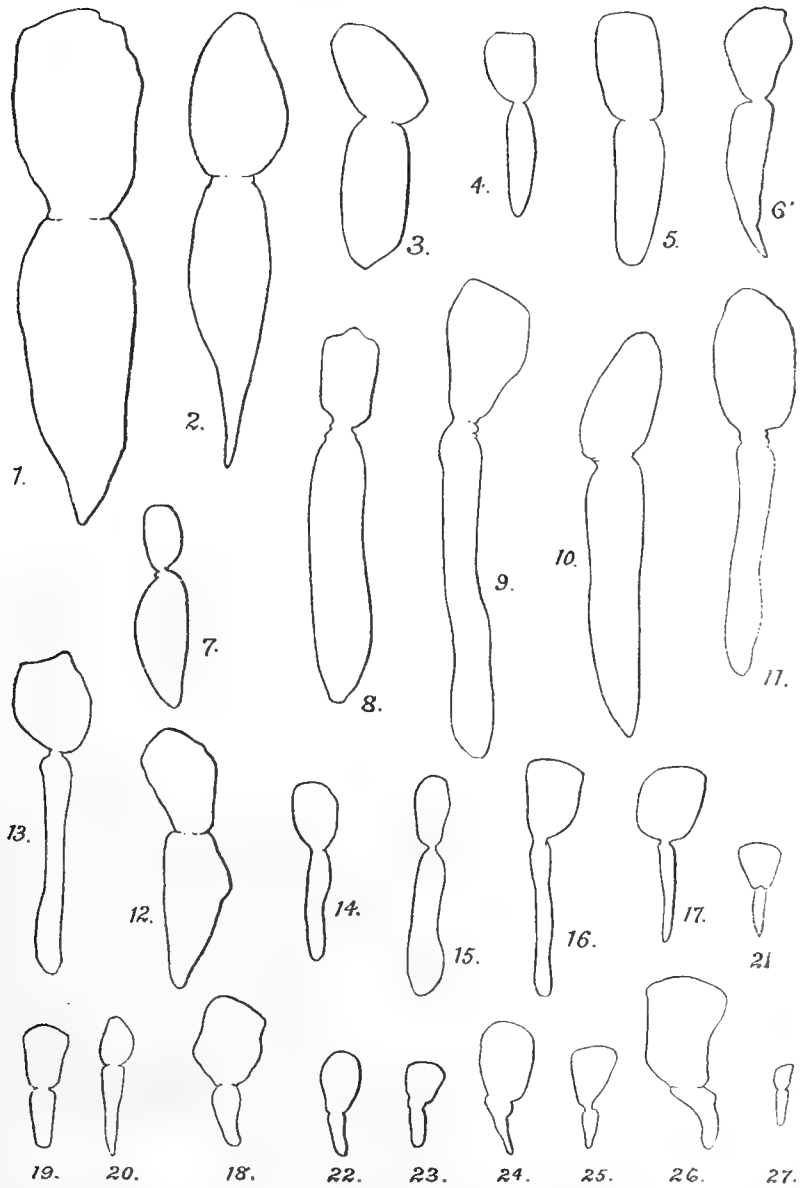
In *Crossochilus* (fig. 2, 4, 4*a*) the mouth is situated considerably behind the tip of the snout and consequently the structure of the mouth-parts is different from that found in *Cirrhina*, and in certain respects resembles that of a specialised form of *Garra*. It may also be pointed out that, like *Garra*, a fringed, tuberculated, well-developed anterior labial fold is present in *Crossochilus*. The articular bone is fairly extensive and only a small portion of the basihyal is visible from below. The branchiostegal rays meet for a short distance behind the tip of the basihyal and then suddenly diverge outwards. The rays are reduced.

AIR-BLADDER AND ASSOCIATED SKELETAL STRUCTURES.

The air-bladder has long been considered to be an organ of the greatest importance in the taxonomy of the bony fishes and especially in distinguishing the families of Cyprinoidea. I have carefully examined this organ in the various species of *Garra* and also in *Labeo rohita*, *Cirrhina mrigala* and *Crossochilus latia*. The comparison is instructive. The normal type of bladder is present in *Cirrhina* (fig. 3, 2) and *Labeo* (fig. 3, 1) and its length is contained about 3·3 times in the length of the fish including the caudal fin. The anterior chamber is smaller than the posterior and is in the form of a short massive cylinder. The posterior chamber is almost as broad as the anterior a short distance behind its commencement, but thence it gradually tapers to the end. In all the less modified species of *Garra* that I have examined, viz. *G. adiscus*, *G. rossicus*, *G. blanfordi* and *G. rufus*, the bladder agrees with this type in form and extent, whereas in all specialised species of the genus and in *Crossochilus latia* it is somewhat modified. The modifications chiefly consist in the form and extent of the posterior chamber, which, instead of being swollen in the middle, may be of uniform thickness throughout, with its walls somewhat thickened. This condition is found in *Garra gravelyi*, *G. jenkinsonianum* and *G. mullya*. In the remaining species the whole of the bladder is greatly reduced and its length is never contained less than 5 times in the length of the fish. The extreme phase of reduction within the genus is reached in *Garra stenorhynchus*, *G. arabica*, *G. gotyla* and *G. nasutus*, in which the bladder is contained about 15 times in the length of the fish without the caudal. In *G. gotyla*, *G. nasutus* and *G. lissorhynchus*, the bladder is covered by a thick, fibrous coat and is firmly fixed to the body-wall. In some species the posterior chamber is greatly reduced and its cavity almost obliterated.

In *Crossochilus* (fig. 3, 11) the bladder resembles that of certain species of *Garra*; its length is contained 5·3 times in the total length of the fish. The posterior chamber is long but of uniform thickness throughout.

Having found so much variation in the species of *Garra* as regards this interesting organ I was almost tempted to regard it



TEXT-FIG. 3.—Air-bladder of *Garra* and allied genera.

1. *Labeo rohita* (Ham. Buch.).
2. *Cirrhina mrigala* (Ham. Buch.).
3. *Garra rufus* (Heckel).
4. *Garra blanfordi* (Boulenger).
5. *Garra rossicus* (Nikolsky).
6. *Garra adiscus* (Annandale).
7. *Garra lamta*, Ham. Buch.
8. *Garra jenkinsonianum*, sp. nov.
9. *Garra gravelyi* (Annandale).
10. *Garra mullya* (Sykes).
11. *Crossochilus latia* (Ham. Buch.).
12. *Garra bicornuta*, Rao.
13. *Garra mullya* (Sykes), hill-stream form.
14. *Garra notata* (Blyth).
15. *Garra* sp. (from Persia).
16. *Garra naganensis*, sp. nov.
17. *Garra prashadi*, sp. nov.
18. *Garra jerdoni*, Day.
19. *Garra kempi*, sp. nov.
20. *Garra abhoyai*, sp. nov.
21. *Garra lissorhynchus* (McClelland).
22. *Garra gotyla* (Gray).
23. *Garra nasutus* (McClelland).
24. *Garra stenorhynchus* (Jerdon).
25. *Garra arabica*, sp. nov.
26. *Garra stenorhynchus* (Jerdon).
27. *Garra rupeculus* (McClelland).

as a specific character; but further examination showed that it is not only variable in the different species of the genus, but differs in individuals of the same species as well. Moreover, in the young individuals it is in all species very much like the normal form. As I have already remarked, it is not surprising to find considerable variation in an organ which shows retrogressive degeneration. I hope to deal with this aspect of the matter shortly in a separate paper dealing with the adaptations of the hill-stream fishes.

I have examined the weberian ossicles in these genera and do not find any great departure in any of them from the normal form. The platform formed by the transverse processes of the third vertebra shows certain modifications, but their discussion is beyond the scope of the present enquiry.

GARRA AND *DISCOGNATHUS*.

Quite recently Annandale and myself (1920) recognised *Discognathus* as a separate genus from *Garra*, basing our distinction mainly on the position of the mouth, which in the former is situated near the tip of the snout, on the presence of vestigial lips and disc in *Discognathus* and lastly on the fact that in the genus *Discognathus* the "opercular and preopercular borders" meet "at an acute angle on the ventral surface some distance behind the adhesive disc." In view of the developmental series described above and also in view of the occurrence in the Darjiling Himalayas of a form very similar to *G. quadrimaculatus* from Oriental Africa, I am unable to retain the view recently expressed by Annandale and myself. If two genera are adopted the systematic position of certain stages in the development of some advanced members of *Garra* becomes obscure and certain abnormalities due to restricted development cannot easily be referred to their proper genera.

Garman (1912) divided the species of the genus *Garra* into three groups which he considered as distinct subgenera. He based his distinction on the number of barbels and recognised Bleeker's (1863) two subgenera, *Garra* and *Discognathus*, as valid. He at the same time proposed a new subgenus, *Ageneiogarra* (to accommodate his species *G. imberba* from China), characterised by the absence of barbels. The specific name he employed for his new species is preoccupied, as Vinciguerra (1889) has described a fish from Burma as *Discognathus imberbis*. The barbels are so minute throughout the genus that I do not regard their occasional absence as a character of subgeneric importance.

As regards the relationship of *Garra* with other Cyprinid genera, it is better to postpone a full discussion until the Malay forms assigned to *Crossochilus* are available for examination. It may, however, be pointed out that great similarity exists between the mouth-parts of *Cirrhina*, *Crossochilus* and *Garra* and that *Cirrhina* holds the same relation to *Crossochilus* which the less specialised members of *Garra* hold to the more specialised forms in the genus.

SYNOPSIS OF THE INDIAN AND SOME OF THE EXTRA-INDIAN SPECIES OF *GARRA*.

In the synopsis I have included 21 Indian and 5 extra-Indian species of *Garra*. With the exception of *G. imberbis*, which can be easily recognised by the total absence of its barbels, I have examined specimens of all Indian species. I have not included *G. wanae* from Waziristan because in Regan's description of the species I could not find those characters which I have employed in building up the synoptic table.

The table does not apply to young individuals. The names of extra-Indian species are placed in square brackets.

a. Barbels absent ... ... *G. imberbis* (Vinciguerra).

a'. Barbels present.
  b. Pupil of eye wholly in posterior half of head.
    c. Proboscis present.
      d. Proboscis trilobed.
        e. Lateral lobes of proboscis short and in front of nostrils ... ... [*G. arabica*, sp. nov.]
        e'. Lateral lobes of proboscis almost as long as central lobe, covering nostrils .. ... *G. bicornuta*, Rao.
      d'. Proboscis a single projection without lateral lobes.
        e. Proboscis well-developed with well defined lateral tubercular areas.
          f Snout as seen from below trenchant and bearing a well-defined almost semi-circular lobe; space between gill-openings on under surface less than post-orbital length of head. *G. monti-salsi*, sp. nov.
          f'. Snout from below evenly rounded and convex; space between gill-openings on under surface greater than post-orbital length of head.
            g. Eyes small, contained 5 to 6 times in length of head; distance between anus and origin of anal fin less than 1/3 the distance between origins of anal and ventral fins ... ... *G. gotyla* (Gray).
            g'. Eyes moderately large, contained 3·7 to 4·3 times in length of head; distance between anus and origin of anal fin greater than 1/3 the distance between origins of anal and ventral fins ... ... *G. stenorhynchus* (Jerdon).
        e'. Proboscis not well developed, represented by a prominent squarish area in front of nostrils; lateral tubercular areas poorly developed.
          f. Dorsal fin considerably higher than length of head; lobes of caudal fin equal ... *G. gravelyi* ♂ (Annandale).
          f'. Dorsal fin almost equal to or less high than length of head; lobes of caudal fin not equal ... ... *G. nasutus* (McClell.).
    c'. Proboscis absent.
      d. Tubercular areas on snout present ... *G. jerdoni*, Day.
      d'. Tubercular areas on snout absent ... *G. annandalei*, Hora.
  b'. Pupil of eye not wholly in posterior half of head.
    c. Pupil of eye nearer posterior margin of operculum than tip of snout.

d. Proboscis present on snout forming a distinct median knob; no groove marking off tip of snout — *G. lamta* ♂, Ham. Buch.

d'. Proboscis absent or represented by a raised area between the nostrils.

e. Tubercles on snout usually present; two short lateral grooves marking off tip of snout ... — *G. mullya* (Sykes).

e'. Tubercles if present few; no grooves on snout (snout smooth).

f. Anterior origin of dorsal equidistant from tip of snout and base of caudal.

g. Scales present in post-pelvic region and on dorsal surface in front of dorsal ... — *G. lissorhynchus* (McClell.).

g'. Scales absent in post-pelvic region and on dorsal surface in front of dorsal .. — *G. abhoyai*, sp. nov.

f'. Anterior origin of dorsal not equidistant from tip of snout and base of caudal.

g. Ventrals distinctly reaching beyond anal opening.

h. Anus situated almost midway between anterior origins of anal and ventral fins — *G. kempi*, sp. nov.

h'. Anus not situated midway between anterior origins of anal and ventral fins.

j. Distance between anus and anterior origin of anal fin greater than 1/3 distance between anterior origins of anal and ventral fins ... ... — *G. naganensis*, sp. nov.

j'. Distance between anus and anterior origin of anal fin less than 1/3 distance between anterior origins of anal and ventral fins ... ... — *G. prashadi*, sp. nov.

g'. Ventrals almost reaching or not reaching the anal opening .. ... — *G. gravelyi*, ♀ (Annandale).

c'. Pupil of eye almost in middle of head or nearer tip of snout than posterior border of operculum.

d. Belly and dorsal surface in front of dorsal fin naked ... ... — *G. rossicus* (Nikolski).

d'. Belly and dorsal surface in front of dorsal fin not naked.

e. Anterior origin of dorsal almost equidistant from tip of snout and base of caudal.

f. Maxillary barbels shorter than diameter of eye.

g. Diameter of eye contained 3·9 times in length of head .. .. — [*G.* sp.]

g'. Diameter of eye contained 4·4 times in length of head ... ... — *G. notata* (Blyth).

f'. Maxillary barbels longer than diameter of eye ... ... — *G. chaudhurii*, sp. nov.

e'. Anterior origin of dorsal not equidistant from tip of snout and base of caudal.

f. Anterior origin of dorsal nearer tip of snout than base of caudal

g. Mental disc absent or rudimentary ... — [*G. adiscus* (Annandale).]

g'. Mental disc present.

h. Anterior origin of ventrals distinctly nearer base of caudal than tip of snout.

j. Anterior origin of anal nearer base of caudal than anterior origin of ventrals ... ... — *G. lamta*, ♀ Ham. Buch.

j'. Anterior origin of anal nearer anterior origin of ventrals than base of caudal ... ... [*G. rufus* (Heckel).]

h'. Anterior origin of ventrals almost equidistant from base of caudal and tip of snout ... ... *G. jenkinsonianum*, sp. nov.

f'. Anterior origin of dorsal nearer base of caudal than tip of snout.

g. Ventrals extending beyond anal opening; anus considerably removed from base of anal fin ... ... *G. rupeculus* (McClell.).

g'. Ventrals just reaching anal opening; anus close to base of anal fin ... [*G. blanfordi* (Boulenger).]

Part I. INDIAN SPECIES OF *GARRA*.

Garra bicornuta, Rao.

1920. *Garra bicornuta*, Rao, *Ann. Mag. Nat. Hist.* (9), VI, p. 57, pl. i, figs. 3, 3*a*, 3*b*.

Of this species I have examined six specimens; three are females and in the remaining three I have not been able to determine the sex.

There is a well-marked trilobed proboscis on the snout. The lateral lobes are free and tapering while the median lobe is represented by an immoveable rectangular prominence. The nostrils are situated near the bases of the former and are covered over by them.

The air-bladder is reduced, but its form is of the normal Cyprinid type. The following are the dimensions of the air-bladder in a specimen 9·7 cm. in length:—

Length of anterior chamber	... 6·5 mm.
,, ,, posterior ,, ...	... 11·0 ,,
Greatest diameter of anterior chamber ...	... 4·6 ,,
,, ,, ,, posterior ,, ...	... 3·6 ,,

In another mature female specimen 12·5 cm. in length, the air-bladder is contained almost 9 times in the total length of the fish

Tunga R., Mysore ... Narayan Rao ... 3 syntypes and 3 other specimens.

Garra monti-salsi, sp. nov.

1872. *Discognathus lamta*, Day, *Journ. As. Soc. Bengal* XLI (2), p. 318.

1878. *Discognathus lamta*, Day (in part), *Fish. India* II, p. 527, pl. cxxiii, fig. 1.

1889. *Discognathus lamta*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 346.

In this characteristic species the dorsal profile is slightly arched, the ventral is straight and horizontal anteriorly but rises to the base of the caudal fin posteriorly. The head is much depressed and is almost rectangular; its length is contained 3·9 times in the length of the fish without the caudal; it is 1·4 times as long as broad. The eyes are situated in the posterior half of

the head and their superior margin is coterminous with the dorsal profile; the diameter is contained 5 times in the length of the head. The interorbital space is somewhat concave and is 2·2 times as broad as the diameter of the eye. The snout is thrice the diameter of the eye and bears a well-developed median proboscis, which extends almost to the anterior end of the snout. The dorsal profile of the proboscis is convex and the ventral concave; it is constricted in the middle and is tuberculated near the anterior swollen end. The snout is marked by a deep transverse cleft near its anterior end and bears two prominent tubercular areas; when seen from below the snout appears to be trenchant and shows a well-defined almost semicircular lobe near its tip. The nostrils are situated externally at the base of the proboscis a short distance in front of the eye. The posterior nostril of each side is completely covered by a rectangular lid. The slit of the mouth is arched and the mental disc is well developed. There are two pairs of barbels shorter than the diameter of the eye. The gill-openings extend for a considerable distance on the under surface and are separated from each other by a distance slightly greater than the diameter of the eye; the opercular bones are not followed by a fleshy flap posteriorly. The lateral line is almost straight and is in the middle of the body; there are 32 scales along its length and 7 longitudinal rows between the bases of the dorsal and the ventral fins. The dorsal fin is situated nearer to the tip of the snout than to the base of the caudal fin; its base is equal to the length of the head in front of the posterior margin of the orbit; the first branched ray is the longest and is much higher than the body; the free margin of the fin is concave. There are eight branched rays in the dorsal besides three that are not branched. The ventrals are situated below the middle of the dorsal and their origin is slightly nearer the base of the caudal than the end of the snout; they extend to the anus and are somewhat shorter than the pectorals which are considerably shorter than the length of the head. The anal almost extends to the base of the caudal fin.

The air-bladder is small and the scales on the chest and on the middle of abdomen are poorly developed.

The unique specimen of the species had been opened out and the viscera removed, but still I have been able to find a few minute eggs in the oviduct. It is a female 109 mm. in length without the caudal fin.

Type-specimen.—F 9953/1, *Zoological Survey of India* (*Ind. Mus.*).

Locality.—The specimen was purchased from Day and is the original of the figure referred to above. It was collected for him "by Dr. Waagen from the Nilwan ravine near the Shapur salt ranges," Punjab.

Since the above description was written, I have found several specimens of the species in the unnamed collection of the Indian Museum from the Khewrah gorge (alt. 2000 ft.) in the Jhelum

District, Punjab. The adults agree with the type-specimen very closely. In the young individuals the proboscis is short and the snout when seen from below is not trenchant but is evenly rounded; the first few rays of the dorsal fin are greatly elongated and the gill-openings are somewhat wider.

Garra gotyla (Gray).

1832. *Cyprinus gotyla*, Gray, *Ill. Ind. Zool.*, pl. 88, figs. 3, 3*a*.
1867. *Garra gotyla*, Steindachner, *Sitz. Ak. Wiss. Wien* LVI (1), p. 360, pl. 2. figs.
1919. *Discognathus kangrae*, Prashad, *Rec. Ind. Mus.* XVI, pp. 163—165, figs. 1 and 1*a*.
1919. *Discognathus jerdoni* var. *kangrae*, Annandale, *Rec. Ind. Mus.* XVIII, p. 74.

It is after long hesitation and not without reserve that I recognise this species as valid. Gray has not given any description of his species, but as most of his figures are made from specimens collected in Northern India, I have referred the North Indian specimens with a well-developed proboscis to this form. The specimens from the Eastern Himalayas differ, as regards the shape and proportions of the head, from those found in the Western Himalayas. The eyes in both sets of specimens, are, however, in the posterior half of the head and are comparatively smaller than in allied species of the genus.

The air-bladder in a specimen from Kangra, Punjab, is minute; its anterior chamber possesses a thick fibrous coat which firmly attaches it to the dorsal body-wall. The walls of the posterior chamber are somewhat thickened. The following are the measurements of the bladder in a specimen 14 cm. in length :—

Length of anterior chamber	4·5 mm.
,, ,, posterior ,, ...	3·5 mm.
Greatest diameter of anterior chamber	3·0 mm.
,, ,, ,, posterior ,, ...	1·5 mm.

Garra gotyla has a fairly extensive but restricted range as it occurs along the base of the Himalayas throughout their length.

Jaugal Khad, Kangra, Panjab ...	N. Annandale ...	4.
Kangra Valley, hill-streams ...	Punjab Fisheries ...	12.
Ravi R., near Madhopur, Punjab	,, ,, ...	Several young.
Simla	Purchased from Day ...	1.
Chumba	,, ,, ...	1.
Dhikla, Gharwal Dist., U.P. ...	R. Hodgart ...	1.
Mahanadi R., Darjiling Dist. ...	G. E. Shaw ...	Several.

Garra stenorhynchus (Jerdon).

1849. *Gonorhynchus stenorhynchus*, Jerdon, *Madras Journ. Lit. Sci.* XV, p. 310.
1849. *Gonorhynchus gotyla*, Jerdon (*nec* Gray), *ibid.*, p. 309.
1867. *Garra gotyla*, Day (*nec* Gray), *Proc. Zool. Soc. London*, p. 288.
1919. *Discognathus jerdoni*, Annandale (*nec* Day) in part, *Rec. Ind. Mus.* XVI, p. 132.
1919. *Discognathus jerdoni*, Annandale (*nec* Day) in part, *Rec. Ind. Mus.* XVIII, p. 73, pl. ix, fig. 1 and pl. xi, fig. 3.

1919. *Discognathus stenorhynchus, id., ibid.*, p. 74, pl. ix, fig. 3; pl. xi, fig. 4.
1919. *Discognathus gotyla, id., ibid.*, p. 75, pl. x, fig. 1; pl. xi, fig. 6.
1920. *Carra jerdonia*, Rao (*nec* Gray) in part, *Ann. Mag. Nat. Hist.* (9) VI, p. 53.
1920. *Garra stenorhynchus, id., ibid.*, p. 53.

The proboscis on the snout exhibits considerable variation and it is on this account that so many different species have been recorded or described from South India. Having examined numerous specimens of this form, I am convinced that all these should be referred to *G. stenorhynchus*. The extent of the snout does not depend upon the age or the sexual maturity of the specimen as is shown by the collection before me. The specimens with a comparatively small proboscis have been referred to *B. jerdoni* (*nec* Day) both by Annandale and Rao; but on dissection some of them have been found to be full of eggs.

The air-bladder is rather characteristic and provides a good specific distinction. In a ripe female specimen 12 cm. in length, the following are the measurements of the bladder :—

Length of anterior chamber	5·0 mm.
,, ,, posteror ,, ...	3·5 mm.
Greatest diameter of anterior chamber	3·8 mm.
,, ,, ,, posterior ,, ...	2·0 mm.

The bladder is provided with a thicker coat; its posterior chamber is swollen anteriorly and drawn out into a fine process posteriorly, the walls of which are thickened.

Nierolay Stream, Bhavani R., Base of Nilgiris.	N. Annandale	11.
Hill-streams, Coorg, Mysore ...	C. R. Narayan Rao ...	18.
Mettupalaiyam, Dist. Coimbatore.	N. Annandale	7.
Nilgiris, Madras ...	F. Day	2.
Madras	,, ...	1.
?	A.S.B.	1.

Garra gravelyi (Annandale).

1918. *Discognathus lamta*, Annandale, *Rec. Ind. Mus.* XIV, p. 45.
1919. *Discognathus gravelyi*, Annandale, *ibid.*, XVI, p. 133, pl. ii, figs. 3, 3*a*.

Of the five specimens procured by Dr. N. Annandale from the Inlé Lake and the He-Ho stream, two are ripe females, one ripe male and two immature males. The type specimen of *G. gravelyi* is the mature male and differs considerably from the female specimens, but the presence of two young males serves to a certain extent as a connective link between the two forms. In the male the mental disc is better developed, the mouth is considerably behind the tip of the snout and consequently the labial fold is more extensive, the pectoral fins are longer than the head, the snout possesses an indistinct proboscis and the head and body are somewhat depressed with the chest almost naked, while the female lacks all these characters.

The air-bladder is quite normal and is not much reduced. In a specimen 9·7 cm. in length, the following are the measurements of the bladder:—

Length of anterior chamber	...	...	11 mm.
,, ,, posterior ,,	...	...	22 mm.

Specimens of this species were examined from the following localities:—

He-Ho stream, S. Shan States	N. Annandale ...	3.
Fort Stedman, Inlé Lake, S. Shan States.	,, ...	2.

Garra nasutus (McClelland).

Plate XXIV, fig. 4.

1838. *Platycara nasuta*, McClelland, *Journ. As. Soc. Bengal* VII (2), p. 947, pl. lv, figs. 2, 2*a* and 2*b*.
1839. *Platycara nasuta*, McClelland, *Asiatic Res.* XIX, p. 300, pl. lxvii, figs. 2.
1839. *Gonorhynchus caudatus*, McClelland, *ibid.*, p. 375.
1868. *Discognathus nasutus*, Günther, *Cat. Brit. Mus. Fish.* VII, p. 70.
1913. *Discognathus lamta*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 247.

This species is known to me from one adult specimen from the Abor Hills and from numerous young and half-grown specimens from Manipur, Assam and Manjhitar, Sikkim. As McClelland's description of the species is brief and his figures totally inaccurate, I take this opportunity to redescribe the species from the adult specimen with notes from the young examples.

D. 2/8—9. A. 2/5. P. 14. V. 8.

In *Garra nasutus* the head and body are greatly depressed and the fish comes to resemble the species of the Homalopterid genus *Balitora* in form. The dorsal profile is slightly arched; the ventral is straight and horizontal throughout. The head is almost as broad as long; the length is contained 5·7 times in the total length of the fish. The length of the caudal fin is contained 5·4 times and the depth of the body near the origin of the dorsal fin 6·2 times in the length of the fish. The eyes are dorso-lateral in position and are invisible from below; they are situated in the second half of the head and their diameter is contained 4·2 times in the length of the head, 2.6 times in the length of the snout and twice in the interorbital distance. There is a short, broad and indistinct proboscis on the snout; the tip of the snout is marked off into a rounded lobe. There are two pairs of short barbels, shorter than the diameter of the eye. The mental disc is almost circular and coextensive with the width of the head. The lateral line is straight; it is somewhat nearer to the ventral than to the dorsal surface. The scales are rather thin and almost indistinguishable; there are 34 scales along the lateral line and 8 longitudinal series of scales between the bases of the dorsal and the ventral fins. The dorsal fin is higher than the body and is almost as long as the head; its origin is nearer to the tip of the snout

than to the base of caudal fin. There are nine branched and two unbranched rays in it and the first branched ray is the longest. The ventrals originate before the fourth branched dorsal ray and extend to beyond the anal opening. The caudal fin is deeply emarginate, the lower lobe is much the longer. The colour of the body and head in spirit is uniformly dark brown with the exception of the ventral surface which is dirty-white. The colour of the upper and the lower surfaces of the paired fins corresponds to the colour of the dorsal and the ventral surfaces of the body respectively. There are black spots at the bases of the dorsal fin rays and the membrane between the rays is also blackened.

Extreme modification of the air-bladder occurs in this species. Both the chambers are minute and possess thick walls. There is a thick fibrous coat covering the bladder and fixing it firmly to the body-wall. The following are the measurements of the bladder in the adult specimen :—

Length of anterior chamber	2·5 mm.
,, ,, posterior ,, ...	3·5 mm.
Greatest diameter of anterior chamber	2·5 mm.
,, ,, ,, posterior ,, .	1·5 mm.

In the young specimens, the head and body is not greatly depressed and the air-bladder is comparatively larger. The two lobes of the caudal fin are unequal and an indistinct proboscis is present on the snout. The head is fairly long and bluntly pointed, and the eye in some examples is not wholly in the posterior half of the head. The upper surface is dark and the under surface of the head and belly is white. The fins are white and at the base of the dorsal fin there are small black spots; sometimes a big black blotch is present before the base of the caudal fin. In an example from Manipur one of the rostral barbels is furcate.

Annandale (see Chaudhuri, 1913) identified the Abor specimen from Siyom River as *Discognathus lamta* subsp. *nasutus* (McClelland).

Distribution.—McClelland recorded it from the Khasi and the Mishmi Hill tracts. Specimens of this species have now been obtained in the Abor Hills and in the Manipur Valley, Assam. I refer numerous young specimens from Sikkim to this species with some doubt.

Siyom R., below Damda, Abor Hills.	S. W. Kemp ...	... 1.
Assam	Purchased from Day	... ?
Manjhitar, Sikkim ...	B. L. Chaudhuri ...	... Several.
Streams in the Manipur Valley	S. L. Hora ...	... 20.

Measurements in millimetres.

Total length, including length of caudal	136·0
Length of caudal	25·0
Depth of body near origin of dorsal...	20·0
Length of head	23·5
Width of head	22·0
Diameter of eye	5·5
Length of snout	14·5

Interorbital width	11·0
Length of caudal peduncle	19·0
Height of caudal peduncle	12·5
Longest ray of dorsal	23·0
,, ,, ,, anal	19·0
Length of pectoral	24·0
,, ,, ventral	23·0

Garra jerdoni, Day.

1867. *Garra jerdoni*, Day, *Proc. Zool. Soc. London*, p. 288.
1878. *Discognathus jerdoni*, Day, *Fish. India*. II, p. 528, pl. cxxii, fig. 6.
1889. *Discognathus jerdoni*, Day, *Faun. Brit. Ind. Fish.* I, p. 247.
1919. *Discognathus elegans*, Annandale, *Rec. Ind. Mus.* XVIII, p. 76, pl. ix, fig. 4; pl. xi, fig. 5.
1920. *Garra platycephala*, Rao, *Ann. Mag. Nat. Hist.* (9) VI, p. 56, pl. i, figs. 2, 2*a*, 2*b*.

This species is readily recognised by its flat or slightly concave head and by the presence of a large number of prominent tubercular areas on the otherwise smooth snout.

Rao described *Garra platycephala* from young specimens in which the tubercular areas are not raised and the snout, though marked by a large number of mucous pores, is uniformly flattened.

The air-bladder is much reduced; the following are its measurements in a female example 13·9 cm. in length:—

Length of anterior chamber	6·5 mm.
,, ,, posterior ,,	5·0 mm.
Greatest diameter of anterior chamber	4·3 mm.
,, ,, ,, posterior ,,	2·5 mm.

Specimens of this species were examined from the following localities:—

Bhavani R., Nilgiris, Madras	...	Purchased from Day	... 1.
Nierolay Stream, base of Nilgiris	...	N. Annandale ...	... 2.
Cavery R., Seringapatam, Mysore	...	C. R. Narayan Rao	1.

Garra annandalei, sp. nov.

1878. *Discognathus lamta*, Day (in part), *Fish. India* II, p. 527, pl. cxxii, fig. 4.
1889. *Discognathus lamta*, Day (in part), *Faun. Brit. Ind. Fish.* I, p. 246, fig. 87.

The fish is almost subcylindrical with the head and body slightly depressed. The dorsal profile rises considerably from the tip of the snout to the base of the dorsal fin beyond which it gradually slopes to the base of the caudal fin. The ventral profile is straight throughout. The length of the head is contained 4·5 times and the depth of the body 4·5 to 5 times in the length of the fish without the caudal fin. The head is 1·2 times as long as wide. The eyes are laterally placed, slightly below the dorsal profile of the head, and are invisible from below; the diameter is contained 5·2 times in the length of the head and about 2·5 times in the length of the snout and in the interorbital width. The mouth

is small and is situated considerably behind the anterior end of the snout; the mental disc is well developed. There are two pairs of short barbels, shorter in length than the diameter of the eye; a distinct deep groove runs from the base of the rostral barbels to the angle of the mouth. The dorsal fin commences in advance of the ventrals and is distinctly nearer the tip of the snout than the base of the caudal fin; its longest ray is shorter than the depth of the body below it. The pectorals are shorter than the head and are separated from the ventrals by half of their own length. The ventrals extend beyond the anus but do not reach the base of the anal fin. The caudal fin is deeply emarginate; the caudal peduncle is 1·2 times as long as high. The lateral line is straight and runs almost in the middle of the body. There are 34 to 38 scales along the lateral line and 8 series of longitudinal rows of scales between the bases of the dorsal and ventral fins. There is a scaly sheath to the base of the dorsal and a scaly appendage to that of the ventrals. The scales are large but inconspicuous on the chest while they are fairly well marked on the belly.

The sides and the upper surface of the head and body, in spirit, are dark; the under surface is dirty white. The pectoral, dorsal and the caudal fins are dusky; the ventrals and the anal whitish. Some of the scales along the lateral line show a pinkish tinge in the centre.

Type-specimen.—F 10071/1, *Zoological Survey of India* (*Ind. Mus.*).

There is a mature female purchased from Day which is labelled as having come from Assam. Several other specimens have recently been sent to us by Mr. G. E. Shaw from various streams at the base of the Darjiling Himalayas.

Measurements in millimetres.

	A.	B.
Length of fish without caudal	118	105·5
,, ,, head	26	23
Width of head	21	18
Depth of body near origin of dorsal	23·5	23
Diameter of eye	5	4·5
Length of snout	13·2	11·7
Interorbital width	12·5	10·7
Length of caudal peduncle	18	17·5
Height of caudal peduncle	16	14
Longest ray of dorsal	20·5	21·5
,, ,, ,, anal	17	17
Length of pectoral	23	19·6
,, ,, ventral	19·5	19

Garra mullya (Sykes).

1841. *Chondrostoma mullya*, Sykes, *Trans. Zool. Soc.* London II, p. 359, pl. lxii, fig. 3.
1844. *Discognathus fusiformis*, Heckel, in Hügel's *Kaschmir*, p. 387, figs.
1865. *Garra malabarica*, Day, *Proc. Zool. Soc. London*, p. 297.
1865. *Garra malabarica*, Day, *Fish. Malabar*, p. 205, pl. xv, fig 1.
1867. *Garra alta*, Day, *Proc. Zool. Soc. London*, p. 349.

1868. *Discognathus lamta*, Günther (in part), *Cat. Brit. Mus. Fish.* VII, p. 69.
1878. *Discognathus lamta*, Day (in part), *Fish. India*, II, p. 527.
1889. *Discognathus lamta*, Day (in part), *Faun. Brit. Ind. Fish.*, I, p. 247.
1919. *Discognathus lamta*, Annandale, *Rec. Ind. Mus.*, XVI, p. 131, text-fig. 1, pl. ii, figs. 1, 1*a*.
1919. *Discognathus jerdoni*, Annandale (*nec* Day) in part, *ibid.*, p. 132.
1919. *Discognathus nasutus*, Annandale, (*nec* McClelland), *ibid.*, p. 132, pl. ii, figs. 2, 2*a*.
1919. *Discognathus lamta*, Annandale, *Rec. Ind. Mus.* XVIII, p. 72.
1919. *Discognathus jerdoni*, Annandale (*nec* Day) in part, *ibid.*, p. 73, pl. ix, fig. 2.
1920. *Garra lamta*, Rao, *Ann. Mag. Nat. Hist.* (9) VI, p. 49.
1920. *Garra jerdonia*, Rao, (*nec* Day) in part, *ibid.*, p. 53.
1920. *Garra jerdonia* var. *brevimentalia*, *id.*, *ibid.*, pp. 54–56, pl. 1, figs. 1*a*, 1*b*.

Garra mullya is the most widely distributed species of the genus in India: its range extends from Kathiawar, through the greater part of the Central Provinces, to the whole of Peninsular India. Consequent upon a wide range it shows a certain amount of variation. In some examples the disc is greatly reduced and its free borders represented by a short fringe. In one example from Bombay, the paired fins are extremely small and show a stunted growth. The form is fusiform and the snout is almost smooth.

Specimens of this species occurring in hill-streams are somewhat flattened and different looking. The air-bladder exhibits considerable variation and in the hill-stream forms it is usually reduced. The species seem to be still in process of adaptation to hill-stream life.

The following are the measurements of the bladder in a specimen from Malabar which is 10 cm. in length without the caudal fin:—

Length of anterior chamber		8·2 mm.
,, ,, posterior ,, ...		17·5 mm.
Streams in Coorg, Mysore ...	C. R. Narayan Rao ...	Several.
Kavery Sangam, Mysore ...	B. L. Chaudhuri ...	8.
Malabar	Purchased from Day ...	1.
Tenmalai, Madras	N. Annandale ...	1.
Mettupalaiyam, Dist. Coimbatore, Madras.	,, ...	2.
Nierolay Stream, base of Nilgiris, Madras.	,, ...	1.
Cochin Forests, Madras ...	J. R. Henderson ...	12.
Yenna Valley, Satara Dist., Bombay.	N. Annandale and F. H. Gravely.	14.
Koyna Valley, Satara Dist., Bombay.	F. H. Gravely	1.
Medha, Satara Dist., Bombay ...	S. P. Agharkar. ...	11.
Dhoni, near Wai, Krishna R., Bombay.	,, ...	11.
Vashishti Valley, Ratnagiri Dist., Bombay.	F. H. Gravely	12.
Borivli, Thana Dist., Bombay ...	Bacteriological Laboratory, Bombay.	2.
Poona	Purchased from Day ...	1.
Khodmal Hills, Orissa ...	J. Taylor	6.
Chanda, C.P.	Mus. Coll.	1.
Birbhum	,, ...	3.

Base of hills, Chakardharpur Singbhoom Dist., Chota Nagpur.	F. H. Gravely ...	... 2.
Pachmarhi, C.P.	A. Buchanan, W. H. Kenrick and F. H. Gravely.	Several.
Near Sasan, Gir Forests, Kathiawar.	S. P. Agharkar...	... 2.
Streams in Girnar Mt., near Junagadh, Kathiawar.	,, ...	... Several.
?	A.S.B. ...	... 1.

Garra lamta, Ham. Buch.

Plate XXIV, figs. 2, 2*a*.

1822. *Cyprinus* (*Garra*) *lamta*, Hamilton Buchanan, *Fish. Ganges*, pp. 343, 393.

D. 2/8. A. 2/5.

As has already been pointed out considerable confusion has centred round this historic species. Having now collected specimens from the type-locality I take this opportunity to define the species precisely. I have compared my specimens with Buchanan's manuscript drawing and find no difference between the two.

Garra lamta is a beautiful little Cyprinid fish with a fusiform body, highest near the origin of the dorsal and tapering towards both ends. The head and body is depressed but not greatly so. The length of the head is contained 4·7 times, of the caudal fin 5 times and the depth of the body 5·2 times in the length of the fish including the caudal fin. The head is 1·2 times as long as broad. The eyes are lateral and are situated slightly below the dorsal profile of the head; they are almost invisible from below. Their diameter is contained four times in the length of the head, twice in the interorbital width and 1·7 times in the length of the snout. In the female the eye is almost in the middle of the head, in the male, however, it is somewhat in the posterior half. The snout is smooth in the female while in the male it is provided with a short knob-like median proboscis in front of the nostrils; the tip of the snout is also marked off by a groove into a transverse lobe which is covered by spiny tubercles. Tubercles are also present on the sides of the snout in front of the nostrils. The mouth in both sexes is a small, slightly arched transverse opening on the under surface considerably behind the anterior end of the snout. In the male the mental disc is better developed. There are two pairs of short thread-like barbels. In the male the barbels are comparatively much longer than in the female; the rostral pair being longer than the diameter of the eye. The origin of the dorsal fin is nearer to the tip of the snout than to the base of the caudal; it is not so high as the depth of the body below it; the last undivided ray is the longest. In the female its free margin is truncate whereas in the male it is slightly concave. The ventrals are situated almost below the middle of the dorsal and their origin is equidistant from the tip of the snout and the base of the caudal fin in the male, while in the female it is much nearer to the

base of the caudal fin than to the anterior end of the snout. The pectorals are shorter than the head and are sharp in the middle. They are separated from the ventrals by a distance less than $\frac{1}{3}$ of their own length; the ventrals extend to the anal opening. The anal fin is short and almost reaches the base of the caudal, which is deeply emarginate. There are 30 to 31 scales along the lateral line and 8 longitudinal series of scales between the bases of the dorsal and ventral fins; a scaly appendage is only present near the base of the ventral fin in the female. The scales on the chest and the belly in the male are much reduced and, indeed, to the naked eye they appear almost absent; in the female conspicuous scales are present on the belly, but on the chest they are somewhat reduced.

The air-bladder, in the young specimens that I have examined, is quite normal; its length is contained about 3 times in the total length of the fish. The following are the measurements of the bladder in an immature male specimen 54·5 mm. in length :—

Length of anterior chamber	5 mm.
,, ,, posterior ,, ...	9·5 mm.
Greatest diameter of anterior chamber	3·3 mm.
,, ,, ,, posterior ,, ...	3·0 mm.

The following changes in the colour of the fish were noticed by keeping it living in water in a small dish :—" immediately after it was removed from the stream the fish was almost transparent, but shortly afterwards a black longitudinal streak was observed along the lateral line and above it was a whitish band running from behind the eye to the base of the caudal fin. An indistinct black blotch was also to be seen on the sides of the tail near the base of the caudal fin." On transferring the fish to weak alcohol, the upper surface was noticed to be greenish and the belly yellowish white, the fins immaculate except for the few rays in the dorsal and the caudal fins which were streaked with black along their length. These observations were made on a female specimen in the field in October; but since then the specimens have changed considerably in spirit and there are marked differences in the colouration of the male and the female examples. In a female specimen the whole of the upper surface of the head and body is dusky and the ventral dirty white. There is also a longitudinal streak on the sides which begins in a prominent black spot near the upper margin of the gill-opening and ends in a rounded black blotch near the base of the caudal fin which is lightly streaked in the middle. In the male the general colouration is very much the same, but instead of a longitudinal black stripe there are 5 or 6 longitudinal wavy black lines, most conspicuous in the tail region, and the black blotch near the base of the caudal fin is replaced by a short vertical bar. There are minute black spots near the bases of the dorsal fin-rays and the membrane between these is also blackened in certain regions.

This species instead of having a very wide range, as stated by a number of authors, is restricted to the eastern part of the

Vindhya Range and the Nepal Terai. Buchanan procured some specimens from the Gorakhpur District, probably from the hill-streams.

Measurements in millimetres of a female specimen.

Total length including caudal	47·0 mm
Length of caudal	9·5 ,,
,, ,, head	10·5 ,,
Width of head	8·0 ,,
Depth of body near origin of dorsal fin	9·0 ,,
Diameter of eye	2·6 ,,
Length of snout	4·4 ,,
Interorbital width	5·5 ,,
Length of longest ray of dorsal	8·0 ,,
,, ,, ,, ,, ,, anal	7·5 ,,
,, ,, pectoral	9·5 ,,
,, ,, ventral	7·8 ,,
,, ,, caudal peduncle	5·7 ,,
Height of ,, ,, ...	5·2 ,,

I have examined specimens of this species from the following localities :—

Bhaura Stream, Kharagpur Hills, South of Monghyr.	S. L. Hora	1.
Uttar Band, Man R., Kharagpur Hills, South of Monghyr.	,, ...	1.
Katin Nallah, Kharagpur Hills, South of Monghyr.	,, ...	6.
Maldhun, Nainital Dist., U.P. ...	Mus. Coll. ...	1.
Narsingpur, C.P.	Maj. W. H. Kenrick ...	1.
Chandli Deoli, C.P.	Col. Biddulph ...	5.

Garra lissorhynchus (McClelland).

Plate XXVI, figs. 2, 2*a*.

1842. *Platycara lissorhynchus*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 587, pl. lxviii, fig.
1868. *Discognathus macrochir*, Günther, *Cat. Brit. Mus. Fish.* VII, p. 70.
1869. *Mayoa modesta*, Day, *Proc. Zool. Soc. London*, p. 553.
1871. *Mayoa modesta*, Day, *Journ. As. Soc. Bengal* XL (2) p. 108, pl, ix, fig. 2.
1878. *Discognathus modestus*, Day, *Fish. India* II, p. 528, pl. cxxii, fig. 5.
1889. *Discognathus modestus*, Day, *Faun. Brit. Ind. Fish.* I, p. 247.

Günther seems to have been unaware of McClelland's *Platycara lissorhynchus*, as no reference is made to this species in his catalogue. McClelland described his species from specimens obtained in the Khasi Hills by Mr. Griffith and from page 574 of the volume cited above, it is clear that he forwarded one specimen " to the Museum at the India House." Günther's form was known to him from two examples, one from the collection of the East India Company and the other from Mr. Griffith's collection. The former example is probably that which was despatched to the India House by McClelland. Having examined numerous specimens from the Khasi Hills and after having carefully compared them with

the figures of McClelland and the description of Günther I find no difference between the various forms. I have also examined the type of Day's *D. modestus* from Northern India, and cannot separate it from other specimens from the Khasi Hills.

The head and body are greatly depressed in this species and the form resembles that of the species of the Homalopterid genus *Balitora;* it was probably the shape which led McClelland to regard it as a species of his genus *Platycara.* The species is also distinguished from other species of *Garra* by the fact that the chest and the middle of the abdomen are naked while big scales are present on the post-pelvic region. The pectoral fin is greatly expanded and is considerably longer than the head.

There is a marked difference in the colour of male and female specimens. In a female example the colour in spirit of the dorsal and lateral surfaces is dark livid grey, obscurely marbled with yellowish brown ; the ventral surface is dull-yellowish. There is a dark streak near the free margin of the dorsal and a broad, black, **W**-shaped band on the anterior half of the caudal fin ; an indistinct black blotch is present near the base of the caudal and a small black spot just behind the angle of the operculum. In the male the colour of the body is much lighter and the characteristic markings on the dorsal and the caudal fins are absent. The specimens from which the early descriptions were taken were in all probability males as no reference to the characteristic colouration of the female is made therein.

The air-bladder in this species has deviated considerably from the normal form. Not only is it much reduced but the posterior chamber has become thread-like and its walls are greatly thickened ; the lumen of the chamber is almost obliterated. The anterior chamber is firmly fixed to the body-wall by a fibrous coat which covers it. In a mature female 56 mm. in length, the following are the measurements of the bladder :—

Length of anterior chamber	... 3·2 mm.
,, ,, posterior ,, ...	... 3·0 mm.
Greatest diameter of anterior chamber ...	... 2·7 mm.
,, ,, ,, posterior ,, ...	... 1·0 mm.

In Day's type of *modestus*, however, the bladder is better developed and corresponds more closely to the normal form. The following are its measurements :—

Length of specimen excluding caudal ...	... 70 mm.
,, ,, anterior chamber	... 3·7 mm.
,, ,, posterior ,, ...	... 5·0 mm.
Greatest diameter of anterior chamber ...	... 3·0 mm.
,, ,, ,, posterior ,, ...	... 2·0 mm.

I have examined specimens of this species from the following localities :—

Nong-priang Stream, Cherrapunji ...	B. Warren ... ... 8.
Northern India (?)	Purchased from Day ... 1.
Assam	Mus. Coll. ... ... 1.
Jaintia Hills, Assam	Col. Godwin Austen ... 3.

Measurements in millimetres.

Total length including caudal	...	...	...	90	mm.
Length of caudal	...	...	...	18·5	,,
,, ,, head	...	...	...	16·2	,,
Width of head	...	...	...	15·5	,,
Depth of body near base of dorsal	...	...	...	14·5	,,
Diameter of eye	...	...	...	3·7	,,
Length of snout	...	...	...	8·5	,,
Interorbital width	...	...	...	8·0	,,
Length of caudal peduncle	...	...	...	12·0	,,
Height of caudal peduncle	...	...	...	9·5	,,
Longest ray of dorsal	...	...	...	14·0	,,
,, ,, ,, anal	...	...	...	17·5	,,
Length of pectoral	...	..	...	14·5	,,
,, ,, ventral	...	...	...	11·5	,,

Garra abhoyai, sp. nov.

Plate XXVI, figs. 1, 1*a*, 1*b*.

D. 2/6—7. P. 15—16. V. 9. A. 1/5.

The fish has a characteristic fusiform body; the dorsal profile rises considerably from the tip of the snout to the origin of the dorsal fin, beyond which it slopes down to the base of the caudal; the ventral is almost straight and horizontal in front of the anal fin, beyond which it slightly rises to the base of the caudal. The under surface of the head and body is flat, but the fish as a whole is not greatly depressed. The length of the head is almost equal to the depth of the body in front of the base of the dorsal and is contained 4·3–4·6 times in the length of the fish. The eyes are almost lateral in position and are situated slightly below the dorsal profile of the head; they are placed somewhat in the posterior half of the head and are invisible from below. The diameter of the eye is contained 4·6 times in the length of the head, 3·3 times in the length of the snout and 3·3–3·6 times in the interorbital width. The snout is smooth and the nostrils are placed considerably nearer to the eye than to the tip of the snout. The mouth is a slightly arched, transverse opening on the under surface and is provided with a well-marked almost circular disc. There are two pairs of short barbels; they are shorter than the diameter of the eye. The lateral line is straight and runs along the middle of the body; there are 33 to 35 scales along the lateral line. On the sides and on the dorsal surface behind the dorsal fin, the scales are well-marked and their boundaries easily distinguishable, while in front of the dorsal fin they are much reduced and, indeed, to the naked eye the surface appears to be absolutely devoid of any scales. The under surface in front of the ventrals is naked but ill-defined scales are present between the bases of the ventral and anal fins. The dorsal fin commences almost in the middle of the distance between the tip of the snout and the base of the caudal fin; the second branched ray is the longest; it is not as high as the depth of the body below it; its free margin is almost truncate. The ventrals commence below the 4th ray of the dorsal. The pectorals

are shorter than the head and are separated from the ventrals by a distance equal to the base of the dorsal fin. Both the paired fins are horizontally placed and are provided with muscles on the ventral aspect of some of the outer rays. The anal fin is considerably removed from the anal opening and its longest ray is twice as high as the shortest. The caudal fin is evenly lobed and deeply emarginate.

The air-blader is reduced; it is not greatly modified in form. The following are its measurements in a mature female specimen 65 mm. in length without the caudal fin:—

Length of anterior chamber	...	3·5 mm.
,, ,, posterior ,,	...	5·0 ,,
Greatest diameter of anterior chamber	...	2·8 ,,
,, ,, ,, posterior ,,	...	1·5 ,,

The fish has a characteristic colouration. The upper surface of the head and body are dusky, while the ventral surface and the fins are dirty white. There is a light black bar across the dorsal and a **W**-shaped black marking on the caudal fin.

Locality.—Three specimens were sent to the Indian Museum by Mr. Pettigrew from Manipur, Assam; Dr. N. Annandale informs me that Pettigrew made his collection in the neighbourhood of Ukhral, which is situated at an altitude of 6000 ft. among the Naga Hills.

Type-specimen.—F 5307/1, *Zoological Survey of India* (*Ind. Mus.*).

Annandale (1913, p. 37) recognised this species to be an undescribed form, but he then considered it a race of *lamta* and did not attempt to describe it. He pointed out, however, that the Manipur race "has the whole of the ventral surface devoid of scales and exhibits marked peculiarities in colouration."

Measurements in millimetres.

	A.	B.	C.
Total length excluding caudal	65	61	64·5
Length of head	14	14	14
Depth of body near base of dorsal	14·5	13·5	13
Diameter of eye	3	3	3·3
Length of snout	7	7	7
Interorbital width	8	7·3	7·5
Length of caudal peduncle	12·5	11·5	9·5
Height ,, ,, ,, ...	8·2	7	7·5
Longest ray of dorsal	11	11·6	11·7
,, ,, ,, anal	10·5	10	10·7
Length of pectoral	13·5	11·5	12·5
,, ,, ventral	12	10·6	11·5

Specimens A and C are females full of eggs; I have not opened B and, therefore, cannot give its sex.

Garra kempi, sp. nov.

Plate XXVI, figs. 3, 3*a*.

1913. *Discognathus lamta*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 247.

D. 2/8. A. 2/5. P. 13. V. 8.

In this fish the head and body are greatly depressed and flattened so that the dorsal and ventral profiles are slightly arched in front of the ventrals, beyond which they gradually slope to the base of the caudal fin. The tail is thick and narrow and almost whip-like. The head is almost squarish, its breadth being contained 1·2 times and its height 1·6 times in the length. The depth of the body is contained 5·6 times and the length of the head 4·5 times in the length of the fish without the caudal fin. The eyes are small, occupy a dorso-lateral position, and are invisible from below. They are situated somewhat in the posterior half of the head; their diameter is contained 5 times in the length of the head, 2 times in the length of the snout and 2·4 times in the interorbital width; their superior margin is in line with the dorsal profile of the head. The snout is broad and semicircular; the nostrils are situated in its posterior half. Slightly in front of the nostrils on both sides is a whitish bony area which is somewhat raised from the general surface. There are two pairs of short thick barbels, the rostral being slightly longer than the diameter of the eye. The mouth-opening is greatly arched and is as wide as the breadth of the head. The mental disc is well-developed and is 1·5 times as broad as long. The tubercles on the labial fold and on the free border of the mental disc are minute. The gill-openings extend on the under surface for a short distance and the branchiostegal rays are not visible.

The origin of the dorsal fin is nearer to the tip of the snout than to the base of the caudal fin. Its first divided ray is the longest and is higher than the depth of the body below it. The ventrals originate slightly behind the dorsal and their origin is also slightly nearer to the anterior end of the snout than to the base of the caudal fin. The paired fins are broad and horizontally situated. The pectorals are as long as the head and are provided with thick pads of muscles on the ventral surface of some of the outer rays; they are separated from the ventrals by a considerable distance. The ventrals extend beyond the anus, but do not reach the base of the anal fin which in its turn does not reach the base of the caudal fin. The anus is raised on a papilla and is situated almost midway between the origin of the ventral and anal fins. The lateral line is almost in the middle of the body and runs straight from the angle of the operculum to the middle of the base of the caudal fin. The scales are rather small; there are 39 scales along the lateral line and 8 longitudinal series of scales between the bases of the dorsal and the ventral fins. The scales are absent on the chest and are much reduced on the belly along the middle line. The caudal peduncle is 1·8 times as long as high.

The air-bladder, though greatly reduced, does not show any special modification in the form of a thick coating, etc. The following are the measurements of the bladder in the type-specimen which is about 9 cm. in length including the caudal :—

Length of anterior chamber	...	...	4·5 mm.
,, ,, posterior ,,	...	...	4·0 ,,
Greatest diameter of anterior chamber	...	...	3·0 ,,
,, ,, ,, posterior ,,	...	...	1·3 ,,

The colour of the upper surface of the body and head is blackish, as is also that of the dorsal, caudal and upper surface of the paired fins. On the under surface it is dirty white. The scales are distinctly edged with black.

Type specimen.—F 7716/1, *Zoological Survey of India* (*Ind. Mus.*).

Locality.—Only one specimen has been examined, procured by Dr. S. W. Kemp in Siyom R., below Damda at an altitude of 1300 ft., among the Abor Hills.

Measurements in millimetres of the type-specimen.

Length of fish including caudal	...	...	...	...	80·5
,, ,, head	...	...	...	...	20·0
Width of ,,	...	...	...	...	17·0
Depth of body near origin of dorsal	...	...	...	...	16·0
Diameter of eye	...	...	...	...	4·0
Length of snout	...	...	...	...	8·0
Interorbital width	...	...	...	...	9·8
Length of mouth-opening	...	...	...	...	12·0
Length of callous portion of disc	...	...	...	...	6·5
Width ,, ,, ,, ,,	...	...	...	...	9·5
Distance of anus from anterior end of snout	...	...	...	...	54·0
Length of caudal peduncle	...	...	...	...	18·5
Height of caudal ,,	...	...	...	...	10·0
Length of pectoral fin	...	...	...	...	19·7
,, ,, ventral ,,	...	...	...	...	17·5

Garra naganensis, sp. nov

Plate XXV, figs. 2, 2a.

D. 2/7. A. 1/5. P. 14. V. 8.

The dorsal profile in this fish rises from the tip of the snout to the base of the dorsal fin beyond which it runs straight to the base of the caudal fin; the ventral is somewhat convex. The head is flattened on the under surface and is 1·2 times as long as broad; its length is contained 4·9 times in the length of the fish without the caudal. The depth of the body near the origin of the dorsal fin is equal to the length of the head. The eyes are almost in the posterior half of the head and look outwards and upwards; their diameter is contained 4 times in the length of the head, 2·1 times in the length of the snout and 2 times in the interorbital width. The snout is broad and semicircular and the nostrils are situated in its posterior third. There are two pairs of short barbels, shorter than the diameter of the eye in length. The mouth is on the under surface considerably behind the anterior end of the snout and is provided with well-developed upper and lower labial folds. The mental disc is oval, its longitudinal diameter being half the transverse diameter. The origin of the dorsal fin is

much nearer the end of the snout than the base of the caudal fin; it is not so high as the depth of the body below it. The ventrals commence below the middle of the dorsal fin and their origin is equidistant from the base of the caudal fin and the tip of the snout. The pectorals are as long as the head and are sharp in the middle; they are separated from the ventrals by a distance which is more than half of their own length. The third ray of the ventral fin is the longest; the fin extends beyond the anal opening, which is situated nearer to the origin of the anal than to that of the ventral. The anal fin is short and does not reach the base of the caudal fin. The caudal fin is evenly lobed and deeply emarginate. The lateral line is straight and runs almost in the middle of the body; there are 39 scales along its length and 8 series of longitudinal scales between the bases of the dorsal and anal fins. The scales are absent near the bases of the pectoral fins and are greatly reduced on the chest and in the middle of the abdomen; large scales are present in the post-pelvic region.

The air-bladder is greatly reduced and the posterior chamber is narrow and long. In a specimen 98 mm in length, the following are the measurements of the bladder:—

Length of anterior chamber ...	... 5·3 mm.
,, ,, posterior ,, ...	... 10·5 ,,
Greatest diameter of anterior chamber ...	... 3·8 ,,
,, ,, ,, posterior ,, ...	... 1·3 ,,

The colour on the upper surface and the sides is black, on the under surface whitish. The dorsal and the caudal fins are dusky as is also the dorsal surface of the paired fins. The anal and the under surface of the paired fins are whitish. There is a minute black spot behind the angle of the operculum.

Type-specimen.—F 9970/1, *Zoological Survey of India* (*Ind. Mus*).

Locality.—A single specimen was obtained by myself in the Senapati Stream near Kairong, among the Naga Hills, Assam, in February, 1920.

Measurements in millimetres.

Total length without the caudal	... 98
Length of head	... 20
Depth of body near origin of dorsal	... 20
Width of head	... 16·5
Diameter of eye	... 5·0
Length of snout	... 10·5
Interorbital width	... 10·0
Length of caudal peduncle	... 20·0
Height of caudal peduncle	... 12·5
Distance of vent from anterior end of snout ...	... 62·5
Length of callous portion of disc	... 1·0
Width ,, ,, ,, ,, ,, ...	... 7·5
Longest ray of dorsal fin	... 16·0
,, ,, ,, anal ,, ...	17·0
Length of pectoral fin	.. 20·0
,, ,, ventral ,, ...	... 18·0

Garra prashadi, sp. nov.

Plate XXIV, fig. 3.

D. 3/7—8. A. 2/5. V. 8—9. P. 13.

The fish is subcylindrical with the head and body somewhat flattened on the under surface. The dorsal profile rises considerably from the tip of the snout to the origin of the dorsal fin, beyond which it gradually slopes to the base of the caudal; the ventral profile is straight and horizontal in front of the anal fin, beyond which it rises to the base of the caudal. The head is short and bluntly pointed; its length is contained 4·5 to 5 times in the length of the fish without the caudal fin; the head is almost 1·1 times as long as broad. The depth of the body near the origin of the dorsal fin is slightly greater than the length of the head. The eyes are lateral and are in the upper half of the head; their diameter is contained 4·3 times in the length of the head and 2 to 2·1 times in the length of the snout and in the interorbital width. The eyes are situated slightly in the posterior half of the head. The mouth is on the under surface, somewhat behind the tip of the snout; its gape is half as broad as the width of the head. The mental disc is comparatively small but is well developed. There are two pairs of short barbels, shorter than the diameter of the eye. The dorsal fin commences nearer the tip of the snout than the base of the caudal fin; it is almost as high as the depth of the body below it. The ventrals are situated below the middle of the dorsal and their commencement is midway between the tip of the snout and the base of the caudal fin. The pectorals are longer than the head and are horizontally placed; they are sharp in the middle and are separated from the ventrals by half their own length. The ventrals extend to the anus and are provided with scaly appendages near their bases. The anal is considerably removed from the ventrals and does not extend to the base of the caudal fin. The caudal fin is deeply emarginate; the caudal peduncle is 1·2 times as long as high.

The air-bladder is minute but of the normal Cyprinid type. In a male specimen 82 mm. in length the following are its measurements:—

Length of anterior chamber	...	...	...	5·5 mm.
,, ,, posterior ,,	...	...	...	6·5 ,,
Greatest diameter of anterior chamber			...	4·0 ,,
,, ,, ,, posterior ,,		...	...	1·2 ,,

The scales in *Garra prashadi*, though well developed, are rather obscure. I have been able to make out 32 along the lateral line and $6\frac{1}{2}$ longitudinal series of scales between the bases of the dorsal and the ventral fins. The scales are poorly developed on the abdomen and are absent on the chest.

The colour is rather characteristic, the dorsal surface of the head is dusky; it is dirty white on the under surface. The upper surface of the body and its sides above the lateral line are

dark, the rest of it and the paired and the anal fins whitish. The dorsal and the caudal fins are dusky, the latter with an oblique black longitudinal bar on its lower lobe. There is a black spot behind the angle of the operculum and a short obscure black bar near the base of the caudal. On the sides of the tail are a number of black, wavy longitudinal lines.

Type specimen.—F 9971/1, *Zoological Survey of India (Ind. Mus.).*

Locality.—Only three specimens of this interesting species have been examined; they were obtained in Malwa Tal, U.P., in May, 1920, by Dr. Baini Prashad and myself.

Measurements in millimetres.

	A.	B.
Length of fish without caudal	82	71
,, ,, head	16·5	15·7
Width ,, ,,	14	13·3
Depth of body near origin of dorsal	17·5	16
Diameter of eye	3·8	3·6
Length of snout	7·5	8
Interorbital width	8	6·9
Length of caudal peduncle	13	11·5
Height of ,, ,,	10·6	9·4
Longest ray of dorsal	17·5	15
,, ,, ,, anal	15·5	13·5
Length of pectoral	19·5	16·5
,, ,, ventral	17	14

Garra notata (Blyth).

1860. *Platycara notata*, Blyth, *Journ. As. Soc. Bengal*, XXIX, p. 161.

To this species I refer three young specimens collected by Major Berdmore in Tenasserim, Burma. Blyth's description of the species is inadequate and I therefore take this opportunity to add a few notes to it.

D. 2/7—8. A. 2/5. P. 14—15. V. 9.

In *Garra notata* the under surface of the head and body are greatly flattened and the ventral profile is straight and horizontal throughout. The dorsal profile is arched; it rises from the tip of the snout to the base of the dorsal fin, beyond which it slopes down to the base of the caudal. The head is almost one and a half times as long as broad; its length is contained 4·1 times in the length of the fish without the caudal fin and is slightly greater than the depth of the body near the origin of the dorsal fin. The eyes are almost lateral but invisible from below; their diameter is contained about 3·3 times in the length of the head, 1·3–1·9 times in the length of the snout and 1·8 times in the interorbital width. There are two pairs of thread-like barbels; the rostrals are longer than the diameter of the eye; the maxillary are very small and liable to be overlooked. The eye is situated almost in the middle of the head or slightly nearer to its posterior margin.

The origin of the dorsal is almost equidistant from the tip of the snout and the base of the caudal fin or it is somewhat nearer to the former. The scales in front of the ventrals on the under surface are greatly reduced and, indeed, to a superficial observer may appear to be almost absent. There are 33–34 scales along the lateral line and 8 series of longitudinal rows of scales between the bases of the dorsal and ventral fins.

The colour has undergone considerable change as the specimens have been preserved in spirit for a long time. Except for the under surface in front of the ventrals and the cheeks, which are whitish, the fish is dark brown. There is a black spot near the angle of the operculum and a series of black markings at the base of the dorsal fin-rays.

Blyth describes the colouration of the fish as follows:—"Colour dusky olive-green above and on the sides, beneath buffy-albescent. Base of the dorsal fin whitish, setting off a series of black spots, larger anteriorly and the hindmost generally obsolete: rest of the fin a little nigrescent. One or more spots also at base of the anal fin. Pectorals somewhat yellowish at base, then blackish; a dusky line along each longitudinal row of scales becoming gradually visible towards the tail." The colouration was noted from a specimen about 6 in. in length.

Measurements in millimetres.

Length of fish without caudal	54	54·5
,, ,, head	13	13·5
Width of head	9	9·6
Depth of body	12·5	13·5
Diameter of eye	3	3·2
Length of snout	5·7	5·3
Interorbital width	5·5	6
Length of caudal peduncle	9·5	9·2
Height ,, ,, ,, ...	6	6·7
Longest ray of dorsal	11	10·7
,, ,, ,, anal	8	9·7
Length of pectoral	11·7	12·5
,, ,, ventral	8·2	10

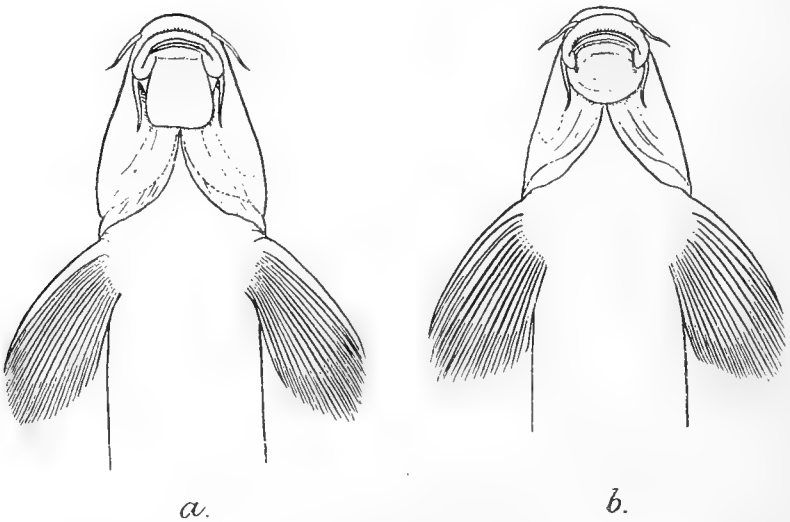
Garra chaudhurii, sp. nov.

Plate XXV, fig. 3.

D. 2/7—8. A. 2/5. P. 13—15. V. 8.

This species is represented by small individuals from the Darjiling District of Northern Bengal. The head and body are depressed and the ventral profile is almost straight; the dorsal profile is arched and slopes considerably on both sides from the origin of the dorsal fin. The head is conical and is 1·3 times as long as broad; its length is contained from 4·1 to 4·9 times in the length of the fish without the caudal. The depth of the body is as much greater than the width of the head as it is less than its length. The eyes are almost lateral and are invisible from be-

low. They are situated nearer to the tip of the snout than to the posterior margin of the operculum; their diameter is contained from 4·6 to 5·7 times in the length of the head, 2–2·1 times in the length of the snout and 2·1–2·6 times in the interorbital width. There are two pairs of barbels, longer than the diameter of the eye. The snout is smooth and the nostrils are situated nearer the margin of the orbit than to the tip of the snout. The mouth-opening is somewhat arched and is situated slightly behind the tip of the snout. The mental disc exhibits considerable variation in the three adult specimens examined. In the ripe female it corresponds to developmental stage 4 and consists of a rectangular pad behind the mouth which is separated by a faint line of demarcation into an anterior portion, the posterior labial fold, and



Text-fig. 4.—Form of mental disc in two ripe specimens of *Garra chaudhurii*, sp. nov.

the posterior portion, the disc proper. In the other two male specimens it is more marked, but the true lips are still visible and the various components of the disc are not well differentiated. The origin of the dorsal fin is slightly nearer to the tip of the snout than to the base of the caudal fin and its longest ray is as high as the depth of the body below it. The pectorals are shorter than the length of the head and are separated from the ventrals by a considerable distance.

In spirit the specimens have lost their natural colouration. They are dusky on the body above the lateral line and on the upper surface of the head. The rest is dirty white and the cheeks are whitish.

The air-bladder is of the normal Cyprinid type; its length is contained 2·8 times in the length of the fish without the caudal fin.

The scales are poorly developed on the under surface and are

greatly reduced anteriorly. There are 32–33 scales along the lateral line and 8 series of longitudinal rows of scales between the bases of the dorsal and ventral fins.

Type-specimen.—F 8146/1, *Zoological Survey of India* (*Ind. Mus.*).

Locality.—There are three specimens of this species from the Darjiling District, presented to the Indian Museum by Dr. Walker.

Measurements in millimetres.

Length of fish without caudal	53·2	56·2
,, ,, head .	13	11·4
Width ,, ,, ...	9·6	8·2
Depth of body	11·5	9·9
Diameter of eye	2·8	2
Length of snout	5·6	4·2
Interorbital width	6	5·3
Length of caudal peduncle	9·6	8·0
Height ,, ,, ,, ..	7	6·7
Longest ray of dorsal	11·7	9·6
,, ,, ,, anal	10·2	7
Length of pectoral	11·7	10
,, ,, ventral	10	8

Garra jenkinsonianum, sp. nov.

Plate XXV, fig. 1.

1910. *Discognathus lamta*, Jenkins, *Rec. Ind. Mus.* V, p. 128.

D. 2/8. A. 1/5. P. 12—14. V. 8—9.

In *Garra jenkinsonianum* the dorsal profile is greatly arched; it rises from the tip of the snout to the base of the dorsal fin, beyond which it slopes gradually to the base of the caudal. The ventral profile is straight and horizontal throughout. The head is somewhat flattened on the under surface and is short and bluntly pointed; its length is contained 4·3 times in the length of the fish without the caudal and it is 1·2 times as long as broad. The body is slightly flattened; its depth near the origin of the dorsal fin is almost equal to the length of the head. The eyes are situated almost in the middle of the head and are lateral in position; they are slightly visible from above and almost invisible from below. The diameter of the eye is contained 4·3 times in the length of the head, 1·8 times in the length of the snout and 2·1 times in the interorbital width. The mouth is small and slightly arched; it is not situated far behind the tip of the snout. The mental disc is small but its various parts are well-marked. There are two pairs of short barbels; their length is shorter than the diameter of the eye. The snout is smooth and rounded, but near the tip it is marked off into a small lobe by two short transverse grooves. The origin of the dorsal is nearer the tip of the snout than the base of the caudal fin; it is considerably in advance of the ventral; its longest ray is shorter than the depth of the body below it and its free margin is almost straight. The pectorals are

shorter than the head and are separated from the ventrals by a distance less than ⅓ of their length. The ventrals are situated at an equal distance from the base of the caudal fin and the tip of the snout; they extend to beyond the anal opening. The anal does not reach the base of the caudal fin, which is slightly emarginate. The lateral line is straight and runs along the side of the fish somewhat nearer to the dorsal than to the ventral surface; there are 33–34 scales along its length and 7½ series of longitudinal rows of scales between the bases of the dorsal and the ventral fins. The scales are absent on the chest but are quite normal on the belly. The anus is situated in the beginning of the last third of the distance between the origin of the ventral and the anal fins.

The air-bladder in this species is of the normal Cyprinid type; its length is contained 2·7 times in the length of the fish without the caudal.

The sides and the upper surface of the head and body are darkish with an indistinct greyish band along the lateral line on each side. The under surface is dull white. There is a distinct black spot just behind the angle of the operculum.

Type specimen.—F 5736/1, *Zoological Survey of India* (*Ind. Mus.*).

Locality.—Numerous specimens were obtained by Dr. Jenkins and Dr. Annandale in Sita Nullah, Paresnath Hills, Bengal.

Measurements in millimetres.

	A.	B.
Length of fish without caudal	63	60
,, ,, head	15	14
Width ,, ,, ...	11·5	11
Depth of body	15·3	14·6
Diameter of eye	3·5	3·2
Length of snout	6·4	5·3
Interorbital width	7·5	7
Length of caudal peduncle	10	12
Height of ,, ,, ...	8	8·4
Longest ray of dorsal	11·8	11·5
,, ,, ,, anal	10·5	10·5
Length of pectoral	14	14·5
,, ,, ventral	11·6	11·5

Sita Nullah, Paresnath Hills... Dr. Jenkins and Dr. Annandale... 14.
,, ,, ... Dr. Jenkins ... ... 2.

Garra rupeculus [1] (McClelland).

Plate XXIV, fig. 1.

1839. *Gonorhynchus rupeculus*, McClelland, *Asiatic Res.* XIX, pp. 281, 343, pl. xliii, figs. 4, 5.
1839. *Gonorhynchus brachypterus*, McClelland, *ibid.*, pp. 283, 374.

McClelland described both the species from the "Mishmee Mountains" where they were obtained by Mr. Griffith. McClelland

[1] When giving a synopsis of the species on page 281 and 283 McClelland spells the name of this species as *rupiculus*, while in the description on page 343 he spells it *rupeculus*.

himself doubted whether the two forms were specifically distinct as on p. 283 (footnote) of the work cited above he remarks of *G. brachypterus*,—"It also agrees with that species (*G. rupeculus*) in the form of its fins; the presence of two very minute cirri being my chief reason for separating them, I have not thought it necessary to give a figure." Having collected a large number of examples of this species, I do not find myself justified in accepting the two forms as distinct species. The barbels are, undoubtedly, very minute and are apt to be overlooked. As a matter of fact there are four short barbels, of which McClelland could see only two in certain individuals. Since the publication of Günther's Catalogue (1868) both these species have been placed under the synonymy of *G. lamta* by several ichthyologists without comment. Some of my specimens, though none of them is more than 2 inches in length, are ripe females as they have been found on dissection to contain eggs. This species is a characteristic hill-stream form.

The species is readily distinguished by its small size, depressed body and head and almost straight profile. The length of the head is contained 4·5–5 times, the depth of the body near the origin of the dorsal fin 5·3–6·9 times in the length of the fish including the caudal fin. The head is 1·2 times as long as broad. The eyes are dorso-lateral and are situated in the middle of the head; their upper margin is in line with the dorsal profile of the head. There are two pairs of minute barbels. The mouth is provided with well-developed labial folds and the mental disc is well-marked. There are rows of open pores on the snout, one extending from the antero-inferior margin of the eye to its tip and another from behind the disc on the under surface, coming upwards and backwards and ultimately continued along the lateral line. The origin of the dorsal fin is slightly nearer to the base of the caudal than to the tip of the snout; it contains six branched rays besides one or two that are not branched. The pectorals are horizontal and rounded, they are shorter than the length of the head and are widely separated from the ventrals. Both the paired fins are horizontally placed and are provided with muscles on the under surface of some of their outer rays. The ventrals extend considerably beyond the anus. The lateral line is straight and runs nearer to the dorsal than to the ventral surface. There are 32–34 scales along the lateral line and 9 longitudinal series of scales between the bases of the dorsal and ventral fins. The ventral surface is naked.

The air-bladder is normal in form. In a specimen 30 mm. long, the following are the measurements of the bladder.

Length of anterior chamber	2·2 mm
" " posterior "	3·0 "
Greatest diameter of anterior chamber	2·5 "
" " " posterior "	1·2 "

The colour is variable; generally it is black on the upper surface and sides of the body and white below. The fins are all

white, except for a light black streak near the free margin of the dorsal and a wavy band in the middle of the caudal fin. There is a deep black bar across the base of the dorsal and this in some specimens is preceded by a narrow white streak. In certain examples the colour below the lateral line is very light while in others a deep black longitudinal band is present along the lateral line and both the surfaces above and below it are light in colour.

Locality.—My specimens were collected in the hill-streams of the Manipur Valley, Assam. It is also known from the adjacent Mishmi Hills.

Measurements in millimetres.

	A.	B.	C.	D.	E.	F.
Length of fish including caudal fin ...	29·8	30	30·2	34·4	30·7	29·7
Greatest depth of body ...	4·3	4·4	4·6	6·4	4·4	5·2
Length of head	6·2	5·8	6·1	7·2	6·3	6·2
Width of head	4·8	4·8	4·8	5·4	4·8	4·4

Garra sp.

I am indebted to my friend Mr. Prashar Bhatia for a young specimen of *Garra* from the neighbourhood of Bannu City, which is situated very near Waziristan. The specimen is only 37 mm. in length and differs from *G. wanae* in the following respects :—

(i) The eyes are partly visible from below.

(ii) The origin of the dorsal fin is slightly nearer to the tip of the snout than to the base of the caudal fin.

(iii) There is a well-developed free tubercular border to the disc with the posterior and lateral edges free.

(iv) There is a round black spot on either side of the tail near the base of the caudal fin.

I have not thought it proper to describe a new species on the basis of a single, probably immature, individual.

Part 2. On some extra-Indian species of *Garra*.

While revising the Indian species of *Garra* I have also examined some specimens of this genus from outside India proper in the collection of the Indian Museum. The specimens dealt with in this part are from the following localities :—

(i) Five specimens (F 8120—24/1) from Lahej near Aden.

(ii) One specimen (No. 9405) from Baluchistan.

(iii) Nine specimens (F 8125—33/1) from the Lake of Tiberias, Palestine.

(iv) Numerous specimens (F 8174—95/1) from the Kushk River, Afghanistan.

(v) Topotypes of *G. blanfordi* (F 8108—8119/1) from Abyssinia.

(vi) Type-series of *G. adiscus* from Seistan.

Except *G adiscus* (Annandale), all have been referred by

various authors to *Garra lamta*. Blanford [1] referred those from Lahej near Aden to the latter species on the authority of Günther Annandale,[2] while recognising that the Palestine species was distinct from the Indian one, considered it merely a local race of *G. lamta* which he called *rufus* (Heck.). Both Lortet [3] and Tristram [4] also described and figured their examples from Palestine as *G. lamta*,[5] while Jenkins [6] referred the Baluchistan specimen to the same species without comment. The Abyssinian form previously referred to *G. lamta* by Blanford (*op. cit.*, p. 460) and Vinciguerra [7] has been separated by Boulenger [8] under the name *G. blanfordi*. Numerous examples collected between the Helmand and the Kushk Rivers in Afghanistan were recorded by Günther [9] himself as *G. lamta*, but Boulenger in the paper cited above has referred the same specimens to *G. variabilis*, Heck., of which he regards Nikolski's[10] *G. rossicus* as a synonym.

In my opinion the Arabian form must be described as a new species. I agree with Boulenger and Annandale as regards those from Abyssinia and Seistan, while *G. rufus* seems to me to be specifically distinct. The single specimen from Persian Baluchistan probably represents an undescribed species, but I prefer not to name it on the basis of a single individual. Boulenger in the paper cited above gives a very wide interpretation to the species *G. variabilis* (Heck.), in which Tate Regan [11] also included the form recently described by Annandale [12] as *G. phryne*. Mr. Tate Regan has, however, recently informed us that there are no specimens in the British Museum that he can refer to *G. variabilis*, and it is clear that several allied forms are capable of specific separation.

Garra arabica, sp. nov.

1870. *Discognathus lamta*, Blanford (in part), *Geol. Zool. Abyssinia*, p. 461.

D. 3/8. A. 2/5. V. 9. P. 14—15.

Garra arabica is a fairly stout fish with the dorsal profile arched and the ventral almost horizontal and straight in front of the anal fin, beyond which it rises to the base of the caudal fin. The head and body are somewhat depressed. The length of the head is contained 4 to 4·3 times and the depth of the body 3·6 to 4

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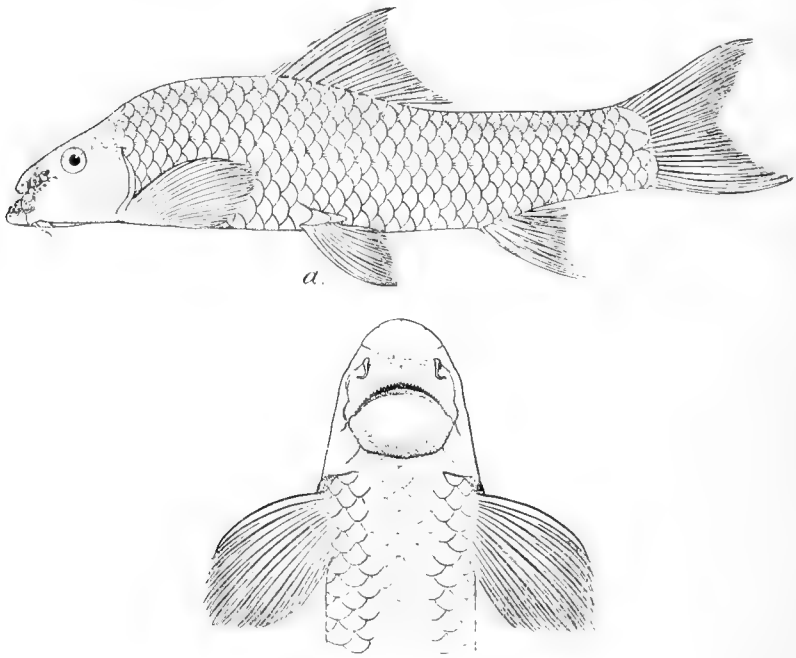
[1] *Geol. Zool. Abyssinia*, p. 461 (1870).
[2] *Journ. As. Soc. Bengal* (n.s.) IX, p. 37, fig. 2 (1913).
[3] *Arch. Mus. d'Hist. Nat. Lyon* III, p. 153, pl. xvi, figs. 4,5 (1883).
[4] *Faun. Flor. Palest.*, p. 172, xix, fig. 3 (1884).
[5] The specimen figured by Lortet is quite distinct from Annandale's Palestine specimens.
[6] *Rec. Ind. Mus.* V, p. 124 (1910).
[7] *Ann. Mus. Genova* XVIII, p. 695 (1883).
[8] *Proc. Zool. Soc. London* II, p. 160 (1901).
[9] *Trans. Linn. Soc.* (2) V, p. 170 (1889).
[10] *Ann. Mus. Zool. Acad. Petersbourg* V, p. 239 (1900).
[11] *Journ. As. Soc. Bengal* II, p. 8 (1906).
[12] *Rec. Ind. Mus.* XVIII, p. 70, pl. x, fig. 3, pl. xi, fig. 2.

times in the length of the fish without the caudal fin. The head is 1·3 times as long as broad. The eye is in the posterior half of the head and is contained 4·5 to 5 times in the length of the head, 2·4 to 2·8 times in the length of the snout and 1·7 to 2 times in the interorbital width. The eyes are dorso-lateral in position and are invisible from below. The snout projects considerably beyond the mouth and the mental disc is well developed. The tubercles on the labial fold and also on the free borders of the disc are comparatively minute. The upper labial fold is fringed. The gape of the mouth is slightly less than half the length of the head. There are two pairs of barbels; those at the angle of the mouth are very



a.

b.

Text-fig. 5.—Lateral view and under surface of head of *Garra arabica*, sp. nov.
a, Lateral view of type-specimen.
b, Under surface of head of same.

small. The length of the rostral barbels is less than the diameter of the eye. There are 33 to 34 scales along the lateral line and 9 longitudinal rows between the bases of the dorsal and the ventral fins. There are three and a half rows of scales between the lateral line and the root of the ventral. The scales are feebly developed in the region of the chest and also form appendages to the bases of the ventrals. The dorsal fin is situated slightly in advance of the ventrals; its first divided ray is the longest and its free margin is concave. Its origin is much nearer to the tip of the snout than to the base of the caudal. The pectoral fin is sharp in the middle and is as long as the head. It is separated from the ventrals by

half its own length. The ventrals extend beyond the anus but the anal does not reach the base of the caudal fin.

In adult specimens there is always a well-developed proboscis, studded with hollow tubercles projecting in front of the nares on the snout. Similar hollow tubercles are also present on other parts of the snout.

The air-bladder is much reduced and the two chambers are separated by a comparatively long and narrow neck. The following are the dimensions of the air-bladder in a specimen 102 mm. long without the caudal:—

Length of anterior chamber	4·5 mm.
,, ,, posterior ,, ...	3·2 ,,
Greatest diameter of anterior chamber	3·3 ,,
,, ,, ,, posterior ,, ...	1·3 ,,

The colour has faded in spirit, but even now indistinct longitudinal black bands can be seen on the body and an indistinct black dot on the operculum near its angle.

Type-specimen.—F 8123/1, *Zoological Survey of India* (*Ind. Mus.*).

Locality.—From Lahej near Aden, where it is said to be very common. The specimens were presented to the Indian Museum by Dr. W. T. Blanford.

Measurements in millimetres.

	A.	B.	C.
Total length excluding caudal	121	121	98
Length of head	29	28	24·5
Width ,, ,, ...	21	21·5	18
Depth of body	33·5	32	24
Length of snout	17	16	13
Diameter of eye	6	5·5	5·5
Interorbital width	11	11·5	9·5
Heigth of dorsal fin	27	27·5	22·0
Length of anal ,, ...	23	22·5	20
,, ,, pectoral ,, ...	28	28	24
,, ,, ventral ,, ...	26	26	21·
Length of caudal peduncle	24	19	17
Depth ,, ,, ,, ...	16	16.5	14·5
Length of rostral barbels	5	4	4·5
Gape of mouth	12	13·5	10

Playfair[1] in 1870, recorded from Lahej some fish, which he referred to *G. lamta*, on the authority of Günther. He also gave a short description of his specimens. My examples do not agree with his account of these fishes and, therefore, I suppose that in Arabia as in other countries where this genus is found there is probably more than one species. Our Arabian specimens certainly do not belong to *G. lamta*, to which they were originally referred. The new species differs from Playfair's description in the following characters:—

(i) The number of the longitudinal series of scales between

[1] *Proc. Zool. Soc. London*, pp. 85, 86 (1870)

the lateral line and the ventrals is three and a half in *G. arabica*, while it is four and a half in Playfair's form.

(ii) In *G. arabica* the pectoral terminates about a half of its own length from the root of the ventral, while in Playfair's examples it terminates "at about its own length before root of ventral."

(iii) The proportions in the two species do not agree. *G. arabica* closely resembles *G. stenorhynchus* and *G. gotyla* from India in the character of the snout, which in these three species possesses a proboscis; but whereas in the two Indian species the proboscis is single, in the Arabian species it is provided with two short processes near its base, one on each side. The three species also differ in proportions and number of fin-rays.

Garra sp.

? 1897. *Discognathus* sp.? Nikolsky, *Ann. Mus. Zool. Acad. Petersbourg* II, p. 348.
1910. *Discognathus lamta*, Jenkins, *Rec. Ind. Mus.* V, p. 124.

In this fish the dorsal profile rises from the anterior end of the snout to the origin of the dorsal fin, beyond which it slopes down to the base of the caudal fin. The ventral profile in front of the ventrals is straight and horizontal. The head and body are depressed and the scales on the chest and the middle of the abdomen are poorly developed. To the naked eye, indeed, the surface appears to be absolutely devoid of scales. The length of the head is contained 3·6 in the length of the fish without the caudal fin. The head is almost 1·4 times as long as broad. The eye is almost in the middle of the head or somewhat in the posterior half; its diameter is contained 5 times in the length of the head. It is dorso-lateral in position and is invisible from below. The interorbital space is slightly less than the length of the snout and almost equals the gape of the mouth; it is twice the diameter of the eye. The snout projects considerably beyond the mouth which is provided with a fringed labial fold. The mental disc is well developed. There are eight branched rays in the dorsal and five in the anal. The origin of the dorsal is equidistant from the end of the snout and the base of the caudal fin and is also considerably in advance of that of the ventral. There are two pairs of short barbels. The maxillary barbels are shorter than the diameter of the eye, while the rostral barbels are longer. There are 33 scales along the lateral line and 8 rows between the bases of the dorsal and the ventral fins.

The air-bladder is slightly reduced, otherwise it is of the normal Cyprinid type. The following are its dimensions in a specimen 51·5 mm. in length without the caudal:—

Length of posterior chamber	9·5 mm.
,, ,, anterior ,, ...	5·2 ,,
Greatest diameter of posterior chamber	2·0 ,,
,, ,, ,, anterior ,, ...	3·5 ,,

In spirit the upper surface of the head and body is dusky and the belly is white

Locality.—Only one specimen from Persian Baluchistan (W. T. Blanford's Persian collection) has been examined. It is immature and the sex cannot be determined.

The species differs from *G. persica*, Berg (1913) in having the upper lip fringed, in having no scales on the belly and in proportions and colouration. In it the eye is situated almost in the centre of the head, while in *G. persica* it is in the posterior half.

Garra rufus (Heckel).

1843. *Discognathus rufus*, Heckel, *Russegger's Reis.* I, p. 1071, pl. 8, fig. 2.
1884. *Discognathus lamta*, Tristram, *Faun. Flor. Palest.*, p. 172, pl. xix, fig. 3.
1913. *Discognathus lamta* var. *rufus*, Annandale, *Journ. As. Soc. Bengal* (n.s.) IX, pp. 36—38, fig. 2.

Through the kindness of Mr. Tate Regan, to whom our best thanks are due, we are now in possession of the original description of Heckel's species. After a careful comparison of Dr. Annandale's Palestine specimens with the description of Heckel's *G. rufus* from Syria, I have not been able to find any specific differences.

In *G. rufus* the air-bladder is well-developed and its length is contained 2·7 times in the total length of the fish without the caudal fin.

Garra blanfordi (Boulenger).

1909. *Discognathus blanfordi*, Boulenger, *Cat. Fresh-w. Fish. Africa* I, p. 249, fig. 263.

While discussing the distribution and relationship of the genus *Discognathus*, Annandale[1] pointed out the possibility that the African species "may be degenerate rather than primitive." He had then no African specimens for examination. I have now dissected a specimen of *G. blanfordi* from Abyssinia in order to see the air-bladder and the weberian ossicles and find the structure of both to be of normal Cyprinid type. The air-bladder is fairly extensive and is not covered by any fibrous coat. The weberian ossicles and the bladder are of the normal Cyprinid type. It is clear, therefore, that *D. blanfordi* is not degenerate in so far as the air-bladder is concerned. The following are the measurements of a specimen 35 mm. in length without the caudal :—

Length of anterior chamber	...	5·2 mm.
,, ,, posterior ,,	...	7·5 ,,
Greatest diameter of anterior chamber	...	3·6 ,,
,, ,, ,, posterior ,,	...	2·3 ,,

Garra adiscus (Annandale).

1919. *Discognathus adiscus*, Annandale, *Rec. Ind. Mus.* XVIII, p. 68 pl. x, fig. 2 ; pl. xi, fig. 1.
1920. *Discognathus adiscus*, Annandale and Hora, *ibid.*, p. 165.

[1] *Rec. Ind. Mus.* XVIII, p. 69 (1919).

Annandale pointed out in the description of the species that it "must be accepted as an extremely primitive representative of *Discognathus*." In another paper in the same volume (p. 165) I concurred in the same view. I have now examined the skeleton and the air-bladder more closely and find some corroborative evidence, but as has already been pointed out it is impossible to express any final opinion on the subject until the Malayan species assigned to *Crossochilus* are examined anatomically.

I have prepared skeletons of the jaws in *Crossochilus latia*, *Cirrhina mrigala* and *Garra adiscus* for comparison and find great similarity as regards their bony structure in *G. adiscus* and *C. mrigala*. Both these differ from *C. latia* in having a longer articular bone and better developed branchiostegal rays. They also differ in the character of the basibranchiostegal bone or urohyal. Correlated with these differences there are others in the air-bladder. Whereas the bladder of *C. mrigala* and *G. adiscus* are of the normal type, in *C. latia* it is somewhat reduced and differs considerably from the normal form, more closely resembling that of some advanced species of *Garra*. The posterior chamber has become cylindrical with an almost uniform thickness throughout, and its walls are also thickened. It is clear, therefore, that *G. adiscus* is more closely allied to *Cirrhina* than it is to *Crossochilus*. In this respect *G. adiscus* agrees with other less modified species of *Garra* I have examined.

The following are the measurements of the bladder in a specimen 58 mm. in length :—

Length of anterior chamber	6·8 mm.
,, ,, posterior ,, ...	11 ,,
Greatest diameter of anterior chamber	4·5 ,,
,, ,, ,, posterior ,, ...	3·2 ,,

The systematic position of this species is rather doubtful. I provisionally include it in the genus *Garra*.

Garra rossicus (Nikolsky).

1889. *Discognathus lamta*, Günther, *Trans. Linn. Soc. London* V (2), p. 107.
?1897. *Discognathus variabilis*, Nikolsky, *Ann. Mus. Zool. Ac. Sci. St. Petersburgh* II, p. 347.
1899. *Discognathus variabilis*, Nikolsky, *ibid.*, IV, p. 412.
1900. *Discognathus rossicus*, Nikolsky, *ibid.*, V, p. 239.
1905. *Discognathus rossicus*. Berg, *Izv. Vost.-sibir.* IV, Vuip. 6, p. 261, pl. iv.
1906. *Discognathus variabilis*, Regan, *Journ. As. Soc. Bengal* II p. 8.
1919. *Discognathus phryne*, Annandale, *Rec. Ind. Mus.* XVIII, p. 70, pl. x, fig. 3 ; pl. xi, fig. 2.
1920. *Discognathus phryne*, Annandale and Hora, *ibid.*, p. 166.

This species is closely allied to *G. variabilis*, Heck., from which it differs in the following characters :—

(i) The origin of the dorsal fin is considerably nearer the base of the caudal fin than the tip of the snout.

(ii) The minimum height of the dorsal fin is contained more than twice in its maximum height.

(iii) The caudal fin is deeply emarginate.

(iv) The chest and back are naked.

(v) The proportions are different in the two species.

Nikolsky described *G. rossicus* from the specimen which he had previously referred to *G. variabilis*. Annandale and myself in 1920 regarded Nikolsky's *G. variabilis* as a synonym of *G. phryne* but overlooked his later paper (1900) in which the specific name *rossicus* is proposed. I have now carefully compared the descriptions of *D. phryne* and *D. rossicus* and do not think that there is any difference between the two forms. In his Latin description Nikolsky makes no mention of the scales on the chest or on the back; but considering that his specimens were obtained from the same locality whence Annandale described his *G. phryne*, I have no doubt that the two species are identical.

I refer to this species the specimens collected by Aitchison when he was attached to the Afghan Delimitation Commission. These examples are not in good condition for detailed examination; but so far as I have been able to make out the only difference between them and the *G. phryne* from Seistan lies in the structure of the mental disc. In the Afghanistan examples the free borders of the disc are well developed.

I also refer to this species Col. MacMahon's specimens from Seistan and several examples collected by Col. Alcock in the Shila and Lora Rivers, Afghanistan.

This species is fairly common in the hilly country of Baluchistan but is rare in Seistan and Oriental Persia.

The air-bladder, like the other less modified species of *Garra*, is fairly extensive and is of the normal form. In a mature female 55 mm. in total length, the measurements are as follows:—

Length of anterior chamber	6·0	mm.
,, ,, posterior ,, ...	11·0	,,
Greatest diameter of anterior chamber ...	5·0	,,
,, ,, ,, posterior ,, ...	3·5	,,

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EXPLANATION OF PLATE XXIV.

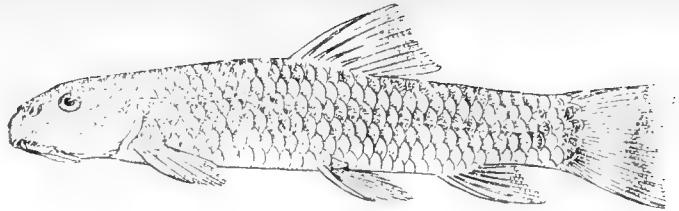
FIG. 1.—*G. rupeculus* (McClelland). ×3.

,, 2.—*G. lamta* (Ham. Buch.). Female ×2.

,, 2*a*.—*G. lamta* (Ham. Buch.), upper surface of head showing short, blunt proboscis on the snout in male ×3.

,, 3.—*G. prashadi*, sp. nov. ×1½.

,, 4.—*G. nasutus* (McClelland). Nat. size.



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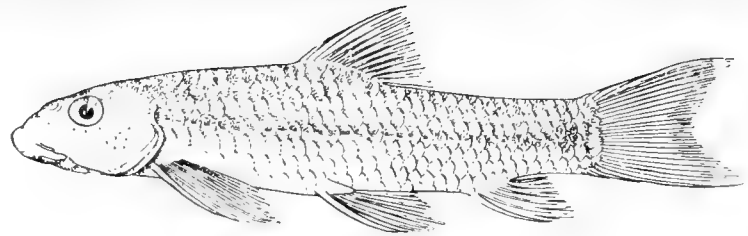

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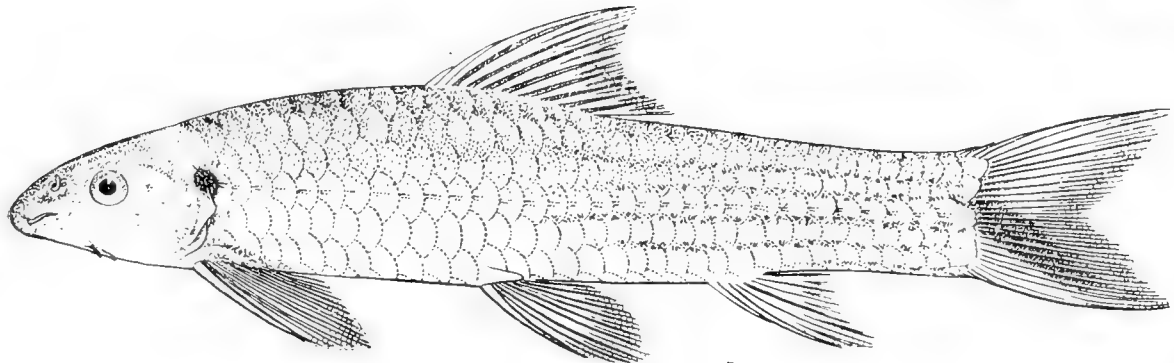

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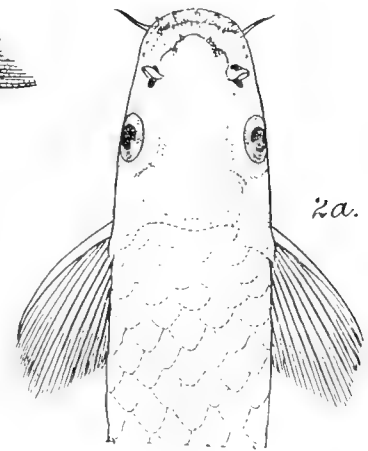

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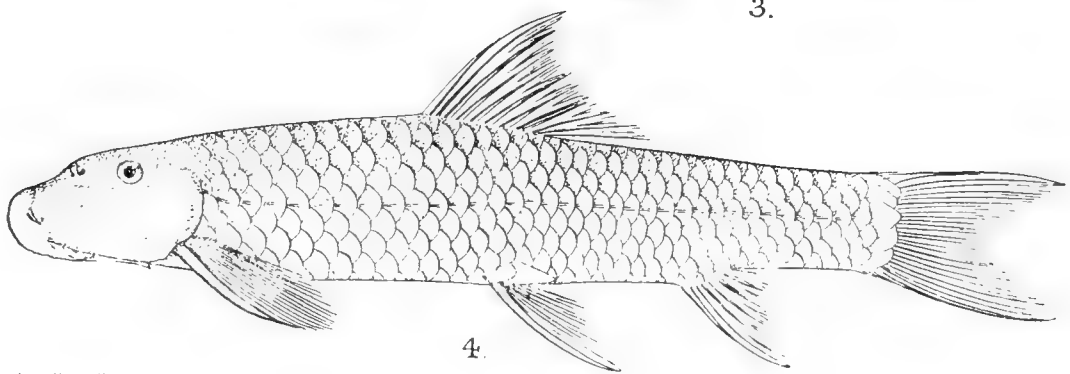

4.

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INDIAN SPECIES OF *GARRA*.

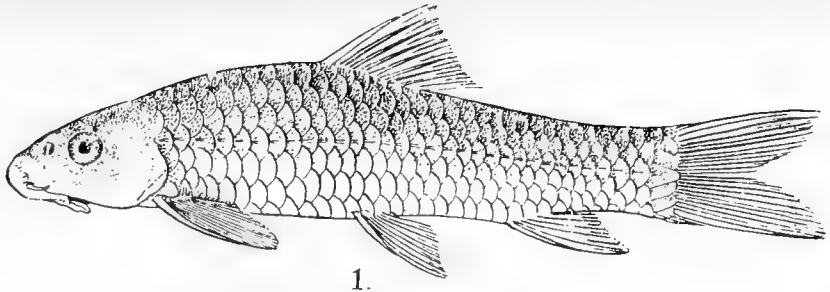
EXPLANATION OF PLATE XXV.

FIG 1.—*G. jenkinsonianum*, sp. nov. × 1½.

,, 2.—*G. naganensis*, sp. nov. Nat. size.

,, 2*a*.—*G. naganensis*, sp. nov. Ventral view from tip of snout to base of anal fin. × 1½.

,, 3.—*G. chaudhurii*, sp. nov. × 2.



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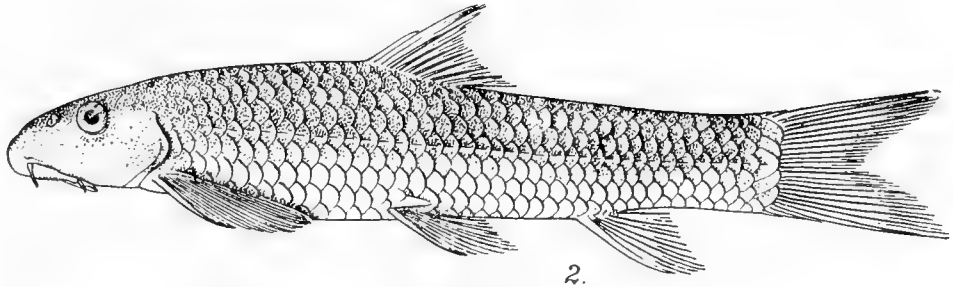

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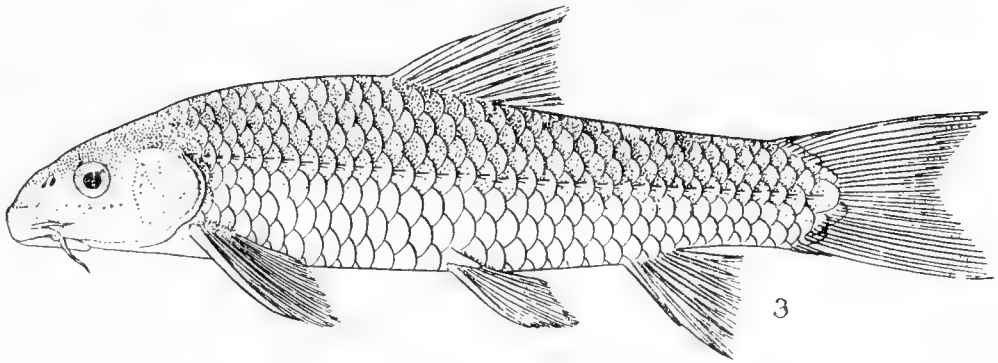

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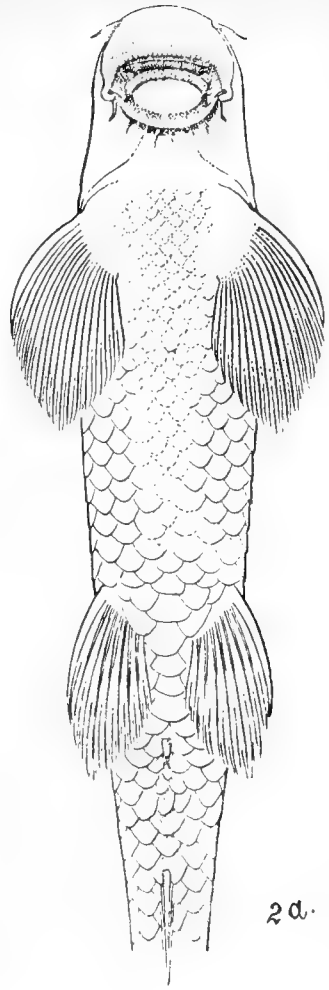

2a.

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EXPLANATION OF PLATE XXVI.

FIG. 1.—*G. abhoyai*, sp. nov. × 1½.

,, 1*a*.—Dorsal surface of same in front of dorsal fin × 1½.

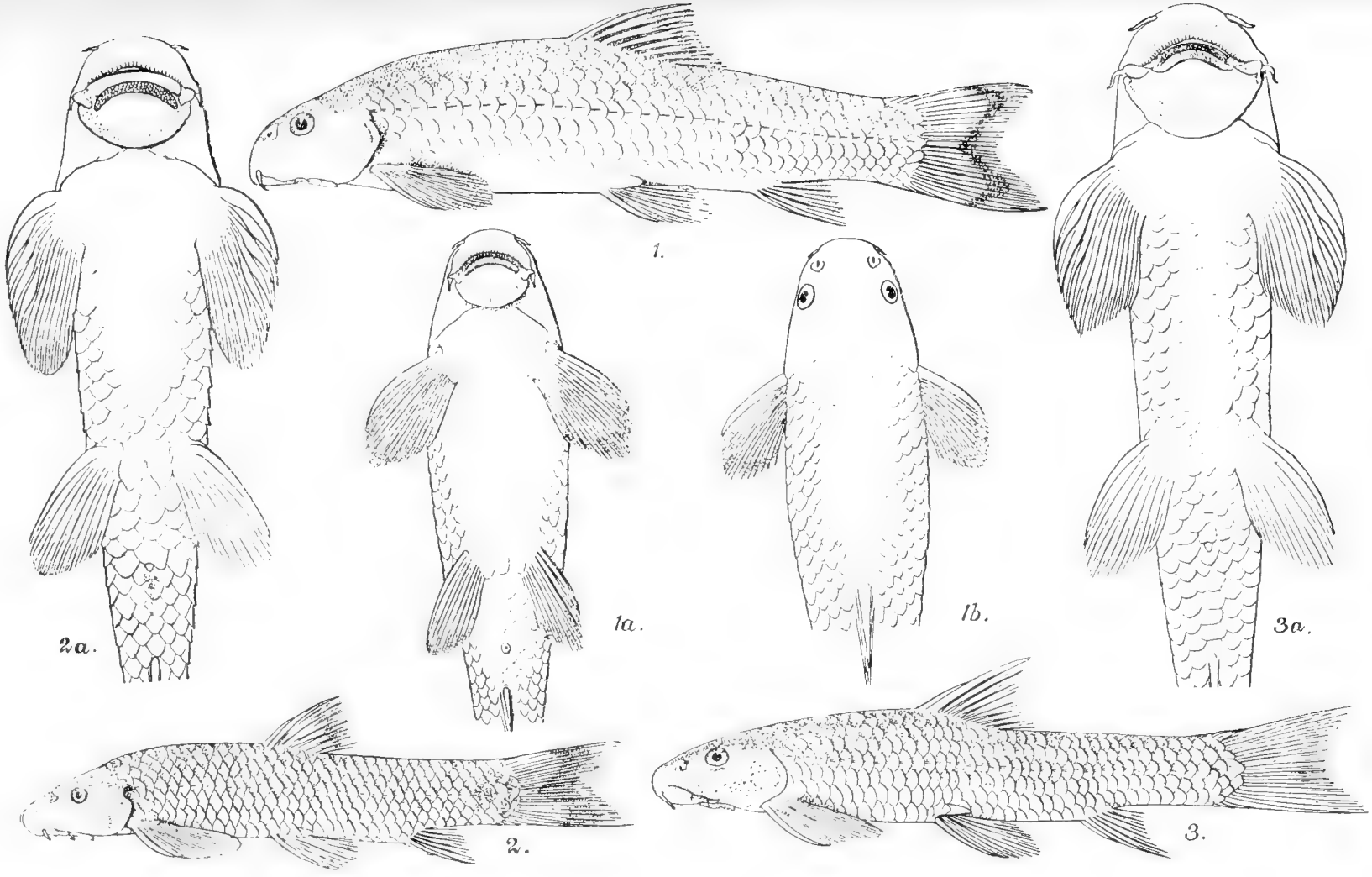
,, 1*b*.—Ventral surface of same in front of anal fin. × 1½.

, 2.—*G. lissorhynchus* (McClelland). × 1½.

,, 2*a*.—Ventral surface of same in front of anal fin. × 2½.

,, 3.—*G. kempi*, sp. nov. Nat. size.

,, 3*a*.—Ventral surface of same in front of anal fin. × 1½.



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INDIAN SPECIES OF *GARRA*.

XXX. NOTES ON SOME LEECHES IN THE COLLECTION OF THE INDIAN MUSEUM.

By Tokio Kaburaki, *Research Student, Imperial University, Tokyo.*

(From the Zoological Laboratory, the Museums, Cambridge.)

The present account is the result of the examination of a large collection of leeches belonging to the Indian Museum, which was placed by Dr. N. Annandale in my hands for identification. The material was originally intended for use, in conjunction with Mr. W. A. Harding, in the preparation of a volume in the "Fauna of British India" series on the said group; but, as Mr. Harding is unable to continue the work, it has become necessary for me to take the whole responsibility upon myself, and also to confine myself to a rough investigation, owing to the unavoidable pressure of many other studies during my stay in foreign countries. It is hoped, therefore, that at least some of the species will be subjected to full anatomical investigation in the future.

Most workers on the systematic side complain of the enormous difficulty of determining the species or even the genera of leeches owing to the fact that the descriptions of many of the known species are based solely upon external characters without any regard to internal structure. This seems to me to be more apparent than real. It is, however, necessary, as has been mentioned by Oka (1917), to submit the group to a thorough revision in reference to internal characters. In the present paper, however, I have adopted the generic designations in current use, leaving the problem to those who may have occasion to study personally a large number of forms and especially to re-examine the species previously recorded.

In the leech, as is well known, the large number of rings found on the body resolve themselves into a series of regularly recurring groups corresponding to the successive somites. It has long been recognised that we have to account for twenty-seven somites in the body excluding the posterior sucker, the number of the somites corresponding with that of the ganglia in the central nervous system. Towards the ends of the body the number of rings in a somite becomes smaller, and at the extremities one or more somites are found represented by only one ring.

Much debate has arisen as to the determination of somite-limits. In this communication, however, I have intentionally abstained from taking part in such a discussion and have adopted the neuromeric standard of somite-limits advocated by Moore

(1900), Castle (1906) and some others. The sensory ring may be regarded as corresponding to the middle ring of each typical somite, lodging a ganglionic mass of the ventral chain and in several cases possessing the "metameric sensillae," which are often rendered conspicuous by association with special colour markings and by elevation upon more or less prominent papillae. Of course it is sometimes extremely difficult or nearly impossible to determine the somites by this means, because of the indistinctness or the entire absence of papillae and colour markings. Here, however, I insist upon this conception: the Chinese species *Myxobdella annandalei*, Oka (1917), seems to indicate that the neuromeric standard of somite-limits is true. In this species the body, though wholly devoid of segmental papillae, is divided by deep furrows into distinctly bounded somites, each being subdivided into rings by much shallower ones. The ganglionic mass occupies a position in the middle of each typical somite.

Here I deem it my duty to express my best thanks to Dr. N. Annandale for the privilege of allowing me to examine this large collection of leeches, and to Professor J. S. Gardiner for providing me with accommodation in his laboratory. My thanks are also due to Mr. W. A. Harding for giving and lending me some literature.

The following is a list of the species dealt with in the present paper:—

Sub-order Rhynchobdellae.

Family ICHTHYOBDELLIDAE.

1. *Ozobranchus jantseanus*, Oka.
2. *Ozobranchus papillatus*, sp. nov.
3. *Pterobdella amara*, Kaburaki.
4. *Cystobranchus anoculatus*, sp nov.
5. *Piscicola olivacea*, Harding.
6. *Piscicola cacca*, Kaburaki.

Family GLOSSOSIPHONIDAE.

7. *Hemiclepsis marginata* (O. F. Müller).
8. *Glossosiphonia weberi*, R. Blanchard.
9. *Glossosiphonia lata*, Oka.
10. *Glossosiphonia ceylanica*, Harding.
11. *Glossosiphonia reticulata*, sp. nov.
12 *Placobdella emydae*, Harding.
13. ? *Placobdella gracilis* (R Blanchard).

Sub-order Arhynchobdellae.

Family HERPOBDELLIDAE.

14. *Herpobdella lineata* (O. F. Müller).
15. *Herpobdella hexoculata*, sp. nov.
16. *Herpobdelloidea lateroculata*, gen. et sp. nov.

17. *Nematobdella indica*, gen. et sp. nov.
18. *Foraminobdella heptamerata*, gen. et sp. nov.
19. *Scaptobdella horsti*, R. Blanchard.

Family GNATHOBDELLIDAE.

20. *Whitmania laevis* (Baird).
21. *Limnatis nilotica* (Savigny).
22. *Limnatis granulosa* (Savigny).
23. *Haemopis sanguisuga* (Linnaeus).
24. *Haemopis birmanica*, R. Blanchard.
25. *Haemopis concolor*, sp. nov.
26. *Myxobdella annandalei*, Oka.
27. *Haemadipsa zeylanica* (Moquin-Tandon).

Sub-order RHYNCHOBDELLAE.

Family ICHTHYOBDELLIDAE.

Genus **Ozobranchus**, de Quatrefages.

1. **Ozobranchus jantseanus**, Oka, 1912.

Numerous specimens of a species identical with Oka's *Ozobranchus jantseanus* from China were obtained by Dr. B. L. Chaudhuri from a *Kachuga donghoka* in the Zoological Gardens of Calcutta, which was originally brought from Oodhua near Rajmahal.

The body is depressed and formed of two distinct regions, a short narrow neck and a long large abdomen, the former being partly invaginated into the abdominal region, as is the case with *Branchellion*. The abdomen is provided with eleven pairs of digitate branchiae, of which the anterior are much larger and more branched than the posterior. The anterior sucker is very small and not distinct from the neck, while the posterior represents a large cupuliform disc with a diameter about as broad as the abdominal part of the body. The large examples are about 25 mm. in length, without the posterior sucker, and 7 mm. across at the middle of the abdomen.

The complete somite is formed of two rings of different size, the first ring being enlarged and the second narrower. In the abdominal, but not in the neck region, each ring, as stated by Oka (1917), is in some cases marked on the dorsal surface with a transverse row of papillae beset with more than one sharp point.

In the preserved specimens the body, though colourless in most instances, is sometimes of a brownish colour, without any trace of markings.

A pair of eyes lie slightly behind the level of the mouth which opens near the centre of the anterior sucker.

The male and female genital organs open in common at the base of the neck, where the latter merges into the abdomen.

The anus is located on the dorsal surface between the last two somites of the body.

2. **Ozobranchus papillatus**, sp. nov.

The collection contains some examples which appear to represent a new species, found by Mr. E. A. D'Abreu on the leg of *Kachuga tectum* at Nerbudda, Nagpur.

The species closely resembles the preceding, in its external features there being distinguished two distinct regions, the neck and the abdomen, with the eleven pairs of digitate branchiae. The typical somite consists of two rings of nearly similar breadth, each ring in the abdomen being provided with conical papillae on the dorsal surface. The papillae are of small size and present a single sharp end, differing from *O. jantseanus*. The colour of the body is grey and exhibits no trace of markings, except a darker shade in the anterior region of the abdomen. All the specimens are strongly contracted and are about 7 mm. long by 4 mm. broad at the middle of the abdomen. The most conspicuous character which distinguishes this species from *O. jantseanus* is the absence of any trace of eye-like organs.

Genus **Pterobdella**, Kaburaki.

3. **Pterobdella amara**, Kaburaki, 1921.

In a recent paper [1] I placed on record in some detail this interesting species which was found in the Chilka Lake, adhering to the mouth of *Hypolophus sephen* and *Trygon uarnak*. The trunk is of a peculiar shape, being divided into three distinct regions, of which the anterior two each carry a pair of conspicuous lateral *fin-like bodies*. *The visual organs are entirely absent.*

Genus **Cystobranchus**, Diesing.

4. **Cystobranchus anoculatus**, sp. nov.

In the collection there are three specimens which appear to represent an interesting member of the genus *Cystobranchus*, their locality being unknown. Hitherto recognised as belonging to this genus are four species,—*C. respirans* (Troschel), *C. fasciatus* (Kollar), *C. vividus* Verrill and *C. mammillatus* (Malm),—all ectoparasitic on various freshwater fish such as *Cyprinus carpio*, *Barbus fluviatilis*, *Thymallus vulgaris*, *Rhodens amarus*, *Trutta fario*, etc. Of these species *C. mammillatus* seems to be by far the most closely related to the species here described.

In shape this leech conforms to the typical *Cystobranchus*-outline, with the short narrow neck, distinctly separated from the abdomen, which is elongate, wide, of a nearly uniform breadth for the greater part of its length and is provided, as in all species of the genus, with eleven pairs of pulsating vesicles. The suckers are large and are centrally attached, the anterior sucker being about one-third as wide as the posterior. In no case have I been

[1] See Kaburaki, *Mem. Ind. Mus.* V, p. 668, figs. 3, 4.

able to observe any trace of the dark spots on the posterior sucker, which are to be observed in *C. respirans*. The body is about 21 mm. long by 3·5 mm. across in the middle of the abdominal region.

The complete somite is formed of seven rings. In the first eleven somites of the abdominal region each somite carries a pair of the pulsating vesicles which, in diastole, arch up the skin, usually extending over rings 2 to 5.

The leech is wholly devoid of any trace of eyes, as is the case with *C. mammillatus*.

The body in the preserved state is of a dirty brown colour, being marked with a darker shade in the region of the genital openings, just anterior to the abdomen.

The mouth lies near the centre of the anterior sucker and leads nto the pharyngeal sheath with the pharynx, which is cylindrical in shape and extends over about three somites, vii–ix. Widely distributed on either side of the pharynx are numerous salivary glands, which make their way to the base of the pharynx. The crop represents a distensible part of the digestive tract and is provided with seven pairs of subdivided lateral diverticula which come off metamerically in each of the first seven somites of the abdomen. The last pair are reflected posteriorly and extend into somite xxii, giving off a secondary, outwardly directed diverticulum in each somite and appearing to fuse together metamerically, as stated by Johansson. The stomach possesses four pairs of nearly pear-shaped lateral pouches, a pair in each of somites xix–xxii. The intestine is in the form of a more or less wide canal, passing to the dorsally situated anus between somites xxvi and xxvii. The walls of the stomach and intestine are richly supplied with blood vessels.

The vascular system seems to be similarly constructed to that of other Ichthyobdellids, there being the dorsal and ventral vessels, which lie respectively in the dorsal and ventral sinuses of the coelome. These sinuses give off metamerically arranged transverse branches and communicate with the lateral vesicles, thus forming a complete circle.

The male genital orifice, though I could not determine it with certainty, appears to lie between the last two rings of somite xi; the female orifice is seven rings behind the male, that is in somite xii.

The six pairs of testes lie anterior to each of the first six pairs of lateral diverticula of the crop. Anteriorly the vasa deferentia on each side assume the character of a wide tortuous passage, and after uniting to form the "prostate," open to the exterior by the male orifice. The female organs appear to be similar in structure to those of other Ichthyobdellids.

Genus **Piscicola**, Malm.

5. **Piscicola olivacea**, Harding, 1920.

This species, as mentioned in my recent paper (*loc. cit.*), is fairly common in the Chilka Lake and occurs usually attached to

the body, or to the palate within the mouth, of fish such as *Hypolophus sephen*, *Tetrodon reticularis* and *Dorosoma indica*. In shape this leech conforms to the typical *Piscicola*-outline, with the circular suckers, of which the anterior is rather less than half the size of the posterior sucker. The eleven pairs of pulsating vesicles are conspicuous, especially in the living forms. Situated dorsally on the anterior sucker are two pairs of eyes, as in *P. geometra*, Linn.

6. **Piscicola caeca**, Kaburaki, 1921.

This leech inhabits the Chilka Lake and was found attached to the jaw of *Hypolophus sephen*. It is closely allied to the preceding species, but may be easily distinguished from it by the absence of eyes.

Family GLOSSOSIPHONIDAE.

Genus **Hemiclepsis**, Vejdovsky.

7. *Hemiclepsis marginata* (O. F. Müller), 1774.

Hirudo marginata (O. F. Müller), 1774.
Glossosiphonia marginata, Moquin-Tandon, 1846.

Some examples of a species identical with *Hemiclepsis marginata* were collected by Dr. F. H. Gravely at Bagra in Hoshangabad District and also by Dr. T. Southwell from a species of *Lamellidens* at Bhandardaha Beel in the Murshidabad District. The species is one of wide distribution, being known to occur throughout the greater part of Europe, China and Japan.

The body in the preserved condition is elongate-lanceolate, the head being separated from the trunk by a slight neck-like narrowing. The dorsal surface is marked with very weakly developed papillae. Centrally attached is the posterior sucker, which is of a nearly circular shape. The largest specimens are about 7 mm. long by 4 mm. across at the middle of the body.

Counted on the dorsal surface are seventy-two rings, which appear to be grouped as follows: somites i and xxvii are uniannulate; ii, iii, iv, xxv and xxvi biannulate; the twenty somites v–xxiv are complete with three rings.

The two pairs of eyes lie in rings 3 and 4 respectively, the first pair being much smaller than the second.

The body is of a yellowish colour in spirit and is marked with pigment-patches which occupy a definite position on the rings, so that those on successive somites form seven longitudinal rows, three in each half of the body and one median in position. The paired rows may be designated as marginal, intermediate and paramedian. The patches forming the median and marginal rows fall on the second ring of each typical somite, while those composing the paramedian and intermediate rows occur on the first ring. The median row is much more conspicuous than any of the others.

The mouth is situated near the centre of the anterior sucker. Extending over about three somites, vii–ix, is the pharynx, which is of a cylindrical shape. The crop is provided with some ten pairs of subdivided lateral diverticula, one pair in each of somites x–xix. The last pair are reflected posteriorly, giving off four secondary, outwardly directed diverticula. The stomach bears four pairs of lateral pouches which lie within the three somites xx–xxii. Opening on the dorsal surface is the anus, which occurs between the last two somites.

The male genital orifice, though I could not find it out definitely, seems to lie between somites xi and xii, and the female orifice is two rings behind the male, that is between the second and third rings of somite xii.

Genus **Glossosiphonia**, Johnson.

8. **Glossosiphonia weberi**, R. Blanchard, 1897.

(Text-fig. 1.)

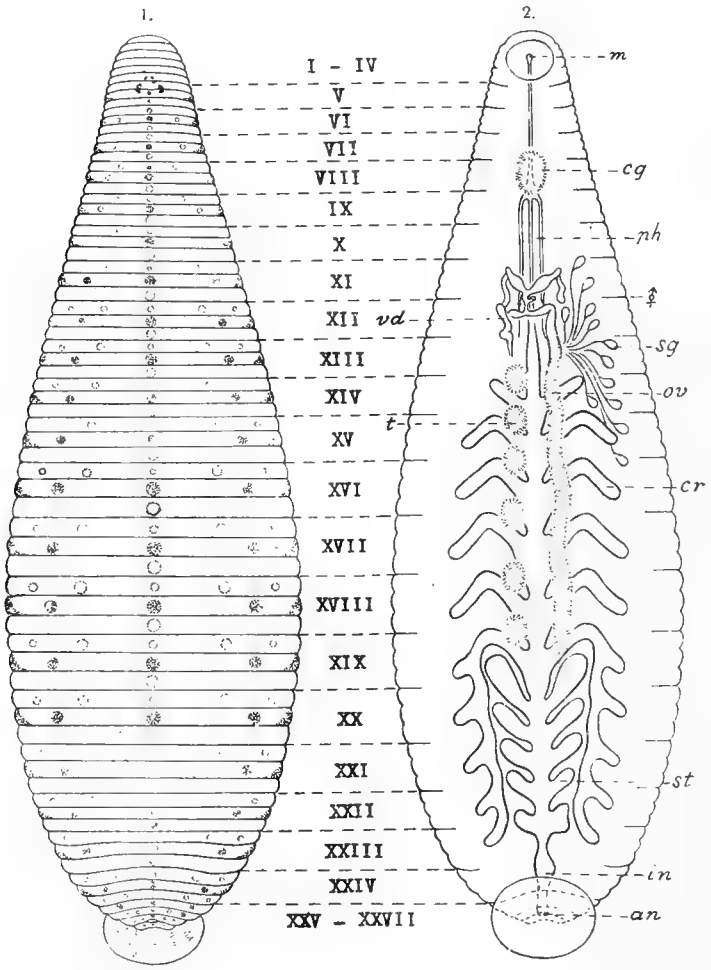
The material was found at the north end of Lake Loktak, Manipur, adhering to the body of *Vivipara oxytropis* (Benson).

On examination, the species, though exhibiting a small difference in the position of the genital orifice, proves to be identical with Blanchard's *Glossosiphonia weberi* from Sumatra described by that author. *Gl. weberi* is very closely related to *Gl. heteroclita* (Linn.) which is of wide distribution in Europe and America, but it is distinguishable from it by the possession of numerous well-developed papillae on the dorsal surface.

The body is generally of small size, in a full grown condition being 8 mm. long, exclusive of the posterior sucker, by 4 mm. across at the middle. In the preserved state the body as seen in dorsal aspect is ovate-elliptical in form, broadest slightly behind the middle, and thence tapering more gradually to the anterior than to the posterior end. The dorsal surface is much arched and quite rough all over, owing to the presence of numerous well-developed conical papillae, while the ventral surface is nearly flat and entirely smooth. The anterior sucker, as in all species of *Glossosiphonia*, lies on the ventral side of the head, within the limits of rings 1–5. The mouth is situated slightly anterior to the eyes, well forward in the anterior half of the said sucker. The posterior sucker is sometimes ventral in position and of a small ovate or circular shape, the diameter being about 1 mm.

The external rings are rather conspicuous; counting dorsally, so far as my observation goes, there are seventy in front of the posterior sucker, of which the preocular rings are in most cases five in number, and rings 5 and 6 coalesce on the ventral surface, forming the posterior margin of the anterior sucker. Blanchard speaks of there being four preocular rings in the Sumatran form, but the number, as Castle (1905*a*) has pointed out, is not constant in the case of *Gl. heteroclita*, and no doubt varies to some extent in

Gl. weberi. The composition of the somites is practically the same in this species as in *Gl. heteroclita.* There are twenty-seven somites, of which somites i, ii, xxvi and xxvii are uniannulate; iii, iv and xxv biannulate; the twenty somites are complete, each consisting of three rings.



Text-fig. 1.—*Glossosiphonia weberi*, R. Blanchard.

1. Diagram showing the annulation and external features of the dorsal surface.
2. Diagrammatic representation of the organization, as seen from the dorsal side; *an.*, anus; *c.g.*, cephalic ganglionic mass; *cr.*, crop; *in.*, intestine; *m.*, mouth; *ov.*, ovary; *ph.*, pharynx; *s.g.*, salivary gland; *st.*, stomach; *t.*, testis; *v.d.*, vas deferens.

The three pairs of eyes are arranged so as to form three groups. The eyes composing the anterior and smallest pair are closely approximated in ring 6, while those forming the second and third pairs are wider apart, occurring in rings 7 and 8

respectively, and are closely apposed on each side. The first two pairs are directed obliquely forwards, the last pair obliquely backwards; all are turned away from the median plane.

Dorsally the rings are marked, as stated above, by conical papillae, which are of various size, and form a transverse row of about 11–17 on every ring. In each transverse row the papillae are arranged, as a rule, symmetrically, some being of larger size and occupying a definite position on every ring, so that those on successive somites form seven longitudinal rows, three in each half of the body and one median in position, as is shown in text-fig. 1. The paired rows may be designated as paramedian, intermediate, and paramarginal. The paramedian rows of non-pigmented papillae are usually constant in occurrence with the intermediate; they fall on the first ring of each somite. The intermediate rows occur upon the second ring of each somite, and usually contain pigment. The papillae composing a median row exist on every ring, though those on the first of each somite are often inconspicuous. The paramarginal rows are less well-developed than any of the others, occurring on the first ring of each somite. This regularity of arrangement loses itself as it proceeds towards both ends of the body.

The body presents a whitish colour in spirit, marked with five longitudinal rows of dark-brown or black pigment-patches which are arranged metamerically extending backwards almost throughout from somite v. These patches mark most often the middle ring of each somite in the position of the papillae forming the median and intermediate rows, as well as at the lateral edge where the dorsal surface passes round to the ventral. On some occasions the median row is seen, without being interrupted, as a continuous stripe. On the posterior sucker we find pigment-patches arranged in some five radial stripes, which correspond to the median, intermediate and marginal rows mentioned. In no case have I been able to observe any trace of special sensory spots.

The specimens had not been preserved in a state fit for the purpose of minute examination. The mouth situated anterior to the middle of the anterior sucker leads into the pharyngeal sheath which extends posteriorly into about somite xii. In it lies the pharynx which is of a cylindrical shape, terminating conically at the free end. At the base the pharynx is furnished from both sides with the ducts of the salivary glands scattered through as many as eight somites, usually somites x–xvii. Posteriorly the pharynx gives rise to the oesophagus, which is a tubular passage opening into the crop, and much longer than that of *Gl. heteroclita*. The wall of the oesophagus is composed of columnar epithelial cells closely set, surrounded by circular muscles. The crop is provided with six pairs of lateral diverticula, one pair in each of somites xiv–xix. In these diverticula there cannot be demonstrated such a tendency to subdivide into two at the tip, as is seen in *Gl. heteroclita*, except in the last pair which extend backwards into somite xxiii and gives off about five secondary, outwardly

directed diverticula, coming off metamerically in somites xix-xxiii. The crop presents a very thin wall and was found to be filled with a dense coagulum. Opening from the crop in somite xix is a short tube leading directly into the stomach which is provided with four pairs of lateral pouches, lying within somites xix–xxii. In structural respects this differs from the crop, possessing its wall which is made up of closely apposed, columnar epithelial cells, surrounded by two sets of muscular fibres, circular and longitudinal. Posteriorly the stomach is continuous with the intestine, which in its course is divided into two chambers by a constriction and finally opens on the dorsal surface between rings 69 and 70.

The vascular and coelomic systems, so far as my observation goes, seem to be constructed on the same plan as in most of the Glossosiphonids.

There are some seventeen pairs of nephridia, the ducts of which lie in the lateral parts of the body, forming a convolution in the central portion. The duct opens ventrally on the middle ring of a somite, somewhat nearer the margin than the median line.

The cephalic ganglionic mass lies for the most part in somite viii, consisting, as usual, of the fused ganglia of the first six somites. The arrangement of its ganglionis capsules is the same as that found in *Gl. heteroclita*, though the most ventral and posterior capsule of neuromere i in the present species exhibits no horn-like process extending backwards laterally into contact with the lateral capsules of neuromere iii. Between the cephalic and acetabular ganglionic masses there exist ventrally twenty-one distinct ganglia, which are metamerically arranged and joined by paired connectives. The usual position of the ganglion is in the middle ring of each somite. Towards either end of the body, however, there can be found a slight centripetal displacement of the gangila, as is seen in many leeches.

The genital organs agree in the main with *Gl. heteroclita*, opening by a common aperture which at a glance seems to lie in the middle of the ring as has been stated by Blanchard. A closer examination, however, has revealed that it is situated between somites xi and xii. It may be considered probable that Blanchard was mistaken, as in the case of *Gl. heteroclita*, in determining the position of the opening.

The male elements consist of six pairs of follicular testes situated intermetamerically on both sides of the median line in somites xiii/xiv–xviii/xix. They are connected on each side by short vasa efferentia with the vas deferens, which proceeds forwards, pursuing a tortuous course, and then dilates into a thick-walled tube, the "prostate." Its entire course could not be definitely made out. About the region of somite xi the prostate on each side makes an abrupt turn downwards and inwards, uniting into a short common duct, which soon opens to the exterior by the common genital aperture from the front.

The female elements are composed of a pair of simple dilated sacs lying ventrally on both sides of the crop and extending almost throughout its whole length. Before opening out by the common aperture from behind, the sac unites with its fellow of the opposite side to form a very short single duct.

9. **Glossosiphonia lata**, Oka, 1910.

Only one example, which appears to be identical with this species, was collected by Professor N. Gist Gee at Soochow, China.

The body is ovate-elliptical, of a firm consistency and presents dorsally a roughened surface owing to the occurrence of papillae. The posterior sucker is a small circular disc, its diameter being about 1 mm. The specimen is 11 mm. in length and 5 mm. in width at the middle of the body.

On the dorsal surface there are seventy-two rings, of which the preocular number seven. These rings, though I could not definitely make them out, appear to resolve themselves into a series of somites somewhat as follows: somites i, xxvi and xxvii are uniannulate; ii, iii, and xxv biannulate; and twenty-one somites complete with three rings.

The three pairs of eyes are similar in their arrangement to those found in the preceding species. The first and smallest pair are approximated in ring 8, while the second and third pairs are wider apart, lying in rings 9 and 10 respectively.

The dorsal surface is marked all over with numerous well-developed papillae which are of various sizes. The larger papillae on successive somites are arranged symmetrically, so as to form seven longitudinal rows, as is seen in *Gl. weberi*. Medially situated on the first and second rings of each typical somite are the papillae which form the median row. The papillae forming the paramedian rows fall on the first ring of each somite in association with those of the paramarginal, which are less developed and partly inconspicuous; while those composing the intermediate rows are situated on the second ring.

In the preserved state the body is of a dark olive colour, marked on the dorsal surface with nine dark brown longitudinal stripes, one median in position and four in each half of the body. Of these four lateral stripes two lie between the median and paramedian rows of papillae, and the other two run just inside the intermediate and paramarginal rows respectively. Besides these an olive-like brown patch marks the middle ring of each somite at the lateral edge of the body. On the ventral surface are also found some interrupted longitudinal stripes which present no regular arrangement.

The crop is provided with six pairs of distally subdivided lateral diverticula, of which the last pair are reflected posteriorly and give off four outwardly directed secondary diverticula. The stomach gives rise, as is usual, to four pairs of pouches. The anus

opens on the dorsal surface between the last two rings of the body.

The male genital orifice is situated between somites xi and xii, and the female orifice appears to open on the first ring of somite xii. There are six pairs of testes, which are each placed in front of the lateral diverticula of the crop.

As is evident from the above, the present species is closely allied to the preceding, *Gl. weberi*; it is distinguished chiefly by the different arrangement of the pigment pattern.

10. **Glossosiphonia ceylanica**, Harding, 1909.

This species is not peculiar to Ceylon, as some examples which I have examined were found in the neighbourhood of Lake Chilka and at Rawalpindi. A full account has been given in my recent paper (*loc. cit.*).

11. **Glossosiphonia reticulata**, sp. nov.

(Text-fig. 2.)

A single individual only, which seems to represent a new species, was collected by Dr. B. Prashad at Jullundur, it having been found attached to the mantle of a species of *Lamellidens*.

The body in the preserved state is slender and broadest at the posterior region, from which it tapers gradually towards the anterior end. The head is marked off from the trunk by a slight neck-like narrowing. The dorsal surface presents a roughened appearance, due to the presence of papillae of various sizes, of which the larger ones are arranged so as to form three longitudinal rows, one median and two lateral. The posterior sucker is of a circular shape and is almost centrally attached. The specimen is 10 mm. in length, exclusive of the posterior sucker, by 2 mm. across at the broadest part of the body.

The body appears to comprise in all seventy-two rings, which are grouped somewhat as follows: somites i and ii are uniannulate; iii, iv, xxv, xxvi and xxvii biannulate; and the twenty somites v–xxiv complete with three rings. The papillae occur on almost all of the rings.

There are two pairs of eyes, of which the first and smaller pair lie in ring 4, the second and larger in ring 5.

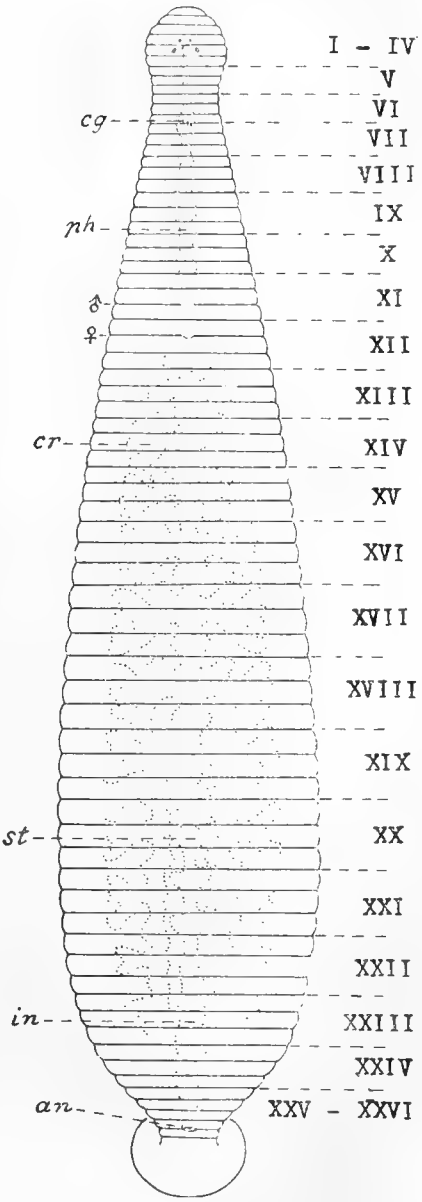
The preserved specimen is of an olive grey colour due to irregular pigment present all over in reticular distribution as well as to the contents of the crop.

The mouth opens in front of the centre of the anterior sucker. The pharynx represents a long cylindrical tube, beginning just behind the cephalic ganglionic mass situated in somite vii and extending behind into somite x. At the base it is supplied with numerous ducts of the salivary glands which are widely distributed in the anterior region. The crop is a distensible part of the digestive tract and is provided with seven pairs of subdivided diverti-

cula, which occur metamerically in each of somites xiii–xix. The last pair are reflected posteriorly and extend into somite xxiii, sending out four lateral pouches in each of somites xix–xxii. The stomach bears fours pairs of lateral pouches and posteriorly joins the wide intestine which opens dorsally between the last two somites.

The male genital orifice is placed between somites xi and xii; the female orifice lies two rings behind the male, that is, between the second and third rings of somite xii.

The present species seems to be allied to *Gl. smaragdina*, Oka, rather than to *Gl. paludosa*, Carena, but may be distinguished from them chiefly by the different arrangement of eyes as well as in the possession of well-developed pigment all over the surface.



TEXT-FIG. 2.—*Glossosiphonia reticulata*, sp. nov.

Diagram showing the annulation and some internal features: dorsal aspect. Index letters as in text-fig. 1.

Genus **Placobdella**, R. Blanchard.

12. **Placobdella emydae**, Harding, 1921.

The collection contains a few individuals identical with Harding's *Placobdella emydae*, described in detail by that author from Lake Chilka and elsewhere. The material was collected by Dr. F. H. Gravely at Hoshangabad, Central Provinces, and at an elevation of about 2000 ft. in Taloshi, Koyna Valley, in the Satara District. An example

found with *Limnatis granulosa* in Burma seems to be identical with the present species. This leech, according to Harding, is fairly common in India and is usually to be found attached to the mud-turtle.

The body is flattened and lanceolate, presenting a head region which is separated from the trunk by a slight neck-like narrowing. The dorsal surface exhibits a roughened appearance due to the presence on each ring of numerous papillae, which are of various size, the larger ones forming some five longitudinal rows, one median in position and two lateral in each half of the body. The anterior sucker lies on the ventral side of the head, within the limits of rings 1–6, the mouth opening near the anterior lip. The posterior sucker is centrally attached and of a small circular shape. The large specimen is about 8 mm. long by 3 mm. across at the hind part of the body.

The colour in spirit is grey or pale olive brown without any trace of markings.

On the dorsal surface seventy-one rings are counted in front of the posterior sucker. Somites i, ii and xxvii, are uniannulate; iii, iv, xxv and xxvi biannulate; the twenty somites, v–xxiv, are complete with three rings.

A pair of eyes is generally placed in ring 3, but may occasionally be shifted behind so as to extend over ring 4.

The crop is provided with seven pairs of lateral diverticula, a pair in each of somites xiii–xix, which are sometimes subdivided distally. The last pair are, as usual, reflected posteriorly and extend into somite xxii, giving off a secondary, outwardly directed diverticulum in each of the four somites xix–xxii. The anus is situated on the dorsal surface between the last two somites.

The male and female genital orifices are separated by two rings, the male orifice being situated between somites xi and xii, the female between the second and third rings of somite xii.

In one case, attached to the ventral surface of the parent, were found numerous larvae which were about 1 mm. in length.

13. ? **Placobdella gracilis** (R. Blanchard), 1897.

Helobdella gracilis, R. Blanchard, 1897.

The collection contained a single specimen, which was found at Nandi, Mysore State, attached to *Limnaeea acuminata* and was not in a state fit for close study and exact identification. The body, presenting a dark grey colour in spirit, is fusiform and of small size, being about 5 mm. in length. This leech may be referred to Blanchard's *Helobdella gracilis* from Java described by that author.

Sub-order ARHYNCHOBDELLAE.

Family HERPOBDELLIDAE.

Genus **Herpobdella,** de Blainville.

14. **Herpobdella lineata** (O. F. Müller), 1774.

Hirudo lineata (O. F. Müller), 1774.
Nephelis quadristriata, Grube, 1850.
Nephelis lineata, Budde Lund, 1873.
Dina blasei, R. Blanchard, 1892, 1893, 1894.
Dina lineata, ibid., 1892.
Nephelis gallica, ibid., 1893.
Dina quadristriata, ibid., 1894.
Nephelis bistriata, Brandes, 1900.
Herpobdella bistriata, Johansson, 1906.

Several specimens of *Herpobdella lineata* were collected by Col. H. T. Pease at Lahore. This species is of wide distribution, having been known to occur in Europe, Palestine, Siberia, Mongolia, North and Central America, Madeira and the Azores.

The body in the preserved condition is elongate, flattened, and of a uniform width for the greater part of its length, though it is attenuated anteriorly. Large specimens are about 25 mm. in length by 3 mm. across at the middle of the body.

The colour in spirit is brownish-yellow without any trace of the longitudinal stripes which are usually a conspicuous feature of the colouration of the typical form.

Somites i, ii and xxvii are uniannulate; iii, iv and xxvi biannulate; v and xxv triannulate: the nineteen somites vi–xxiv are complete with five rings, of which the last ring, although often difficult to detect, is usually enlarged and divided transversely by a superficial furrow. Occasionally the same subdivision is true of the ring forming somite ii.

There are in all four pairs of eyes of which the first and second pairs lie in a transverse curved line in somite ii and the third and fourth are placed in the first ring of somite iv.

The male genital orifice lies on the second ring of somite xi; the female orifice is two rings behind the male, that is between the fourth and the last ring of the same somite.

The anus lies on the dorsal surface between somites xxv and xxvi.

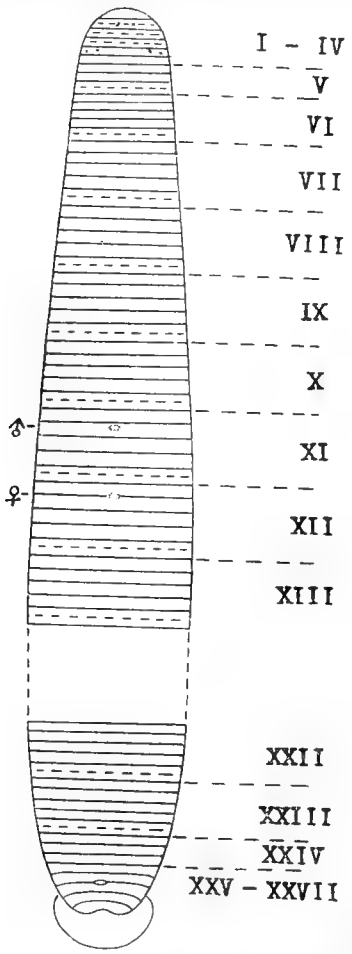
15. **Herpodbella hexoculata,** sp. nov.

(Text-fig. 3.)

Numerous examples of this species, which appears to be new to science, were collected by Dr. F. H. Gravely at Burhampur and Hoshangabad, as well as by Dr. N. Annandale from the Baitulgharib stream about eight miles from Nowshera in the Peshawar District.

The body in the preserved state is elongate, flattened, attenuated anteriorly, bluntly rounded posteriorly, and of nearly similar breadth posterior to the genital region. The posterior sucker is

small and circular in outline, its diameter being about 1 mm, The large examples measured about 25 mm. in length and 2 mm. in breadth at the middle of the body.



Text-fig. 3.—*Herpobdella hexoculata*, sp. nov.

Diagram of the anterior and posterior extremities, as seen from the dorsal side.

The colour in spirit is light brownish yellow, marked with irregular pigment present all over in reticular distribution.

The rings forming the body number in all 107, which appear to resolve themselves as follows: somites i, ii and xxvii are uniannulate; iii, iv, xxv and xxvi biannulate; v and xxiv triannulate; eighteen somites vi–xxiii are complete with five rings, of which the last ring in each somite is broader than the others, being transversely subdivided into two primitive rings. The same is true of rings 2, 3, 4, 9. etc.

There are three pairs of eyes, the first pair lying in somite ii and the second and third pairs being situated in the first ring of somite iv, as is the case with *Herpobdella weberi* (R. Blanchard).

The male genital orifice exists on the second ring of somite xi; the female orifice lies five rings behind that of the male, that is between the first and second rings of somite xii.

The anus is situated on the dorsal surface between somites xxv and xxvi.

The present species is nearly allied to *Herpobdella weberi* which is known to occur in Java, Sumatra and Celebes, but may be distinguished from it chiefly by the absence of the two supplementary genital orifices on the ventral surface.

Genus **Herpobdelloidea**, nov.

16. **Herpobdelloidea lateroculata**, sp. nov.

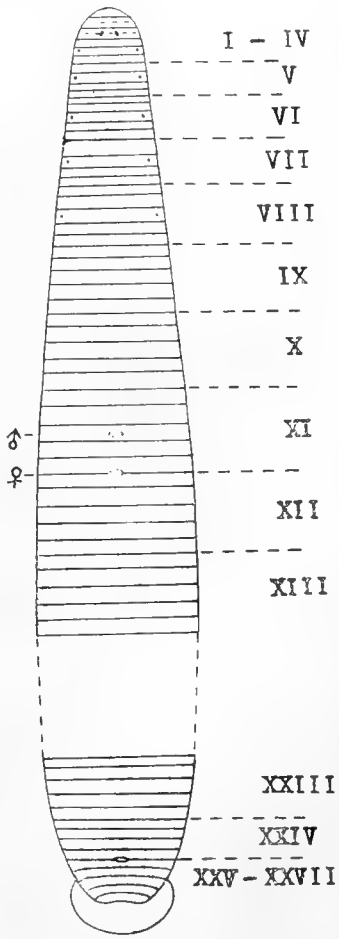
(Text-fig. 4.)

Some examples of this interesting species, which seems to be new to science, were collected by Dr. F. H. Gravely at Burhampur and also at Saugor in the Central Provinces.

This leech presents a great resemblance in its form and size to the preceding two species. The body is of nearly similar breadth posterior to the genital region, from which it tapers gradually towards the anterior end. The dorsal surface is more or less rough all over, owing to the presence of minute papillae which present no regularity in arrangement. Most of the specimens are of similar dimensions, measuring about 14 mm. long by 3 mm. broad at the middle of the body.

The colour is faded in spirit to a pale yellow, on some occasions revealing the male genital elements as an irregular dark longitudinal stripe on each side of the body, extending from behind the female orifice to the anal region.

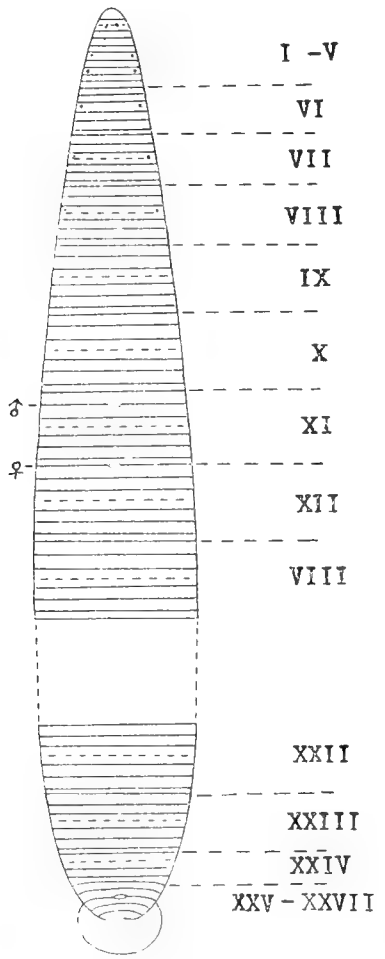
Counting the first oculiferous ring as the first ring there are in all 109 rings, which appear to be grouped somewhat as follows,—somites i, ii, iii and xxvii are uniannulate; xxv and xxvi biannulate; iv triannulate; v and xxiv quadriannulate, of which the latter occasionally bears five rings owing to the subdivision of the last ring. The eighteen somites vi–xxiii are complete, each being formed of five rings of nearly similar width. On some occasions



TEXT-FIG. 4.—*Herpobdelloidea lateroculata*, gen. et sp. nov.
Diagram of the anterior and posterior extremities: dorsal view.

rings 2 and 3 are transversely subdivided into two primitive rings.

As is seen from text-fig. 4, there are six pairs of eyes, of which the first and largest pair occur dorsally on either side of the median line in somite iii, while the other pairs are arranged submarginally on the ventral side. The second pair lie in the second ring of somite iv; the third in the second rings of somite v, the remaining three pairs respectively in the middle ring of each of somites vi–viii. The last pair represents the smallest spots. Occasionally just in front of the first pair occur a small pair of provisional eye-spots.



Text-fig. 5.—*Nematobdella indica*, gen. et sp. nov.

Diagram showing the anterior and posterior extremities, as seen from the dorsal side.

The male genital orifice is placed on the middle ring of somite xi; the female orifice lies two rings behind the male, that is between somites xi and xii.

The anus is situated dorsally between somites xxiv and xxv.

As is apparent from the above, the present species seems to be closely related to the genus *Herpobdella*, but stands distinctly at variance from it in the six pairs of eyes, of which the first pair occur dorsally in somite ii, the other five pairs laterally in each of somites iv–viii respectively. It appears to me that the difference is of sufficient value to separate the two forms generically.

Genus **Nematobdella**, nov.

17. **Nematobdella indica**, sp. nov.

(Text-fig. 5.)

Some representatives of this interesting leech were found at the base of the Simla Hills near Dhurampur Kooa, Patiala State.

The body is elongate, slender, and of a nearly uniform breadth for its greater length, though it

tapers towards the anterior more than the posterior end, which is bluntly rounded. The papillae are very weakly developed on the dorsal surface and present no regularity in arrangement. The posterior sucker is a small circular disc with a diameter about half as wide as the greatest breadth of the body. The large specimens are 45 mm. in length by 4 mm. across at the middle of the body.

The colour is faded in spirit, being a translucent olive-brown without any trace of pattern

The external rings, numbering about 126, are grouped somewhat as follows,—somites i, ii and xxvii are uniannulate; iii, xxv and xxvi biannulate; iv, v and xxiv triannulate; the eighteen somites vi–xxiii are complete with six rings, which are not of similar width, the third ring being enlarged and the last the narrowest of all. The enlarged ring in each typical somite is divided transversely by a superficial furrow. The same is true of the ring corresponding to somite ii.

The six pairs of eyes are arranged in similar manner to those found in the preceding species. The first pair are placed dorsally in ring 2, while the other pairs occur on the ventro-lateral side of the body. The second pair lie in the second ring of somite iv; the third in the first ring of somite v; the other three pairs respectively in the third ring of each of somites vi–viii.

The male genital orifice is situated between the first and second rings of somite xi; the female orifice is five rings behind the male, between somites xi and xii.

The nephridial pores, although difficult to detect, are situated in the furrow separating the second and third rings of the complete somite.

The anus opens dorsally between somites xxv and xxvi.

The clitellum embraces about four somites, ix–xii.

This interesting leech agreees in its arrangement of eyes with the preceding species, but it is separable from it chiefly in having the complete somite with six rings, which, as mentioned above, are not of similar breadth.

Genus **Foraminobdella**, nov.

18. **Foraminobdella heptamerata**, sp. nov.

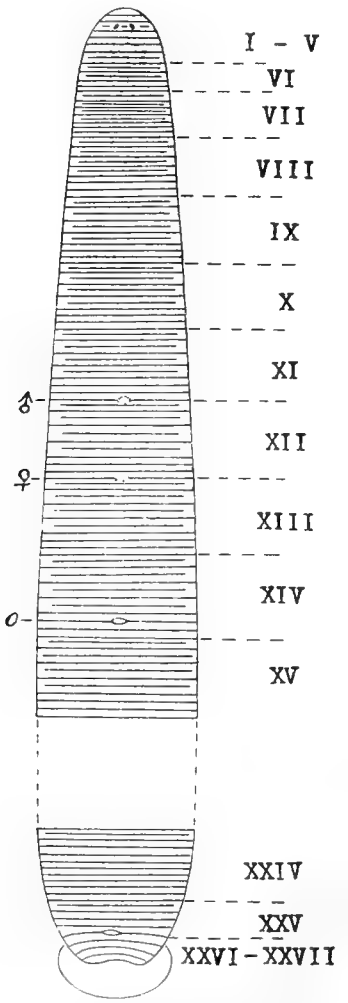
(Text-fig. 6.)

A single representative of this interesting species was found by Capt. R. B. Seymour Sewell, I.M.S., in a stream at Neduattan, at an altitude of 6200 ft., in the Nilgiri District, Madras. The specimen had not been preserved in a state statisfactory for close examination

The body, which is oval or circular in cross section, is smooth on the surface and of nearly similar breadth for the greater part of its length. The posterior sucker is small and circular in outline, its diameter being about half as wide as the greatest width

of the body. The length of the body is 40 mm. and the breadth about 5 mm. at the middle.

The dorsal surface is of a black colour, while the ventral surface is much lighter than the dorsal, and of an olivaceous colour.



TEXT-FIG. 6.—*Foraminobdella heptamerata*, gen. et sp. nov.

Diagrammatic representation of the anterior and posterior extremities; dorsal aspect. *o.*, dorsal opening of digestive tract.

The somites, although not traced out definitely may be regarded as being grouped somewhat as follows,—somites i, ii and iii are uniannulate; iv, xxvi and xxvii biannulate; v triannulate; vi and xxv quadriannulate; the eighteen somites vii–xxiv are complete with seven rings. In each typical somite the first four rings are enlarged and usually divided transversely either superficially or completely, but the remaining three are narrow. In somite v the last two rings are fused on the ventral surface to form the posterior margin of the anterior sucker. The superficial division is to be seen in the ring corresponding to somite iii, in the first and second rings of somite vi as well as in the first ring of somite xxv.

There are a pair of eyes which are placed in ring 3.

The male and female genital orifices are separated by seven rings, being situated respectively just behind the last ring of somites xi and xii.

Great interest is attached to an external opening of the digestive tract, which occupies a position on the mid-dorsal surface, as is the case with *Trematobdella perspicax* (R. Blanchard). So far as my observation goes, it seems to lie between the fifth and sixth rings of somite xiv. Such a peculiar opening of the digestive tract is also known to occur in Horst's *Nephelis dubia* from Sumatra, described by that author, in which the tract opens to the exterior on the ventral surface by a pair of slender

passages. The openings lie twenty rings behind the male genital orifice.

The anus lies on the dorsal surface between somites xxv and xxvi.

The clitellum embraces four somites, x–xiii.

In spite of the existence of a dorsally situated opening of the digestive tract, this leech may be distinguished from *Trematobdella* by the difference in the number and arrangement of rings composing the typical somite; in this respect it seems to be somewhat related to *Mimobdella*. To me it appears to represent a new genus of the Herpobdellidae.

Genus **Scaptobdella**, R. Blanchard.

19. **Scaptobdella horsti**, R. Blanchard, 1897.

I refer five specimens from Java to Blanchard's *Scaptobdella horsti* which is known to occur also in Sumatra and Borneo. The present material was found at an elevation as high as about 4700–6500 ft. in Tjibodas.

The body, presenting some resemblance in its external feature to the earth-worm, is soft, smooth on the whole and oval or circular in cross section, its anterior end being narrower than the rounded posterior end. The lateral sides of the body are nearly parallel for the greater part of its length. The posterior sucker is in the form of a shallow circular disc with a diameter rather less than the breadth of the body. All the specimens are of nearly similar size, about 175 mm. long, exclusive of the posterior sucker, by 12 mm. across.

The ground colour, though faded in spirit for the most part, is dark olive without any trace of markings.

The complete somite is formed of six rings, of which the first two rings are broadest, in most instances being divided transversely by a superficial furrow into primitive rings. On some occasions, especially in the hind region of the body, the same subdivision is to be found on the other narrower rings of each typical somite, excepting the fifth ring.

No trace of visual organs has been detected in the present species.

The male genital orifice lies between the third and fourth rings of somite xi, and the female orifice is six rings behind the the male, that is on the third ring of somite xii. In one case there is found a minute aperture at the dorso-lateral edge of the ring just behind that bearing the female orifice.

The anus is placed on the dorsal surface just in front of the last three rings of the body.

The clitellum embraces twenty-one rings, as described by R. Blanchard, extending from the second ring of somite x to the first ring of somite xiii.

Family GNATHOBDELLIDAE.

Genus **Whitmania**, R. Blanchard.

20. **Whitmania laevis** (Baird), 1869.

Hirudo laevis, Baird, 1869.
Leptostoma pigrum, Whitman, 1886.
Whitmania pigra, R. Blanchard, 1887.

The two examples which I have identified with *Whitmania laevis* were collected by the Manipur Survey party at Pagla Nadi and from Thanga Island. This species is very wide in its distribution, being well known to occur in Japan, the Amur region, China, the Philippines, Malacca, India, Celebes, Sumatra and elsewhere.

The body is large and tapers considerably towards the anterior end. A short distance behind the anterior tip is a slight constriction in the specimen from Thanga Island. The specimen from the latter locality is of larger size than that from Pagla Nadi, and is about 140 mm. in length and 18 mm. in breadth at the middle of the body.

The anterior sucker is very small, lying ventrally within the limits of rings 1–6. The jaws, presenting three small alternate folds, are devoid of proper denticles, but are beset with two series of irregular, thin denticular plates, which are more or less united, especially at the outer and inner angles, where the two series bend, as mentioned by Whitman, into each other.

The posterior sucker is somewhat ventrally attached and circular in outline, about 8 mm. in diameter.

The body is formed of 107 rings, of which rings 6 and 7 are fused ventrally to form the posterior boundary of the anterior sucker, and rings 8 and 9 are also united on the ventral side. On the dorsal side coalescence is found between the two rings of somite xxvi. The same is true of the last two rings. All the rings are grouped, as usual, into twenty-seven somites as follows: somites i, ii and iii are uniannulate, iv, v, xxvi and xxvii biannulate; vi triannulate; vii and xxv quadriannulate; the seventeen somites viii–xxiv are complete with five rings.

The five pairs of eyes are arranged as in *Hirudo*, that is in rings 2, 3, 4, 6 and 9 respectively.

The segmental papillae are so regularly arranged as to exhibit six longitudinal rows on both sides, dorsal and ventral. In the complete somites they occur on the middle ring.

The male genital orifice in the two examples from Manipur occurs in the middle of ring 34, that is on the last ring of somite xi, and the female orifice is five rings behind the male, that is slightly anterior to the centre of the last ring of somite xii. Occasionally both the orifices are displaced near the anterior edge of the corresponding rings, appearing, in preserved specimens, to lie between the rings. In an example from Japan included in the collection the male and female openings appeared to be respectively between the last two rings of somites xi and xii.

The nephridial pores comprise in all seventeen pairs, lying in the furrow separating the second and third rings of the middle seventeen somites.

The anus opens on the dorsal surface just behind the last ring.

The body, though showing some individual variations in colour and markings, is usually brownish olive or olive-yellow, with five black stripes, one median and two lateral, along each of which are found, at regular intervals, oval or quadrangular spots which are free from pigment. In the second and third rings of each somite the spots are divided into two by a transverse line. On each side of the median stripe is seen a shadowy stripe, which, in some instances, may be marked by clear spots. The margins of the body are generally of a lighter colour, bordered on the inner side with a narrow stripe of black, or with flecks of the same colour. A specimen from Japan is of a greyish-olive colour with dark brown stripes, along which the spots are much reduced in size or sometimes wanting.

The ventral surface is generally dotted with black flecks, which alongside the lateral margin are so numerous that they form broad black borders.

Genus **Limnatis**, Moquin-Tandon.

21. **Limnatis nilotica** (Savigny), 1822.

I have examined a single example[1] identical with *Limnatis nilotica*, which occasionally attaches itself to the mouth, throat, and nasal cavity of human beings and cattle, generally causing haemorrhage. It represents one of six specimens obtained at Quetta, Baluchistan, from the throat of an Austrian soldier.

This leech has a wide distribution, extending from the Azores, through part of Western Europe as well as Northern Africa, to part of Western Asia, and even into the boundaries of the Indian Empire. It can be easily distinguished from the following, *L. granulosa*, by the difference in colour markings.

22. **Limnatis granulosa** (Savigny), 1820.

This species represents one of the commonest Indian leeches, numerous examples having been collected at several localities: Panjab, Bombay, Mysore, Madras, Orissa, Bihar, Assam, Burma, Ceylon and elsewhere. As has been mentioned in a recent account (*loc. cit.*), this leech exhibits great variability in colour and markings.

L. javanica (Wahlberg), which is known to occur in Java, Borneo, Sumatra, Burma, Bengal, etc., is nearly allied to the present species, but can be easily distinguished from it by the separation of the genital orifices by seven instead of five rings as well as by the enormous size of its posterior sucker.

[1] See Kaburaki, *Rec. Ind. Mus.* XVIII. p. 213 (1921).

Genus **Haemopis**, Savigny.

23. **Haemopis sanguisuga** (Linnaeus), 1758.

The three specimens of this well-known leech which occurs throughout the greater part of Europe, were obtained by Capt. R. B. Seymour Sewell from the Waddi Gwyzie (Gaza) in Palestine. It is of particular interest that its range extends into Transcaucasia, Syria and Palestine. As is well known the term "horse-leech" or "cattle-leech" is applied to this species more than *Limnatis nilotica*; it frequently occurs in springs, and thereby causes great discomfort and even danger. This species has, especially in the last few years, been subjected to many changes of name (see Harding, 1910).

The body is smooth on the surface, attenuated anteriorly and bluntly rounded posteriorly, its lateral sides being more or less parallel for the greater part of its length. The posterior sucker represents a large circular disc and is almost centrally attached. The largest specimen was 30 mm. long, in front of the posterior sucker, by 11 mm. across at the middle of the body.

The colour in spirit is dark brownish, appearing to show some traces of geometrical patterns on the dorsal surface.

There are 103 rings, of which rings 6 and 7 are fused ventrally to form the posterior boundary of the anterior sucker. The same is true of rings 8 and 9 on the ventral side. Somites i, ii, iii and xxvii are uniannulate; iv, v and xxvi biannulate; vi, vii and xxv triannulate; viii quadriannulate; the sixteen somites ix–xxiv are complete with five rings.

The five pairs of eyes lie respectively in rings 2, 3, 4, 6 and 9.

The male genital orifice is situated between rings 31 and 32, that is between the fourth and fifth rings of somite xi; the female orifice lies five rings behind the male, that is between the last two rings of somite xii.

The nephridial pores, numbering in all seventeen pairs, are placed in the furrow between the second and third rings of the middle seventeen somites.

The anus opens dorsally just behind the last ring of the body.

24. **Haemopis birmanica**, R. Blanchard, 1894.

Haemopis weberi, R. Blanchard, 1897.

The collection contains some examples of a species which agrees precisely with Blanchard's *Haemopis weberi* from Sumatra. The latter may be regarded as synonymous with *H. birmanica* from Burma described by the same author, and here I have so treated it. This leech is closely allied to *Haemopis sanguisuga*, so that I was for some time inclined to regard it as a variety of that species. The specimens examined were obtained from various parts of the Darjiling District, the East Himalayas, at Lahore and also at Khunlan in Siam. It is of some interest that an example from Lahore was found in the nasal cavity of a horse.

The body is very closely similar in its external features to *Haemopis sanguisuga*, being entirely devoid of segmental papillae and possessing a large posterior sucker. The largest specimen is 145 mm. in length, exclusive of the posterior sucker, and 18mm. in width at the posterior region of the body.

The colour in spirit is dark grey on the dorsal and lighter on the ventral surface, without being marked with any trace of pattern.

Counted on the dorsal surface are 104 rings, of which rings 6 and 7 are fused on the ventral surface to form the posterior margin of the anterior sucker. The same is true of rings 8 and 9 on the ventral surface. On some occasions ring 14 is subdivided transversely into two on the ventral surface, and rings 96 and 97 present a tendency to fuse on the dorsal surface. Somites i, ii and iii are uniannulate; iv, v, xxvi and xxvii biannulate; vi, vii and xxv triannulate; viii quadriannulate dorsally, but occasionally with five rings ventrally owing to the subdivision of the first ring (14). The sixteen somites ix–xxiv are complete with five rings.

The eye-spots are very small and are not discernible easily from the exterior, their arrangement quite agreeing with that found in *Haemopis sanguisuga*.

The male genital orifice is situated near the anterior edge of the last ring of somite xi, and the female orifice lies five rings behind the male, between the fourth and fifth rings of somite xii.

The anus is situated on the dorsal surface just behind the last ring of the body.

The clitellum extends over four somites, x–xiii.

25. Haemopis concolor, sp. nov.

(Text-fig. 7.)

The three individuals, which seem to represent a new species, were collected by Dr. B. Prashad from a spring at Kasauli in the Western Himalayas.

In shape the body is much like the preceding two species and is smooth on the whole, there being neither papillae nor tubercles to roughen the surface. The larger specimen is 40 mm. long by 6 mm. broad, while the smaller is 5 mm. long by about 1·5 mm. across.

The body is of a dark olive colour, without any trace of markings.

In front of the posterior sucker there are 103 rings, of which rings 8 and 9 are fused on the ventral side. Somites i, ii, iii and xxvii are uniannulate; iv, v and xxvi biannulate; vi, vii and xxv triannulate; viii quadriannulate; the sixteen somites ix-xxiv are complete with five rings. In the small examples the furrows marking the boundaries of the somites appeared somewhat conspicuous in consequence of the curvature which the body had assumed in preservation. It is of some interest that the furrows separating the rings in some somites are not of similar depth, differing from

the other species of *Haemopis*. The shallower furrow is the one separating some rings of somites vii–xi and xxvi, as is shown in text-fig. 7 by the broken line.

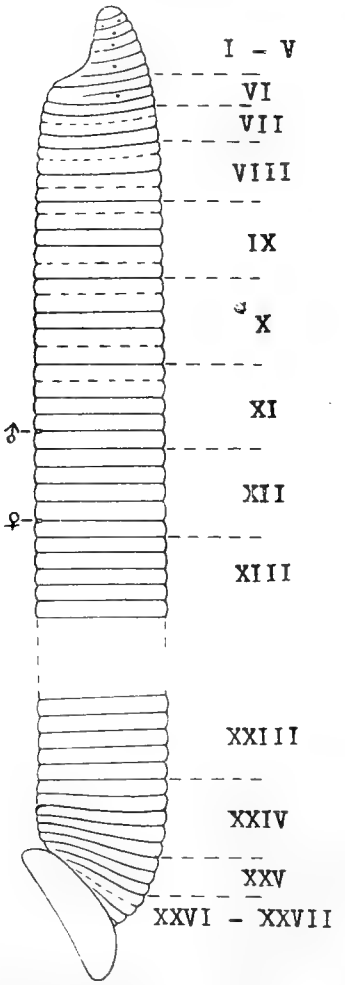
The arrangement of eyes is in agreement with that of *Haemopis sanguisuga*.

The male and female genital orifices occupy a position respectively between the last two rings of somites xi and xii.

The nephridial pores are situated in the furrow between the second and third rings of the middle seventeen somites

The anus is located on the dorsal surface just behind the last ring of the trunk.

This leech appears to be nearly allied to *Haemopis sanguisuga*, but may be distinguished from it by the different annulation of the body.



Text-fig. 7.—*Haemopis concolor*, sp. nov. Diagram of the anterior and posterior extremities, as seen from the lateral side.

Genus **Myxobdella**, Oka.

26. **Myxobdella annandalei**, Oka, 1917.

There was in the collection a single example which may be identical with Oka's *Myxobdella annandalei* from Hong Kong described by that author. The specimen was found in a hill stream at Yercaud, Madras.

The body is smooth on the whole, entirely devoid of papillae and almost uniformly broad for the most part, though it tapers off considerably in front. The dorsal surface is convex throughout while the ventral is nearly flat. The posterior sucker is circular in outline and in the preserved state is entirely hidden when viewed from above. The specimen measured 17 mm. in length and about 4 mm. in breadth at the middle of the body.

As has been described by Oka in detail, the most conspicuous f the external features is that the body is divided by deep furrows

into well-bounded somites. So far as my observation goes, somites i, ii, iii and xxvii are uniannulate; iv, v and xxvi biannulate; vi, vii, xxiv and xxv triannulate; viii and ix quadriannulate; the fourteen somites x–xxiii are complete with five rings. In each typical somite the furrows separating the rings are not of equal depth, the deepest ones being always found between the second and third as well as the third and fourth rings. The furrow between the first and second rings is, in most instances, the shallowest of all.

The five pairs of eyes are arranged in the same manner as those observed in *Hirudo or Haemopis*.

The male and female genital orifices are placed between the fourth and fifth rings of somites xi and xii respectively.

The anus opens on the dorsal surface just behind the last ring of the body.

Genus **Haemadipsa**, Tennent.

27. **Haemadipsa zeylanica** (Moquin-Tandon), 1826.

Hirudo zeylanica, Moquin-Tandon, 1826.
Hirudo flava, Schmarda, 1861.
Hirudo (Chthonobdella) sumatrana, Horst, 1883.
Haemodipsa sylvestris, R. Blanchard, 1894.

In his paper R. Blanchard puts on record a form closely resembling the present leech as a distinct species, *Haemadipsa sylvestris*, chiefly on account of the presence of a narrow interpolated ring between the two oculiferous rings 4 and 5, which, according to a careful examination of a large series of examples, appears not to be of a constant occurrence. I am, therefore, of the opinion that this difference may be regarded as being of insufficient value to separate the two forms specifically.

As is well-known, the species is of wide distribution in the Oriental region, it having hitherto been recorded from Ceylon, the Himalayas, Burma, Cochin China, Tonkin and also from various localities in the Indo-Malayan Archipelago, such as Sumatra, Borneo, Celebes, Java, etc. The collection which I have examined contained a great number of this species obtained from several localities in India and its vicinity: at elevations of 1300–6500 ft. in the Darjiling District, the East Himalayas, Assam, Central Provinces, Madras, Lower Burma and elsewhere.

The body is nearly cylindrical, tapering gradually towards the head end. Centrally attached is a circular posterior sucker which is rather less than the greatest width of the body. The large specimens are about 40 mm. long, excluding the posterior sucker, by 7 mm. across at the posterior region of the body.

The body consists generally of 98 rings, of which rings 5 and 6 coalesce ventrally to form the posterior margin of the anterior sucker. Among the examples with the same colour markings from Kovalai, at elevations of 1300–3000 ft., in Cochin State, there was one individual only in which rings 7 and 8 are also fused on the ventral side. On some occasions a narrow ring occurs interpolated between the oculiferous rings 4 and 5, but this, so far as my observa-

tion goes, is not constant in occurrence, as mentioned above. Somites i, ii, iii, iv, xxvi and xxvii are, it seems to me, uniannulate; v and xxv biannulate; vii and xxiv triannulate; viii quadriannulate; the fifteen somites ix–xxiii are complete with five rings. Occasionally somite iv is composed of two rings owing to the presence of a narrow interpolated ring.

There are five pairs of eyes, of which the first four pairs are usually arranged in a semicircle in rings 2, 3, 4 and 5, and the fifth pair lie two rings behind the fourth, that is in ring 8.

On both sides, dorsal and ventral, are found six segmented papillae which generally fall on the middle ring of each typical somite.

The male and female genital orifices are separated by five rings, lying between the last two rings of somites xi and xii respectively.

The nephridial pores, numbering in all seventeen pairs, open laterally in the furrow separating the second and third rings of the middle seventeen somites.

The anus opens dorsally just behind the last ring of the body.

The clitellum extends over four somites, x–xiii.

This species is generally of a yellowish colour variegated with brown, but exhibits great variability in markings. So far as my observations are concerned, there are distinguishable four varieties, which occur associated together, but with some intergrading forms.

(i) In a few specimens from the East Himalayas and Bengal the dorsal surface is divided into three longitudinal areas, a median and two lateral. The median area is lighter in colour, and slightly narrower than the lateral areas which present a dark brown colour, getting lighter towards the lateral margins of the body. The median area is traversed longitudinally by a thick dark brown median stripe, which extends with the lateral bands throughout the whole length of the body, but in some cases it vanishes, or nearly so, on the dark head end.

(ii) Some examples obtained from several localities of the Assam, Bengal and Bihar Districts, as well as of Lower Burma, are generally marked on the dorsal surface with three fine dark brown stripes, one median, and on each side one lateral, in position corresponding to the boundary line between the median and lateral areas mentioned above. On some occasions the median stripe is faint or sometimes obsolete.

(iii) In examples from several places in the East Himalayas and Cochin State the markings agree in their plan with the forms mentioned above, but may be distinguished from these by the different aspect of the lateral bands which are very faint or sometimes obsolete.

(iv) In some forms from the East Himalayas, North Kanara, Madras and Cochin State the body is marked on both sides, dorsal and ventral, with dark brown blotches, which occasionally join together in the positions corresponding to the dorsal and lateral areas.

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XXXI. RECORDS OF SOME INDIAN CICINDELIDAE.

By CEDRIC DOVER *and* SYDNEY RIBEIRO, *Assistants, Zoological Survey of India.*

Having recently had occasion to re-arrange the Cicindelidae in the collection of the Zoological Survey of India, we found that it contained many specimens from localities unrecorded by Canon Fowler in his volume on the Cicindelidae and Paussidae in the "Fauna of British India" series; and, as in most other groups of Indian insects, much remains to be known about their geographical distribution, we have drawn up the following note in the hope that it will be useful. We have endeavoured to incorporate the few records of Indian species that have been published since Fowler's volume appeared.

It may be mentioned that most of the specimens listed here have been collected by the officers of this department; especially by Dr. S. W. Kemp, in Assam and elsewhere, and Dr. F. H. Gravely in the Darjiling District. Dr. and Mrs. Kemp's collection from the Garo Hills, Assam, made in July and August, 1917 is perhaps the most interesting recent addition to the collection, as these hills were hitherto practically unexplored.

The identifications of all the more critical species mentioned in this paper have been verified by Dr. Walther Horn.

Collyris brevipennis, Horn. Talewadi near Castle Rock, N. Kanara Dist. (*Kemp*, 3–10·x·16) and Castle Rock (11–26·x·16). Dr. Kemp tells us that he took the Talewadi specimen on a small bush while it was boring with the posterior end of its body into one of the branches, presumably with a view to oviposition.

Neocollyris redtenbacheri, Horn. Tura, Garo Hills, Assam, 200–1500 ft. and above Tura, 3000 ft. This species is not rare in the Darjiling Dist., from 1500–5000 ft. It has also been taken in Kousanie, Kumaon, 6075 ft. (*Tytler*, 25·vii·14).

Neocollyris attenuata, Redt. Darjiling Dist., from 1500–5000 ft.

Neocollyris variitarsis, Chaud. Tura, 1200–1500 ft., and Singla, Darjiling Dist., 1500 ft.

Neocollyris variicornis, Chaud. Tura, 1200–1500 ft., Sitong near Mungphu, 3800–4000 ft., Darjiling Dist. (*Kemp*, 2–5·vii·18) and Singla, 1500 ft. The species has also been taken in Tonkin.

Neocollyris bonelli ,Guer. Rangamati, Chittagong Hill Tracts, (*Hodgart*, 11–16·vii·15), Siripur, and Khargpur, Bengal. Sibsagar, Khasi Hills, and above Tura, Assam, Hills near Taiping, Perak (*Annandale*, 26–30·xii·15), This species is widely distri-

buted in Bengal and Fowler's doubt of the Calcutta locality seems, therefore, uncalled for. The variety *ortygia* Buq., has been taken in Siripur (26–27·ix·10), Singla, 1500 ft. and Tura. We have specimens from Pashok, 3500 ft., Darjiling dist. and Tura under the name "var. *diversipes*, Fowl.", but Dr. Horn who examined one of these says that they are really intermediate forms between *N. bonelli* and *distincta*. In the "Fauna" volume *distincta* is given specific rank, but it is best considered as a subspecies of *bonelli*. We have examples of *distincta* from Balighai near Puri, Orissa (*Annandale* and *Gravely*, 16–20·viii·11).

Neocollyris fuscitarsis, Schm.-Goeb. Singla, Darjiling Dist., 1500 ft.

Neocollyris saphyrina, Chaud. Pashok, 2500 ft., Darjiling Dist.

Neocollyris insignis, Chaud. Above Tura, Garo Hills, Assam, 3900 ft. In India the species appears to be entirely confined to the hills, and is rather common in the Darjiling Dist.

Neocollyris smaragdina, Horn. Soom, Darjiling Dist., 4000–5000 ft (7·vii·14).

Neocollyirs feae, Horn. Rangamati, Chittagong Hill Tracts, (*Hodgart*. 11–16·vii·15).

Tricondyla gounelli, Horn. Trivandrum, Travancore.

Tricondyla macrodera, Chaud. A common species in the Darjiling Dist. and in Assam. Dr Kemp took fifteen examples at Tura, and above Tura, on the doorstep of his bungalow and on tree-trunks.

Tricondyla mellvi Chaud. Above Tura, 3500–3900 ft.

Derocrania longesulcata, Horn. Castle Rock, N. Kanara Dist. (*Kemp*, 11–26·x·16).

Therates hennigi, Horn. Above Tura, 3900 ft. Dr. Kemp says that the species was rare in the Garo Hills, where it occurred only in one place, about 100 ft. below the top of the ridge. The jungle on either side of the path in this locality consisted of very large trees with light undergrowth.

Therates dohertyi, Horn. Pashok, 5000 ft., Darjiling Dist. (*Hartless*).

Therates chenelli, Bates. N. Shan States, U. Burma (*Mackwood* (4·v·14).

Therates obliquus, Fleut. Pashok, 5000 ft. (*Hartless*).

Therates gestroi, Horn. A common species above Tura in the Garo Hills, 3500–3900 ft. The subspecies *annandalei* is common in damp shady places, among shrubs and herbage, almost throughout the Eastern Himalayas.

Prothyma proxima, Chaud. Balugaon, Puri Dist., Orissa (*Annandale*, 21–30·vii·13) and Coimbatore, S. India (*Fletcher*, 18·xi·13)

Prothyma reconciliatrix, Horn. Above Tura, 3500 ft.

Heptodonta nodicollis, Bates. A widely distributed species in the Darjiling Dist. and Assam. Fleutiaux records it from Tonkin.

Heptodonta kraatzi, Horn. A fairly common species above Tura, 3000–3500 ft. and in the Darjiling Dist. from 1500–5000 ft.

Heptodonta pulchella, Hope. Not an uncommon species at Tura, 1000–1200 ft. *H. ferrarii*, Gestro, is sunk as a synonym of this species by Fowler, but Fleutiaux in a recent paper (1917) seems to consider it distinct, and after carefully examining the specimen in the Indian Museum we cannot but agree with him. Our example is from the N. Shan States, Upper Burma (*Mackwood*, 4·v·14), and the species is also recorded from the Karen Hills in Burma and Laos.

Cicindela viridicincta, Horn. Mr. Fletcher has taken this species in Pollibetta, Coorg, S. India (15–25·v·14).

Cicindela tetrastacta, Wied. Annandale and Dover record this species from Barkuda I., and Gantasila on the Chilka Lake.

Cicindela dromicoides, Chaud. Not uncommon in the Darjiling Dist., and Kumaon. Dr. Gravely has taken a specimen in Ghumti, Darjiling Dist., 4000 ft., with the elytron of a common small Chrysomelid in its mandibles. The *Cicindela* probably feeds on the Chrysomelid.

Cicindela triguttata, Hbst. Rangamati, Chittagong Hill Tracts, (*Hodgart*, 11–16·vii·15), Siliguri, base of E. Himalayas (*Annandale* and *Kemp*, 3–4·vi·11), Darjiling Dist., 600–4500 ft., Tura, Garo Hills, and Tonkin.

Cicindela umbropolita, Horn. Mr. Fletcher has taken this species at Coorg, S. India, in May, 1914.

Cicindela foveolata, Schaum. Tura, 1200 ft., Nilgiri Hills, 3000 ft., and Tonkin.

Cicindela spinolae, Gestro. Rangamati and Tura, 1000–1500 ft. A jungle species fairly common in the Eastern Himalayas.

Cicindela bigemina, Klug. Siliguri (3–4·vii·11), and Chakradharpur, Chota Nagpur (*Gravely*, 1·x·11). The *habitat* of the variety *brevis*, Horn, is given by Fowler as "Indes Orientales." We have specimens from the bank of the River Sohan in Rawalpindi, Punjab (*Hodgart*, vi–vii·17).

Cicindela viridilabris, Chaud. Fowler gives the *habitat* of this species as "East Indes," but remarks that Dr. Horn thinks that they are probably from North India. Mr. Hodgart has taken it in Kalka at the base of the Simla Hills, 2400 ft., in July, 1917.

Cicindela seriepunctata, Horn. A widely distributed form in the Eastern Himalayas.

Cicindela fastidiosa, Dej. Annandale and Dover record this species from Barkuda I., Chilka Lake, where they took brownish, greenish and bluish specimens.

C. decempunctata var. *obscure-dilatata*, Horn. A species recently described by Horn (1914, p. 28) from Delhi. We have a single specimen from Lahore, Punjab (*B. Das*, 5·x·12, "river-side").

Cicindela melancholica, Fabr. Kalka, base of Simla Hills, 2400 ft. (*Annandale*, 21·vii·11, "in railway carriage"), Ambala, Punjab (*Annandale*, 16·vii·11, "in railway carriage"), Kaladhungi, Naini Tal Dist. (*Hodgart*, 4–6·v·13), and Bushire, Persia.

Cicindela undulata, Dej. Annandale and Dover record this species from Barkuda I., and elsewhere. The variety *dubia*, Horn is recorded doubtfully in the "Fauna" from "India." We possess specimens from Singla, Darjiling Dist., 1500 ft., and Mandalay in Upper Burma (*Molesworth*, 1915, "at light").

Cicindela imperfecta, Chaud. Fowler records it from various localities, but adds a note to the effect that Dr. Horn says that some of these records may be erroneous, as this species is known only from Bengal. The Museum possesses two specimens: one from Surat in Bombay, and the other from Ranchi, which are certainly authentic.

Cicindela distinguenda, Dej. This species is recorded from Pondicherry and Ceylon, and Annandale and Dover record a single specimen from the shore of Barkuda I., Lake Chilka.

Cicindela discreta var. *reducta*, Horn. Tura, Garo Hills, 1000–1500 ft.

Cicindela grammophora, Chaud. Widely distributed in Bengal. We have specimens from Kaladhungi, Naini Tal Dist. (*Hodgart*, 4-6·v·13).

Cicindela cognata, Wied. Dr. Gravely has taken this species on the banks of the River Mahanadi in Cuttack, Orissa (21–22·viii·11) and Mr. Hodgart in Goalbathan, E. Bengal (9·vii·09).

Cicindela minuta, Oliv. Tura, 1000 ft., and Garobadha (*Kemp*, 1·ix·17), Garo Hills, Assam; Orissa, Delhi, and Satara Dist., Bombay Presidency. Apparently widely distributed in India and Burma.

Cicindela nitida, Wied. Naini Tal Dist. and Orissa. The species though widely distributed is, like *C. biramosa*, which lives only on the seashore, curiously particular in its choice of *habitat*. It inhabits river-banks composed of dry mud with a good amount of sand. We have seen it in very large numbers on the bank of the River Bhagarati at Berhampur, Murshidabad District, in the beginning of July, 1921, where it lives in company with a Muscid fly to which it bears a remarkable resemblance on sunny days. Both the beetle and the fly are extremely difficult to catch as they seem to move by a series of unaccountably swift leaps, and with the sun shining on them it is impossible to tell the beetle from the fly. In the cabinet they bear no resemblance whatever to each other.

Cicindela angulata, Fabr. Tura, Garo Hills, Assam, 1000 ft., Sitong, Darjiling Dist., and Cuttack, Orissa (*Gravely*, 21–22·viii·11, "on bank of R. Mahanadi").

Cicindela sumatrensis, Hbst. A widely distributed species usually abundant where it occurs (*cf.* Annandale and Dover, 1921). The variety *imperfecta* Horn is found throughout the Bombay Presidency, and Dr. Gravely has also taken it in the Cochin State. We are of opinion that *C. despectata* Horn (1892, p. 86) from Perak in the Malay Peninsula and the Phillipines will probably prove to be only a form of *C. sumatrensis*.

Cicindela cardoni, Fleut. Satara Dist., Bombay Presidency,

2000 ft. In the Manbhum District of Chota Nagpur the species is not uncommon on sand by the river-bank.

Cicindela chloris, Hope. A common Western Himalayan species, taken also in the Darrang Dist., Assam-Bhutan Frontier (*Kemp*, 26·xii·10).

Cicindela funerea, McLeay. This form occurs in the Darjiling Dist., from 500–5000 ft., and almost throughout Assam. In the Garo Hills it is not uncommon at Tura, 1000 ft. Dr. Annandale has also taken it on the shore of Lake Talé Sap in Patalung, Siam.

Cicindela intermedia, Chaud.[1] Taken in Kumaon from 1200–6075 ft.

Cicindela octonotata, Wied. Sukna, 500 ft., E. Himalayas. (*Annandale*, 1·viii·08), Darjiling, Garobadha (*Kemp*, 1·x·17) and Tura, Garo Hills, Assam, 1200 ft.

Cicindela duponti, Dej. Tura, 1000–1400 ft. and Tonkin. The variety *barmanica*, Gestro, has been taken by Mr. Hannyngton at Coorg, 2000 ft., S. India, and by Mr. Mackwood in N. Shan States, U. Burma. The Museum possesses an example of *C. chinensis*, De Geer, from Simla, but Fowler thinks it probable that this locality is incorrect.

Cicindela aurulenta, Fabr. Hills near Taiping, Perak (*Annandale*, 26-30·xii·15), N. Shan States, U. Burma; Tamansari, Idjen Massip, 1600 ft., E. Java (*Kloss*, i·20). The variety *virgula*, Fleut., is widely distributed in the Eastern Himalayas and in Assam. Dr. Kemp found it not uncommon at Tura, 1000–1400 ft. He has collected specimens of the variety *batesi* Fleut. (*cf.* Fleutiauxe 1893, p 491) which is not recorded in the "Fauna", in the Doîphang Valley, Darrang Dist., Assam-Bhutan Frontier (21·x·12).

Cicindela hamiltoniana, Thoms. Mr. Fletcher has taken this form in Pollibetta, Coorg, and we have an example from Nadgani, Malabar.

Cicindela assamensis, Parry. Tura, Garo Hills, Assam, 1000–1500 ft., above Tura, 3000 ft., Pashok, 2000 ft., Darjiling Dist., and Rungbong Valley in Darjiling. In the Garo Hills the species is found in the same situation as *Therates hennigi*, but at lower altitudes.

Cicindela mouhoti var. *cariana*, Gestro. N. Shan States, U. Burma

Cicindela vigintiguttata, Hbst. Barkul, Puri Dist., Orissa (*Gravely*, 9–13·xi·12).

Cicindela striolata, Ill. Dr. Gravely in June, 1914 found this species not rare in long grass above jungle in the Darjiling Dist.,

[1]. It might be of interest to mention here that a common African Cicindelid has long been known under the name *C. intermedia* Klug (1853), but as Chaudoir described the Indian species of this name a year earlier, Dr. Horn proposes to call the African form *C. intermediola*. I am indebted to Mr. C. N. Barker of the Durban Museum for this information. [*C.D.*]

3000–3500 ft. It has also been taken at Coorg and Rangamati. The variety *lineifrons* Chaud. is represented in our collection from above Tura, 2500 ft.(*Kemp*, 15·vii·17, "jungle path").

Cicindela albina, Wied. On banks of River Sohan at Rawalpindi, Punjab, and Lohardaga, Ranchi Dist., Chota Nagpur. At Balighai near Puri on the Orissa Coast Dr. Annandale found that it occurred only on sand dunes, not on the seashore.

Cicindela copulata, Schm.-Goeb. Fowler gives the distribution as Calcutta and Karachi, but remarks that the former is rather doubtful. Schmidt-Goebel described it from "Cossipore near Calcutta," but this is undoubtedly an error for Cossipore is on the banks of the River Hughli, and fully ninety miles away from the sea; there is soft mud on the fore-shore, and no sand at all. The locality has no resemblance whatever to Karachi. Moreover, *C. copulata* has never again been recorded from near Calcutta, while it has often turned up at Karachi. It is thus safe to assume that it does not occur in the former locality. The species is generally found in open sandy places. Fleutiaux (1917) records what he considered this species from Annam, but in a later paper (1919) he showed that it was really *C. punctatissima*, Schaum.

Cicindela quadrilineata, Fabr. In recording this form and *C. biramosa* Fabr., from Chandipore on the Orissa sea-coast Dr. Gravely (1919, p. 398) remarks: "*Cicindela quadrilineata*, Fabricius is sometimes to be found where the ground is muddy. In 1919 it was comparatively abundant on muddy sand at the mouth of the Burhabalang River. Both species are common seashore insects, living near high-tide mark, but I am not aware that they have been found so closely associated before. In Annandale and Horn's Annotated List of Indian Museum Cicindelinae (Calcutta, 1909), *C. biramosa* is recorded from various places from N. Kanara on the Malabar coast to Java, and *C. quadrilineata* from Burma and Bengal to south of Madras; and the known range of the latter species is extended in the 'Fauna of British India' to Sind and Baluchistan. More recent observations both by Dr. Annandale and myself suggest that *C. biramosa* is the common seashore species of the east and southwest coasts of the Indian Peninsula, and that *C. quadrilineata* holds this position on the northern parts of the west coast. Mr. Kemp found both on the coast of Portuguese India." In a fortnight's visit to Chandipore in the latter half of September, 1920, we did not see either of these species, but *C. limosa*, Saund., was occasionally observed in the burrows of the crab, *Ocypoda macrocera*, Milne-Edwards, a brilliant red species of considerable size, very common on the beach. The beetle probably only goes into the burrow for shelter and the case must not be taken as one of commensalism. A damaged example of *limosa* has been taken by Gravely from the nest of a gregarious spider (*Stegodyphus*) at Durgapur, Salt Lakes, near Calcutta. The variety *renei*, Horn, of *C. quadrilineata* has been taken by Kemp at Pamben in the Gulf of Manaar (24·11·13.)

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XXXII. REMARKS ON A SPECIMEN OF *CALAMARIA JAVANICA*.

By Colonel F. Wall, *I.M.S.*

I have recently examined an example of the genus *Calamaria* belonging to the collection of the Zoological Survey of India. As this specimen is a valuable one, the following notes on it should I think be placed on record.

The specimen (No. 4450) was referred by Sclater (*List Snakes Ind. Mus.* 1891) to *Calamaria pavimentata*. I am of opinion that it should be referred to *C. javanica*.

It was obtained from Johore in the Malay Peninsula, and measured 142 mm. ($5\frac{5}{8}$ inches).

Lepidosis. Rostral.—Touching four shields, the rostro-praefrontal sutures longer than the rostro-labials. Portion visible above a shade less than its distance to the frontal. *Internasals.*—Wanting. *Praefrontals.*—Length greater than the frontal, touching the rostral, 1st and 2nd supralabials, eye and supraocular. *Frontal.*—As long as the snout, half the parietals, equal to its breadth. *Supraoculars.*—Length one-third the frontal, breadth one-fifth the frontal. *Nasal.*—Very small. *Loreal.*—None. *Praeocular.*—None. *Postocular.*—None. *Supralabials.*—Four, the 3rd very short, the 4th longer than the 2nd and 3rd taken together, two-thirds the parietals; 2nd and 3rd touching the eye. *Sublinguals.*—Posterior, not separated, touching the 3rd and 4th infralabials. *Infralabials.*—The 1st in contact behind the mental; 4th largest, length three-fourths the posterior sublinguals, breadth equal to those shields. *Costals.*—In 13 rows in the whole body length, the ultimate row not enlarged, smooth. *Ventrals.*—187. *Anal.*—Entire. *Subcaudals.*—15, entire.

Tail compressed basally. Eye about one-third the length of the snout, less than its distance to the edge of the lip. Uniform light brown dorsally and ventrally, the costals with rather lighter edges. No head marks, nor tail marks.

XXXIII. ON SOME NEW OR RARE SPECIES OF FISH FROM THE EASTERN HIMALAYAS.

By SUNDER LAL HORA, *M.Sc., Assistant Superintendent, Zoological Survey of India.*

(Plate XXIX.)

The fish on which the following notes are based formed part of a collection recently made by Mr. G. E. Shaw in the foot-hills of the Eastern Himalayas below Darjiling. Mr. Shaw has taken great pains to make his collection of the fishes of this area complete and I am greatly indebted to him for the opportunity of examining it. Among the specimens I have found examples of *Psilorhynchus sucatio* and *Erethistes clongata* which were hitherto known only from the original descriptions of Hamilton Buchanan and Day, while there are three species which appear to be new. Mr. Shaw has very kindly presented specimens of the species he collected to the collection of the Zoological Survey of India.

Psilorhynchus sucatio (Ham. Buch.).

(Pl. XXIX, figs. 1, 1*a*.)

1822. *Cyprinus sucatio*, Hamilton Buchanan, *Fish. Ganges*, pp. 347 and 393.
1839. *Psilorhynchus sucatio*, McClelland, *Asiatic Res.* XIX pp. 300 and 428, pl. 50, figs. 1 and 1*a*. [343.
1868. *Psilorhynchus sucatio*, Günther, *Faun. Brit. Ind. Fish.* VII, p.
1871. *Psilorhynchus sucatio*, Day, *Journ. As. Soc. Bengal* XL, p. 107, pl. ix, fig. 1.

This species has hitherto been known only from Hamilton Buchanan's description published in 1822 and from the manuscript drawing preserved in the library of the Asiatic Society of Bengal. In 1871 Day, in the work cited above, remarked : "it does not appear at all impossible that the other, *P. sucatio*, H. Buch., may be destitute of an air-bladder and would thus form a distinct genus appertaining to the subfamily Homalopterinae," but in his later work[1] he suggested that it was synonymous with *Homaloptera bilineata*.

I have found three specimens in Mr. Shaw's collection which agree with the description and figure of Hamilton Buchanan's *Cyprinus sucatio*. The species possesses a fairly well-developed bladder of the cyprinid type and is destitute of barbels. In its

[1] Day, *Fish India* II, p. 526 (1878).

elongate snout it closely resembles certain species of the genus *Homaloptera*, but it can be readily distinguished by the absence of barbels and by the presence of a free air-bladder in the abdominal cavity.

Buchanan found the species in "the rivers of Northern Bengal," while his second species, *P. balitora*, was "found in the rivers towards the north-east of Bengal." McClelland (*op. cit.*), who had examined only a single specimen of *P. balitora* forwarded to him from "Upper Assam" by Capt. Hannay, gave the habitat of both the species as "north-eastern parts of Bengal." Günther (*op. cit.*) who followed McClelland made the same mistake. The specimens of *P. balitora* in our collection enable me to confirm Buchanan's statement that the species occurs in the Khasi Hills (north-east of Bengal), while *P. sucatio* is found at the base of the Darjiling Himalayas (Northern Bengal). I [1] referred some young specimens collected by Dr. Annandale at Siliguri in the Mahanadi River to *P. balitora*, but on further examination I find that they are the young of *P. sucatio*. The mistake was due to the immaturity of the specimens.

The genus *Psilorhynchus* comprises three Indian species, one of which was recently described by myself (*op. cit.*, p. 208) from immature specimens found in the Naga Hills. The new species is readily distinguished from those previously known by its straight profile, by the absence of any grooves on the under surface of the head and by the position of the eye, which is considerably nearer to the tip of the snout than to the posterior limit of the operculum. *P. sucatio* differs from *P. balitora* in possessing a long depressed snout and a greatly elevated back fin.

Annandale [2] described a species of fish from the Bombay Presidency under this genus, but quite recently I [3] have referred it to a separate genus for which I have proposed the name *Parapsilorhynchus*.

In *Psilorhynchus sucatio* the dorsal profile is greatly arched. It is highest near the base of the dorsal fin, whence it slopes considerably towards both ends. The ventral profile is only slightly arched. The caudal peduncle is narrow and elongated. The head is much depressed and both the upper and the lower surfaces are greatly flattened; it is one and a quarter times as long as broad. The length of the head is contained about 5 times in the length of the body excluding the caudal fin. The depth of the body in full grown specimens is slightly less than the length of the head and is contained 5·5 times in the length of the body. The snout is broad and evenly rounded; the interorbital space is somewhat concave. The eyes are large and globular and are situated in the posterior half of the head; they are only slightly visible from below. The diameter of the eye is contained almost

[1] Hora, *Rec. Ind. Mus.* XIX, p. 210 (1920).
[2] Annandale, *Rec. Ind. Mus.* XVI, p. 128 (1919).
[3] Hora, *Rec. Ind. Mus.* XIX, p. 209 (1920).

3 times in the length of the head and the snout is 1·5 times the diameter of the eye in length. The interorbital width is greater than the diameter of the eye. The mouth is situated on the under surface of the head considerably behind the tip of the snout and is bordered by thick lips. The lower lip and the skin immediately behind it is somewhat papillated. There are two curved grooves running from the angle of the mouth to the tip of the snout. The nostrils are situated considerably nearer to the eye than to the tip of the snout.

The dorsal fin commences in advance of the ventrals, and its origin is much nearer to the tip of the snout than to the base of the caudal fin; its free margin is truncate and oblique. The longest ray of the dorsal fin is considerably higher than the depth of the body below it; its shortest ray equals the longest ray of the anal fin in length. There are two spines and 7 or 8 branched rays in the dorsal fin. The pectoral fins are greatly expanded and are horizontally placed. They contain 13 or 14 rays, of which the first four are not branched. It is separated from the base of the ventral fins by half its own length. The ventrals are only slightly shorter than the pectorals; they are expanded and horizontally placed. They contain 9 or 10 rays, of which the first two are not branched. The ventrals extend considerably beyond the anal opening. The anal fin is short and rounded and is placed nearer to the base of the caudal than to that of the ventral fin. It contains seven rays, of which five are branched. The caudal fin is as long as the length of the head and is deeply forked. Both the lobes are pointed; the upper is slightly longer than the lower.

The lepidosis is quite normal except on the chest, where the scales are either absent or greatly reduced. There are 38 scales along the lateral line from the angle of the operculum to the base of the caudal fin, and six series of longitudinal rows of scales between the bases of the dorsal and the ventral fins. A scale from near the base of the dorsal fin is semicircular in outline with an almost flat base and an arched apex. The nucleus is eccentric and is situated close to the base. There are about 5 or 6 radii to the apex and the circular striae are indefinite and closely packed together.

The air-bladder has undergone a certain amount of degeneration from the normal cyprinid type. The anterior chamber is laterally flattened and covered with a thick fibrous coat. The posterior chamber is narrow and elongated and is of uniform thickness throughout; its walls are greatly thickened. It is displaced from its original position and comes to lie on one side of the anterior chamber.

Hamilton Buchanan describes the colour of the species as follows: "Above the *colour* is greenish, with scattered dots; on the sides these are collected into clouds, and below the body is whitish and diaphanous. The fins of the back, breast and tail, are dotted. The eyes are brown, with a narrow golden circle round the pupil." The specimens before me possess five broad,

clouded vertical bands on the body and a number of stripes on the caudal fin. The membranes between the first few rays of the dorsal fin are black, and here and there are a number of black patches on the head and on the body. The under surface of the head and body are pale white.

Locality.—Psilorhynchus sucatio is found in rapids at the base of the Darjiling Himalayas. Four young specimens were collected by Dr. Annandale in the Mahanadi River at Siliguri (alt. 200 ft.) Mr. Shaw's specimens are from the Mahanadi River and the Sivoke River of the Darjiling District.

Measurements in millimetres.

	A.	B.	C.
Total length of body (excluding caudal) ...	69·7	55·5	51·2
Length of head	15·0	12·0	10·5
Width ,, ,, ...	10·2	9·2	8·0
Depth of body	13·2	12·8	11·6
Diameter of eye	4·5	4·3	3·5
Length of snout	7·7	5·6	5·0
Interorbital width	6·9	4·8	4·3
Length of caudal peduncle	12·7	7·8	6·2
Least height of caudal peduncle	5·0	4·8	4·2
Distance from tip of snout to anterior origin of dorsal fin	30·0	26·5	24·2
Distance from base of caudal fin to anterior origin of dorsal fin	39·7	29·7	27·0
Distance from tip of snout to anal opening ...	38·0	32·6	30·8
,, ,, base of caudal fin to anal opening ...	31·0	22·9	20·4
Longest ray of dorsal	17·4	11·6	11·2
,, ,, ,, anal	9·8	8·8	8·3
Length of pectoral fin	14·0	13·5	12·3
,, ,, ventral ,, ...	12·2	12·0	10·2

Oreinus molesworthi, Chaudhuri.

1913. *Oreinus molesworthi*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 243, pl. vii, figs. 2, 2*a*, 2*b*.

This species was described by Chaudhuri (*op. cit.*) from a single specimen from Yembung at an altitude of 1100 ft. in the Abor Hills. There is one specimen in Mr. Shaw's collection which I refer to this species after having compared it with the type-specimen and with the description and figures given by Chaudhuri.

Chaudhuri says that "the width of the mouth is nearly two and a half times the length of the head." Probably he meant to say that the width of the mouth was contained nearly two and a half times in the length of the head; this is very nearly correct. I find that the so-called scaleless portion of the body, which is situated behind the opercle and below the lateral line, possesses rudimentary scales which in the type-specimen are mostly hidden by the slime of the skin. In the specimen from the Darjiling Himalayas, which is 185 mm. in length including the caudal, there are only a few small conical warts on the snout and the body is comparatively less deep. The caudal fin is deeply forked with both the lobes pointed, the upper longer than the lower.

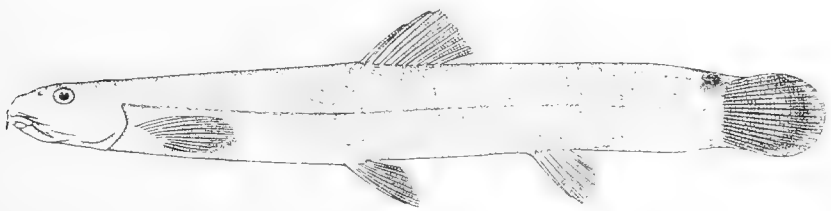
Mr. Shaw collected his specimen in the Reang River at an altitude of 2000 ft. in the Darjiling District.

Aborichthys elongatus, sp. nov.

This species is represented in Mr. Shaw's collection by three specimens, two of which are young and one adult in a bad state of preservation. It can, however, be readily distinguished from the only other known species of the genus, *Aborichthys kempi*, Chaudhuri,[1] in the points tabulated below :—

A. kempi, Chaudhuri.	*A. elongatus*, sp. nov.
1. The snout is a little shorter than the post-orbital part of the head.	The snout is almost equal to the post-orbital part of the head.
2. There are 7 branched rays in the dorsal fin.	There are only six branched rays in the dorsal fin.
3. The dorsal is equidistant between the tubular nostrils and the root of the caudal.	The dorsal is equidistant from the tip of the snout and the base of the caudal fin in the adult specimen ; in younger specimens it is somewhat nearer to the tip of the snout than to the base of the caudal.

Besides these points the proportions and the colouration are totally different in the two species.



Lateral view of *Aborichthys elongatus*, sp. nov. Slightly enlarged.

A. elongatus is greatly elongated and compressed from side to side. Both the dorsal and the ventral profiles are straight and horizontal behind the pectoral fins and run almost parallel to each other to the base of the caudal fin. The head is rounded and cylindrical; its length is contained 6·1 times, the depth of the body 8·6 times and the length of the caudal fin 6·5 times in the total length including that of the caudal fin. The eyes are situated on the dorsal side in the middle of the head and are not visible from below; their diameter is contained 7·6 times in the length of the head and 3·2 times in that of the snout. The mouth is situated on the under surface a short distance behind the tip of the snout and is bordered with thick lips; the lower lip is interrupted in the middle. The lips are not fringed. The nostrils are close together and are situated nearer to the eye than to the tip of the snout; the membranous fold between the two is produced into a barbel-like outgrowth on either side. The dorsal fin commences

[1] Chaudhuri, *Rec. Ind. Mus.* VIII, p. 245, pl. vii, figs. 1, 1*a*, 1*b* (1913).

behind the ventrals and its origin is almost equidistant from the tip of the snout and the base of the caudal fin; it contains six branched rays besides two unbranched rays anteriorly. The pectorals are shorter than the head and are separated from the ventrals by a distance equal to their length. The ventrals extend considerably beyond the vent and are separated from the anal by a considerable distance. The anal fin is likewise short and contains six rays. It is separated from the root of the caudal fin by a distance almost equal to its length. The caudal fin is slightly shorter than the length of the head and its free posterior border is convex. The caudal peduncle is long and broad; it is 1·7 times as long as high.

Colour.—The sides and the upper surface of the head and body in front of the dorsal fin are dusky, while the under surface in the same region is either white or dull pale-olivaceous. From behind the origin of the dorsal fin to the base of the caudal fin the body is marked by a number of broad black bands alternating with narrow bands of a yellowish-orange colour. The bands form almost complete rings with slight interruptions on the extreme dorsal and the ventral sides. The pectoral, ventral and the anal fins are dull white while the dorsal fin is streaked with black along the rays. The caudal fin is dusky with a whitish margin. In the middle of the fin there are two short whitish bands. There is an intensely black ocellus at the upper corner of the root of the caudal fin.

In young specimens the bands on the body extend forward to the middle of the pectoral fins. The caudal fin is marked by a number of black blotches forming three bands.

Type-specimen.—F10087/1, *Zool. Surv. Ind.* (*Ind. Mus.*)

Locality.—Two young specimens and one adult were collected by Mr. Shaw in the Reang River at an altitude of 2000 ft. in the Darjiling District. The only other species of the genus, *A. kempi*, has been recorded from the Abor country, the Garo Hills and the Putao Plains in Upper Burma.[1]

Measurements in millimetres.

Total length excluding caudal fin	74
Length of caudal fin	13
Depth of body	9·8
Length of head	13·6
,, ,, snout	6
Diameter of eye	1·8
Length of pectoral fin	11·2
,, ,, ventral ,, ...	9·5
Longest ray of anal fin	9·0
,, ,, ,, dorsal ,, ...	6·8

Macrones (Macronoides) merianiensis, Chaudhuri.

1913. *Macrones merianiensis*, Chaudhuri, *Rec. Ind. Mus.* VIII, p. 253, pl. ix, figs. 1, 1*a*, 1*b*.

[1] Chaudhuri, *Rec. Ind. Mus.* XVI, p. 278 (1919).

This interesting species has so far been known from a single specimen in our collection found in a pond at Mariani junction, Assam. In Mr. Shaw's collection there are three specimens from the Sivoke River (alt. 500 ft.) in the Darjiling District, which agree in almost all respects with Chaudhuri's description of the species. They are 70, 60 and 56 millimetres in length respectively.

Quite recently[1] I have separated this species along with *Macrones affinis* (Blyth)[2] and *M. dayi*, Vinciguerra,[3] into a distinct subgenus *Macronoides*. The fishes of this subgenus are readily distinguished by their short barbels which do not exceed the length of the head, by the possession of pores on the under surface of the head and by the fact that the mandibular pairs of barbels are placed in an almost horizontal line.

Macrones marianiensis is known from the Abor Hills and the base of the Darjiling Himalayas.

Olyra kempi, Chaudhuri.

1912. *Olyra kempi*, Chaudhuri, *Rec. Ind. Mus.* VII, p. 443, pl. xl, figs. 4, 4*a*, 4*b*.

Chaudhuri (*op. cit.*) described this species from five young specimens, the largest measuring 54 mm., which were collected by Dr. S. W. Kemp in the Darrang District (Assam-Bhutan Frontier). There is one specimen in Mr. Shaw's collection which measures 78 mm. in length and which closely resembles the type-series except in colour. The Darjiling example is dusky with a black caudal fin. The under surface of the head is pale olivaceous while the belly is white. The longitudinal stripes on the body, which Chaudhuri described, are lacking.

In the specimen both the pectoral spines are broken which shows that the fish is regarded as poisonous by the local fishermen.

The species closely resembles *Olyra longicauda*, McClell., but in the absence of specimens from the Khasi Hills, it is impossible to make a detailed comparison between the two forms. They can, however, be distinguished by the number of rays in the anal fin. In *O. longicauda* there are said to be 23, while in *O. kempi* there are only 17–19.

Mr. Shaw collected his specimen in the Sivoke River at an altitude of 500 ft. at the base of the Darjiling Himalayas. This is only the second record of this genus from the Eastern Himalayas.

Pseudecheneis sulcatus (McClell.).

1842. *Glyptosternon sulcatus*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 587, figs. 1, 2 and 3.

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[1] Hora, *Rec. Ind. Mus.* XXII, pp. 179, 180 (1921).
[2] Blyth, *Journ. As. Soc. Bengal* XXIX, p. 150 (1860).
[3] Vinciguerra, *Ann. Mus. civ. Stor. Nat. Genova* XXIX, p. 230, pl. vii, fig. 3 (1889).

1860. *Pseudecheneis sulcatus*, Blyth, *Journ. As. Soc. Bengal* XXIX, p. 154.
1919. *Pseudecheneis sulcatus*, Chaudhuri, *Rec. Ind. Mus.* XVI, p. 278 (see references).

Of all the hill-stream fishes with which I am personally acquainted, this species has the widest range. McClelland (*op. cit.*) described it for the first time from the "Kasyah mountains." Day[1] recorded it from the Darjiling District and Chaudhuri[2] extended its range to the Abor Hills. Vinciguerra[3] found some specimens of this species in Fea's collection from Khakhyen (Kachin) Hills and Chaudhuri (*op. cit.*) has recently recorded it from Upper Burma. It is interesting to find that a fish so highly specialized for life in rapid running waters should be distributed over so wide an area.

The only specimen in Mr. Shaw's collection measures 75 mm. including the caudal fin. It was procured by him in the Reang River at an altitude of 2000 ft. in the Darjiling District.

Amblyceps mangois (Ham. Buch.).

1919. *Amblyceps mangois*, Chaudhuri, *Rec. Ind. Mus.* XVI p. 275 (see references).

There is only one specimen of this species from the Sivoke River (alt. 500 ft.) in the Darjiling District. It measures 68 mm. in length without the caudal fin and is a ripe female. The eggs are large and I have been able to count about 36 in this specimen. The diameter of the mature egg was found to be 2·2 mm.

This species is widely distributed in the fresh waters of Northern India and Burma and usually occurs along the bases of the hills.

Erethistes elongata (Day).

1871. *Hara elongata*, Day, *Proc. Zool. Soc. London*, p. 704.
1878. *Erethistes elongata*, Day, *Fish. Ind.* II, p. 453, pl. cii, fig. 5.
1889. *Erethistes elongata*, Day, *Faun. Brit. Ind. Fish.* I, p. 207.

Erethistes elongata has hitherto been known from a single specimen found in "a stream near the Garraw Hills." Day in his later works gives the Naga Hills, probably in error. Mr. Shaw's example was procured in the Mahanadi River near Siliguri, at the base of the Darjiling Himalayas; it is 50 mm. in length without the caudal fin and is longer than the type-specimen figured by Day. I give below the measurements of the two specimens for comparison.

Measurements in millimetres.

	A (type).	B.
Total length of body (excluding caudal)	45·0	50·0
Length of head	9·5	9·6
Width " "	7·0	7·8

[1] Day, *Fish. Ind.*, II, p. 500, pl. cxvi, fig. 1 (1878); *Faun. Brit. Ind. Fish.* I, p. 107, fig. 44 (1889).
[2] Chaudhuri, *Rec. Ind. Mus.* VIII, p. 255 (1913).
[3] Vinciguerra, *Ann. Mus. civ. Stor. Nat. Genova* XXIX, p. 252 (1889-90).

	A (type).	B.
Depth of body	6·7	7·8
Diameter of eye	1·3	1·3
Length of snout	5·0	5·6
Interorbital width	3·2	3·7
Length of caudal peduncle	10·8	13·5
Least height of caudal peduncle	2·7	2·2
Distance from tip of snout to anterior origin of dorsal fin	17·0	18·2
Distance from base of caudal fin to anterior origin of dorsal fin	28·5	32·0
Distance from tip of snout to anal opening	24·0	26·8
Distance from base of caudal fin to anal opening ...	21·5	23·4
Length of dorsal spine	11·2	13·5
,, ,, pectoral spine	11·6	12·8
Length of ventral fin	6·8	7·0
,, ,, anal fin	7·0	8·0

Erethistes elongata is abundantly distinct from the remaining species of this genus and is easily recognised by its elongate form and short scapular processes. It also possesses a well-marked tubercle in the middle of the upper jaw. In other species of the genus the scapular processes are long and the skin covering the belly is smooth, but in *E. elongata* the scapular processes are short and the skin on the under surface is thrown into grooves and ridges. These longitudinal folds of skin extend from between the bases of the pectoral fins to the ventrals; they appear to have a definite biological significance, and are probably used by the fish in adhering to rocks and stones in rapid running waters.

The fish is black in colour throughout with the exception of the chest, which is dirty white. The fins are marked with white bands.

Laguvia, gen. nov.

The genus *Laguvia* may be characterized as follows :—

The head and body are slightly depressed and the skin covering the belly is corrugated, suggesting an adherent function. The pectoral fins are provided with strong denticulated spines; the dorsal spine is strong and bony and may or may not be serrated anteriorly. The adipose dorsal is short but well marked. The mouth is subterminal and is surrounded by thick lips. There are eight barbels, one pair of nasal, one pair of maxillary and two pairs of mandibular. The nostrils are situated close together and are separated by a flap bearing the nasal barbel. The gill-openings are wide and almost meet each other in the middle on the under surface. The occipital and cubito-humeral process are present. There is a short scapular process which may or may not be followed by bony tubercles posteriorly. The eyes are minute and are situated on the dorsal surface of the head. The air-bladder is divided into two lateral chambers which are not enclosed in bone.

The new genus comprises small fish inhabiting rapid running waters at the base of mountains. It closely resembles *Erethistes*, Müll. and Trosch., from which it can be readily distinguished by the nature of its gill-openings which are very wide. From the genus *Glyptothorax* it differs in the possession of scapular, pro-

cesses, the presence of free bony tubercles on the sides of the body and in the absence of a well-marked adhesive apparatus on the chest. In most respects the genus is intermediate between *Erethistes* and *Glyptothorax*.

I refer to this genus *Pimelodus asperus*, McClell.,[1] besides two new species from the base of the Darjiling Himalayas described below. McClelland's species was described from Chusan in China; it has been referred to the genus *Hara*, Blyth, both by Günther[2] and Bleeker,[3] while Chaudhuri[4] has quite recently recorded it as *Erethistes asperus* from Upper Burma (N. Frontier).

Laguvia shawi, sp. nov.

(Pl. XXIX, fig. 2).

This species comprises small subcylindrical fish in which the head is slightly depressed and the body arched both above and below. The dorsal profile rises considerably from the tip of the snout to the base of the dorsal, beyond which it slopes down to the root of the caudal. The belly bulges somewhat downwards. The head is long and broad; its length is contained about 3·3 times in the length of the fish without the caudal fin. It is 1·2 times as long as broad. The snout is broad and almost semicircular in outline; it is as long as the post-orbital part of the head. The eyes are minute and are situated on the dorsal surface of the head in the middle; they are not visible from below. The mouth is a wide transverse slit on the under surface of the head a short distance behind the tip of the snout. The nostrils are situated close together and are separated from each other by a membranous flap bearing the nasal barbel; they are situated at an equal distance from the tip of the snout and the anterior margin of the eye. There are eight barbels; those of the maxillary pair are broad at their bases and reach the bases of the pectoral fins. The outer mandibular barbels are longer than the inner and are slightly shorter than the maxillary barbels. The nasal barbels are as long as the distance between the nostrils and the middle of the eye; they are short and thin and are apt to be overlooked. The dorsal fin commences greatly in advance of the ventrals and its origin is much nearer to the tip of the snout than to the base of the caudal fin; its first divided ray is the longest but is not so high as the depth of the body below it; it contains 5 or 6 branched rays and two spines anteriorly. The dorsal spine is strong and bony; it is smooth anteriorly but somewhat roughened posteriorly. The pectoral fin is almost as long as the head and is provided with a strong spine which is serrated externally but internally it possesses about 7 hooked spines. The ventrals are not

[1] McClelland, *Calcutta Journ. Nat. Hist.* IV, p. 404, pl. xxiv, fig. 2 (1844).
[2] Günther, *Cat. Brit. Mus. Fish.* V, p. 189 (1864).
[3] Bleeker, *Ned. Tijdschr. Dierk.* IV, p. 105 (1873).
[4] Chaudhuri, *Rec. Ind. Mus.* XVI, p. 276, pl. xxii, figs. 2, 2*a*, 2*b*.

separated from the pectorals by any great distance; their origin is distinctly nearer to the root of the caudal fin than to the tip of the snout. The ventrals almost reach the base of the anal fin which contains 9 rays, the anteriormost of which is not branched. The caudal fin is long and its free posterior border is almost semicircular; the two extremities are sharp and pointed.

The air-bladder has receded inwards towards the vertebral column and consists of two chambers, one on either side of the basioccipital process of the skull. The occipital, cubito-humeral and the scapular processes are finely tuberculated and there is a bony nodule covered by skin below the base of the dorsal spine.

Colour.—The sides and dorsal surface of the head are black; the ventral surface is dull white. The general colouration of the body is pale yellow, but the sides are marked with two broad black bands formed by an aggregation of black dots. The anterior band is below the bases of the anterior dorsal fins and the posterior band is situated below the bases of the adipose dorsal and the anal fins. The fins are indistinctly marked with black bands.

Type-specimen.—F 10085/1, *Zool. Surv. Ind.* (*Ind Mus.*).

Locality.—There are three specimens in Mr. Shaw's collection, two from the Mahanadi River and one from the Sivoke River. Both these rivers flow at a very low altitude at the base of the Darjiling Himalayas.

Measurements in millimetres.

Total length including caudal fin	30·0
Length of caudal fin	5·4
Depth of body	5·0
Length of head	8·0
Width ,, ,,	6·5
Length of snout	4·0
Interorbital width	2·5
Height of dorsal spine	4·2
Length of pectoral spine	5·5

One of the specimens on dissection was found to be full of eggs. The eggs are small in this species.

Laguvia ribeiroi, sp. nov.

Pl. XXIX, fig. 3.

This species differs from the preceding in several respects and was obtained by Mr. Ribeiro in an adjacent locality. The following table shows some of the salient points in which the two species differ:—

L. shawi, sp. nov.	*L. ribeiroi*, sp. nov.
1. The nostrils are equidistant from the tip of the snout and the anterior margin of the eye.	The nostrils are nearer to the tip of the snout than to the anterior margin of the eye.
2. The origin of the ventral fin is distinctly nearer to the base of the caudal than to the tip of the snout.	The origin of the ventral fin is almost equidistant from the tip of the snout and the base of the caudal fin.

3. The dorsal spine is almost smooth along both the borders.	The dorsal spine is finely serrated along the whole of its anterior border and also along the upper one-third of the posterior border.
4. The skin covering the belly is smooth.	The skin covering the belly is corrugated to form a kind of rudimentary adhesive apparatus.

Besides these points the two species differ in proportions and colouration. Moreover the eggs of *L. shawi* are minute whereas those of *L. ribeiroi* are much larger.

L. ribeiroi is a small subcylindrical fish with the head and body slightly depressed. The dorsal profile rises gradually from the tip of the snout to the base of the dorsal fin, beyond which it falls to the root of the caudal fin. The ventral profile is somewhat arched. The head is short and broad; its length is contained about 3·7 times in the length of the fish without the caudal fin. The eyes are minute and are situated almost in the middle of the head on the dorsal surface; they are not visible from below. The mouth is situated on the under surface slightly behind the tip of the snout and is bordered by moderately thick lips. The nostrils are situated close together; they are nearer to the tip of the snout than to the anterior margin of the eye. The gill-openings are very wide. There are 8 barbels; the maxillary barbels are provided with broad bases and do not reach the base of the pectoral fins. The skin covering the belly is thrown into oblique grooves and ridges which form a **V**-shaped adhesive apparatus similar to that found in the genus *Glyptothorax* but not so well-developed. The dorsal fin commences somewhat in advance of the ventrals and its origin is much nearer to the tip of the snout than to the root of the caudal fin; it is provided with a strong spine and six rays. The dorsal spine is not so high as the depth of the body below it; it is serrated along the whole of its anterior border and along the upper part of its posterior border. The pectoral is slightly shorter than the head and is separated from the ventrals by a short distance. The pectoral spine is flat and strong; externally it is serrated but internally it is provided with eight curved spines. The ventrals just extend beyond the anus but do not reach the base of the anal fin which contains 10 rays. The caudal fin is long and its free posterior border is semicircular; the two extremities are sharply pointed, the lower is slightly longer than the upper.

The scapular process is small and there are a number of bony tubercles behind the gill-opening in a horizontal line. The bones of the head and the various processes are slightly corrugated but not distinctly tuberculate.

Colour.—The sides and the dorsal surface of the head and body are dark; the ventral surface is dull white, speckled with black dots. There are two broad yellowish bands on the body; the anterior is between the rayed dorsal and the adipose dorsal fins and the second is below the posterior half of the base of the

adipose fin. The adipose dorsal is dusky, while the other fins are distinctly banded.

Type-specimen.—F 10086/1, *Zool. Surv. Ind.* (*Ind. Mus.*).

Locality.—There is a single specimen collected by Mr. Ribeiro in the Khoila River, a tributary of the Tista at Jalpaiguri in the Darjiling District.

Measurements in millimetres.

Total length including caudal	31·5
Length of caudal fin	6·4
Depth of body	5·8
Length of head	7·5
Width ,, ,,	6·5
Length of snout	3·6
Interorbital width	2·5
Height of dorsal spine	5·3
Length of pectoral spine	6·5

The specimen is a female and was found on dissection to be full of eggs. The eggs are large; the longest diameter being 1·4 mm.

Besides the ten species of fish discussed in the foregoing pages the following species were also represented in Mr. Shaw's collection:—

Callichrous pabda (Ham. Buch.).
Macrones vittatus, Bloch.
Pseudeutropius murius (Ham. Buch.).
Garra gotyla (Gray).
Garra annandalei, Hora.
Semiplotus semiplotus (McClell.).
Barbus stigma (Ham. Buch.).
Barbus conchonius (Ham. Buch.).
Danio aequipinnatus (McClell.).
Danio rerio (Ham. Buch.).
Rasbora daniconius (Ham. Buch.).
Nemachilus botius (Ham. Buch.).
Nemachilus multifasciatus, Day.
Lepidocephalichthys guntea (Ham. Buch.).
Ophiocephalus gachua (Ham. Buch.).
Glossogobius giuris (Ham. Buch.).
Dorichthys deocata (Ham. Buch.).

In addition there are some specimens of the genus *Nemachilus* which I have not been able to refer to any known species.

Quite recently Dr. Murray Stuart of the Geological Survey of India has brought back a small collection of fish from the North-Eastern border of Burma and the Naga Hills. He has very kindly presented this collection to the Indian Museum. I have been able to identify the following fish in this collection:—

Garra gotyla (Gray).
Crossochilus latia (Ham. Buch.).
Barbus clavatus (McClell.).

Barbus ticto (Ham. Buch.).
Barbus conchonius (Ham. Buch.).
Barbus chrysopterus (McClell.).
Danio aequipinnatus (McClell).
Rasbora rasbora (Ham. Buch).
Barilius vagra (Ham. Buch.).
Nemachilus botius (Ham. Buch.).
Ambassis nama (Ham. Buch.).

EXPLANATION OF PLATE XXIX.

Fish from the Eastern Himalayas.

FIG. 1.—Lateral view of *Psilorhynchus sucatio* (Ham. Buch.). × 2.

,, 1*a*.—Under surface of head and chest of same. × 2.

,, 2.—Lateral view of *Laguvia shawi*, sp. nov. × 3.

,, 3.—Lateral view of *Laguvia ribeiroi*, sp. nov. × 3.

S. C. Mondul & D. Bagchi, del.

Bemrose, Collo, Derby.

FISH FROM THE EASTERN HIMALAYAS.

XXXIV. OLIGOCHAETA FROM MANIPUR, THE LACCADIVE ISLANDS, MYSORE, AND OTHER PARTS OF INDIA.

By J. STEPHENSON, *M.B., D.Sc., Lieut.-Col., I.M.S., Lecturer in Zoology, the University of Edinburgh.*

(Plate XXVIII).

CONTENTS.

INTRODUCTION.

The present paper deals with Oligochaeta received from the three following sources :—

(1) The majority of the specimens were received from the Indian Museum, and a large number of these were brought from Manipur by the Manipur Survey Party; others are from the Nilgiris in S. India, and a few from other parts.

(2) I received a small collection from Mr. R H. Whitehouse, Marine Biologist to the Madras Fisheries Department, obtained from the Laccadive Islands during a recent visit by one of his assistants.

(3) A tube of specimens, collected in May, 1920 in the forests of Shimoga and Kadur Districts, Mysore, which contained three interesting species, two of which are new, was forwarded to me, at the suggestion of Prof. J. P. Hill, by Mr. A. Subba Rau, a student of University College, London.

To the Director of the Zoological Survey, and to the other gentlemen named, I am much indebted for the opportunity of examining these collections. I propose to offer a few general remarks on them before passing to the systematic description.

Distribution of the species investigated.

The species are distributed as follows:—

Manipur ..	..	*Branchiura sowerbyi*, Bedd.
		Pheretima hawayana (Rosa).
		Pheretima heterochaeta (Mich.).
		Perionyx excavatus, E. Perrier.
		Eutyphoeus manipurensis, sp. nov.
Madras Pres.:—		
Madras City	..	*Branchiodrilus menoni*, Steph.
		Branchiura sowerbyi, Bedd.
Nilgiris	..	*Tubifex* (*Tubifex*) *tubifex* (O. F. M.).
		Plutellus aquatilis, sp. nov.
		Pheretima heterochaeta (Mich.).
		Perionyx saltans, Bourne.
		Perionyx sansibaricus, Mich..
Barkuda I.	..	*Nais paraguayensis*, Mich. var. *barkudensis*, nov.
		Octochaetus barkudensis, Steph..
		Eudichogaster barkudensis, sp. nov.
Godaveri Dist.		*Megascolides annandalei*, sp. nov.
		Megascolex mauritii (Kinb.).
Mysore	..	*Drawida raui*, sp. nov.
		Perionyx mysorensis, sp. nov.
		Glyphidrilus annandalei, Mich..
Central Provinces	..	*Nais paraguayensis*, Mich..
		Branchiodrilus sp.
		Aulodrilus remex, sp. nov.
Laccadive Islands.	..	*Megascolex mauritii* (Kinb.).
		Megascolex konkanensis, Fedarb.

The Oligochaeta of the Laccadive Islands.

The Laccadives are a group of coral islands, the nearest of which is about 150 miles from the Malabar Coast. The only previous account of the Oligochaeta of these islands is by Beddard,

on the basis of Gardiner's collections from the Maldives and Laccadives, made in 1899 and 1900 (1). Beddard received two species only from the Laccadives, both from Minikoi,—*Pontodrilus laccadivensis* (united by Michaelsen with *Pontodrilus bermudensis*, Bedd.), and *Megascolex mauritii* (Kinb.). In the present more extensive collection also only two species are found, *Megascolex mauritii* (Kinb.) and *Megascolex konkanensis*, Fedarb.

Pontodrilus bermudensis, littoral in habit, as are all the species of the genus, has spread widely on the shores of tropical and subtropical seas all round the world. *Megascolex mauritii* is also in a special degree peregrine; it is very common in India, and inhabits also the lands bordering the Indian Ocean, and S. and S.E. Asia generally. *Megascolex konkanensis* is common on the Malabar coast,—*i.e.* that part of India which is nearest to the islands, and with which communication is most frequent.

It appears therefore that the earthworm fauna of the Laccadives, as was to be expected, is entirely introduced, and is very limited in the number of species.

The Indian Tubificidae.

Tubificids appear to be rare in India, and hitherto only four species have been recorded, belonging to as many genera:—*Branchiura sowerbyi*, Bedd., *Limnodrilus socialis*, Stph., *Bothrioneurum iris*, Bedd., and *Monopylephorus parvus*, Ditlevsen. The present communication brings a fresh record for *Branchiura sowerbyi* (from Manipur), and adds two more species to the Indian list,—*Tubifex* (*T.*) *tubifex* and a new *Aulodrilus*.

Branchiura sowerbyi, remarkable for its gills, was discovered first by Beddard in the mud of the Victoria regia tank in the Royal Botanical Society's Gardens in London in 1892, it was not seen again for sixteen years, when Michaelsen found it in a warm water tank of the Botanical Gardens at Hamburg; Southern then found specimens in the Victoria regia tank at Dublin, and Perrier in the Rhone; and in recent years a number of finds have been recorded by Keyl and Stephenson from warm houses in Europe, and from the open in India, Burma, China and Japan. Indeed it appears to be quite common in the East.

Tubifex (*Tubifex*) *tubifex* (O. F. M.), a widely spread European species, is now found in the Nilgiris, where it differs but slightly from the common form.

The genus *Aulodrilus* was established by Bretscher in 1899 (2) for *A. limnobius*, found in Switzerland. Though he places it as an appendix to the Tubificidae, he recognizes that it fits in neither with that family nor with the Lumbriculidae, and suspects that it may be necessary to found a new family for it. The reproductive organs are still, as they were to Bretscher, unknown; but the genus is distinguished from most other Tubificidae by the fact that the needle setae (crotchets) have the upper tooth (the one on the outer side of the curve of the shaft) much smaller than

the other,—the reverse is the case in most other genera of the family.

A second species was described in 1906 by Piguet (10), who placed it among the Naididae as *Naidium pluriseta*, but later (11) transferred it to *Aulodrilus*.

The justification for the inclusion of these species in the Tubificidae is to be found in the absence of asexual reproduction by fission, which is a constant characteristic of the Naididae; as well as, perhaps, if *A. pluriseta* resembles *A. limnobius* and *A. remex*, in the presence of large parietal vascular loops at the hinder end of the body. It must however be owned that if, as Piguet states, an *Aulodrilus* from the S. of France, the study of which was not completed when he wrote, has retractile penes in front of the ventral setae of segment vii, the genus is probably nearer to the Naididae than to the Tubificidae, though capable of inclusion in neither; and Michaelsen's caution in placing *Aulodrilus* as a doubtful genus (of Tubificidae) (6) is justified.

A. limnobius and *A. pluriseta* form tubes, as does perhaps, to judge from the foreign matter which adhered to the present specimens, the Indian species also. The hinder end of both *A. pluriseta* and the present species (and, it may be conjectured, *A. limnobius* also) is remarkable; the most posterior region shows no proliferation, nor even any segmentation; but there is a zone of proliferation and formation of numerous new segments some little distance *in front of* the anus. These zones are known in other worms in two situations;—terminal, in probably all Oligochaetes and other segmented worms which continue to produce new segments during their life; and in the middle of the body, in *Aeolosoma* and the Naididae, where such a production of new segments (a "budding zone") indicates the site of approaching fission. Such a budding zone as that of the present genus is, so far as I know, unique.

The terminal unsegmented region Piguet looks on as physiologically a gill; it possesses a rich cutaneous vascularization; and during life the anus can dilate, giving rise to a "branchial fossa."

Some interesting species in the collections.

Drawida raui, sp. nov., described below is interesting from the fact that it possesses a well-developed pair of prostates in segment ix, equal in size to those in segment x. The anterior pair have no direct communication with the male reproductive apparatus, while the posterior are, as usual, joined by the vasa deferentia. Michaelsen has previously (7) found a rudimentary second pair in segment ix in *D. willsi*, and has argued that the genus originally possessed two fully-developed pairs, of which the anterior has disappeared. This anterior pair, in turn, is the index of a formerly existing second pair of testes, the ancestors of the genus *Drawida* having been holandric while their present-day representatives are metandric (retaining only the posterior of the two original pairs of testes). The genus *Desmogaster* (Burma, Sumatra, Borneo) is

actually holandric, and is to be looked on as the most primitive member of the family.

Drawina raui may thus be regarded as the most primitive existing member of the genus, at any rate in respect of its male reproductive apparatus. There are other primitive features also:—(1) In a considerable number of species of the genus segment xi, which lodges the ovaries and female funnels, forms an "ovarian chamber," being shut out from the body-wall by the meeting and coalescence of the septa which bound it; in the present species however, as in some others, the septa have the usual arrangement, and there is no ovarian chamber. (2) In many species of the genus the setae are remarkably small, and in some may even be absent or unrecognizable in the most anterior segments; here however the setae are remarkably large for so small a worm. (3) The fact that the spermathecal atrium is large and sac-like may not improbably be another primitive feature; in this case the numerous species in which it is small, almost or entirely hidden in the body-wall, or even absent, would represent a secondary condition.

A specimen of *Branchiodrilus* (interesting, like *Branchiura*, from the possession of gills), the species unfortunately indeterminable, comes from Burhanpur in the Central Provinces. The genus, so far found only in India, and for long represented only by Bourne's *Chaetobranchus semperi* (Madras, 1890), has been in recent years rediscovered in Madras, and occurs also at Lahore and Lucknow.

The new species *Plutellus aquatilis*, *Eutyphocus manipurensis*, and *Eudichogaster barkudensis* bring about no change in the areas of distribution of these genera as already known. *Megascolides annandalei* (Godaveri District, on the E. coast) extends the range of this genus to a region where it had not previously been found; the genus appears to be widely spread, but nowhere abundant.

The rediscovery of Bourne's *Perionyx saltans* after thirty-five years, in the Nilgiris, not far from where it was originally found, is interesting.

Systematic changes adopted in the present paper.

I have, following Michaelsen, restored the worm which for a long time has been known as *Lampito mauritii* to the genus *Megascolex*. Michaelsen, who in the Tierreich volume (6) had united Kinberg's genus *Lampito* with *Megascolex*, separated it again in 1909 (7), in consequence of finding two other worms which agreed with *L. mauritii* in the possession of a peculiar form of nephridial system,—micronephridia throughout the body, and meganephridia in addition in the postclitellar segments; to these three species Stephenson later added two others (13, 14). Michaelsen again fused the two genera in 1916 (8), since he had come to believe that the coexistence of micro- and meganephridia had no special impor-

tance; the peculiarity has arisen at various times, and is found in a number of genera of Megascolecinae,—*Megascolides*, *Notoscolex*, *Megascolex*, and *Plionogaster*. With this I agree; there are many varieties of nephridial distribution in the genus *Megascolex*, and I see no reason for separating the worms possessing this particular form of nephridial distribution as a separate genus; indeed. *M. eschericlii* var. *papillifer* has this special arrangement while the type form of the species has not. Nor is there anything in the geographical distribution of the worms with this special arrangement to suggest a common origin.

The genus *Eudichogaster* I have placed under the subfamily Octochaetinae, instead of, as has been done by Michaelsen, under the Trigastrinae. I have discussed the question of the descent and systematic position of the genus at some length in a recent paper (16), and need not refer to it further here.

Michaelsen has recently (9) united the Glossoscolecidae and Lumbricidae as one family, the latter group becoming a subfamily, the Lumbricinae, and the several subfamilies of the former becoming subfamilies of the Lumbricidae, *s.l.* I can have no hesitation in adopting the view of one whose experience of these groups entitles him to speak with the authority of Dr. Michaelsen.

Fam. NAIDIDAE.

Gen. **Nais**, O. F. M. *em.* Vejd.

Nais paraguayensis, Mich.

Pachmarhi, Satpura Hills, Central Provinces; 300 ft. no date. F. H. Gravely. Numerous specimens.

Indian specimens have been found to be larger than those originally described by Michaelsen (5), and the number of their segments greater; this is the case also with the present specimens, the longest of which measured 13–14 mm. In one example 106 segments were counted, plus a posterior region of some little length in which new segments were about to be differentiated. None showed any sign of fission.

The coelomic corpuscles are large, a fairly large one being 16μ in diameter, and one of average size 12μ; they are circular in shape, with a central nucleus.

No budding zone, nor any sign of approaching fission has apparently as yet been observed in this worm, nor have sexual organs been seen. It is therefore a question how the animal ordinarily reproduces itself. I think it possible that it does so by simple fragmentation,—*i.e.* without the formation of an internal budding zone,—and subsequent regeneration. Thus, in the present batch of material, besides the longer worms are some much shorter, with a large number of new segments, evidently rapidly produced, at the hinder end; this appearance of a considerable length of rapidly produced posterior segments seems to be a frequent characteristic (compare, for example, the description

and figure in 12). Others are shorter still,—about 30 segments,—with a short stumpy conical "tail," evidently about to regenerate a hinder end. One or two fragments have not yet begun to regenerate, but these may possibly be simply the result of injury at the time of capture.

var. **barkudensis**, nov.

(Pl. XXVIII, fig. 1.)

Pond, Barkuda Island, Chilka Lake, Ganjam Dist., Madras Pres. Aug. 19 (no year). F. H. Gravely. Three specimens, all disintegrating.

The condition of the worms was quite useless for any study of the anatomy. The discrimination of the species of the Naididae however is based largely on setal characters; and since these were still discernible in the specimens,—and indeed more easily than in better preserved material,—it seems justifiable to offer the following description.

One specimen is a fragment 2 mm. long, incomplete at both ends; the other two are incomplete behind, and about 4 mm. long. The original length of the worm may thus be about 5 mm.

The anterior end, comprising the first six segments, is rather bulbous. There seem to have been no eyes; the pigment of the eyes is usually fairly resistant, and would have been visible if eyes had existed. As far as can be seen, there is no stomachal dilatation on the alimentary tube.

In one specimen there are 33 fully developed segments, followed by 21 very short and recently produced segments, after which the hinder end is broken off. In the other there are 31 segments, after which two short ones follow; these are apparently the beginning of a posterior series of rapidly produced segments, the rest of which are wanting.

The ventral setae of segments ii–v differ from those of the remainder of the body. In this anterior group of segments they are four per bundle, 100μ in length and 3μ in thickness; the nodulus is proximal to the middle of the shaft (proximal portion: distal portion : : 4 : 5); of the two terminal prongs, the distal is nearly twice as long as the proximal, and about equal to it in thickness at the base, or perhaps slightly thinner. In the rest of the body the ventral setae are 4–5 per bundle, their length 90μ and thickness 3μ; the nodulus is distal to the middle of the shaft (proximal portion: distal portion : : 5 : 3 or almost 2 : 1); the prongs are equal in length, and the proximal is one and a half times as thick as the distal.

The dorsal setae begin in segment vi, and each bundle consists of two or three hairs and two or three needles,—perhaps most often of two of each. The hairs are about ·25 mm. long, rather less than the diameter of the body. The needles, about 94μ in length, have a slight sabre-like curve; the nodulus is one-third the length of the shaft from the distal end; the tip is bifid, the prongs being visible to the ordinary high power, set at an acute

angle, that on the outer side of the curve of the shaft being rather longer and perhaps slightly stouter than the other (fig. 1).

Remarks.—In the absence of the posterior end of any of the specimens, there is no strict proof that they may not belong to the genus *Dero* or *Aulophorus*, which have gills around the anus, though their setal characters are similar to those of *Nais*. The existence of a long region of newly budded segments posteriorly, however, is very suggestive of *Naïs paraguayensis*; and it is difficult to imagine developed gills at the hinder end of a series of rudimentary or still undifferentiated segments.

The three varieties of *Nais paraguayensis* form a series distinguished by the relative sizes of the inner and outer prongs of the dorsal needles:—

N. paraguayensis typica....outer prong considerably smaller.
,, ,, var. *aequalis*....prongs equal.
,, ,, var. *barkudensis*....inner prong smaller.

The difference between the typical form of the species and the present variety is such that, but for the existence of the intermediate variety *aequalis*, it would have been necessary to separate them as distinct species.

Gen. **Branchiodrilus**, Mich.

Branchiodrilus sp.

Burhanpur, Central Provinces. 4-6·iii·1919. F. H. Gravely. A small fragment, in a tube with *Aulodrilus remex*.

The fragment was incomplete at both ends, and the species therefore indeterminable.

Branchiodrilus menoni, Steph.

Madras, Prof. K. Ramunni Menon's collection 5-iii-1912. Seven specimens or fragments, in a tube with two specimens of *Branchiura sowerbyi*.

One specimen was undergoing fission, but showed no budding zone; the gills of the posterior animal began immediately behind the point of impending separation. The heads of the other specimens showed a prebranchial region of varying extent, sometimes small, sometimes comprising four seta-bearing segments.

Fam. TUBIFICIDAE.

Gen. **Branchiura**, Bedd.

Branchiura sowerbyi, Bedd.

Northern portion of Loktak Lake, Manipur, Assam; 2600 ft. 16–17·ii·1920. Three specimens.

Loktak Lake, Manipur; on *Vivipara lecythis*. 17·ii·1920. A single specimen.

Off Thanga Island, Manipur. 24·iii·1920. Three specimens, all fragments, two probably comprising together one individual.

Madras, Prof. K. Ramunni Menon's collection. 5·iii·1912. Two specimens.

The following measurements were made from two specimens of the first batch:—(*a*) Length of animal 62 mm.; whole gill-bearing region one-sixth of length of animal; length of gills half diameter of body; hints of gills on seven segments, gills quite small in the next seven, of moderate size on 51 segments, and small on the three last (total 68 segments with gills); (*b*) length of animal 60 mm.; whole gill-bearing region nearly one-third of the length of the animal; length of gills half diameter of body; hints of gills on 16 segments, gills quite small on the next 19, of moderate size on 64, and small on the terminal one or two (total 100).

Gen. **Tubifex**, Lm.

Tubifex (Tubifex) tubifex (O. F. M.).

Law's Falls below Coonoor, Nilgiris; *ca.* 6500 ft., 9·iv·1919. N. Annandale and R. B. S. Sewell. A number of specimens.

The only difference from the current diagnosis discoverable in the present specimens is in the ventral setae. The diagnosis gives the upper prong as longer than the lower. I find them usually equal, but slightly variable; either one or the other may be slightly the longer.

Gen. **Aulodrilus**, Bretscher.

Aulodrilus remex, sp. nov.

(Pl. XXVIII, figs. 2–6.)

Burhanpur, Central Provinces. 4-6·iii·1919. F. H. Gravely. Three specimens.

Some yellowish foreign matter had to be pencilled off two of the specimens, to which it adhered round a short length of the middle of the body in the manner of an incomplete tube.

Length 12 mm. Diameter ·43 mm. anteriorly; the hinder portion of the worms was however much thinner, the diameter being ·25 mm. one-third of the length of the animal from the hinder end. Segments 49 plus a considerable region of greater opacity where new segments are differentiating, and this again followed by a terminal transparent region, not divided into segments nor the site of formation of new segments (fig. 2). The number of new segments forming in the region of proliferation is very large; in one specimen about 30 can be distinguished, while in the type-specimen there are about 40, and even behind these there is a cellular mass where no differentiation of segments whatever can be made out, before we arrive at the transparent terminal region. The worm has thus a characteristic appearance.

There is no budding zone or sign of fission anywhere in the middle of the animal's length.

The prostomium has the shape of a blunt equilateral triangle. There are no eyes.

The dorsal setae begin in the second segment. The bundle consist of needles and hairs, the latter short, with a bayonet curve

(fig. 3); the hairs are only about half as long again as the needles, and thus are very much shorter than the diameter of the body. In the anterior segments some needles are singly pointed and rather blunt, and others, perhaps the majority, double-pointed with the outer prong much shorter and less conspicuous than the inner. In this anterior region the bundles consist of about seven needles with one, two, or up to four hairs.

Further back the needle setae of the dorsal bundles are peculiar and characteristic. The distal end becomes flattened and blade-like or oar-like, the tip being usually rounded in outline (fig. 4*a*); occasionally the flattened part retains a trace of the bifid character (fig. 4*b*). These oar-like setae begin in segment xiii in one specimen, in vii in another; they continue to the hinder end of the body. The number of setae in a bundle in the hinder part of the body is usually 5 needles with two or three hairs. The length of the needles in the anterior segments is from 74μ to a maximum of 98μ; and posteriorly about 60μ.

Some of the needles in the posterior dorsal bundles seem to be of the single-pointed type, but I think this is only the appearance of the flat blade seen edgewise. Indeed I am not absolutely confident that any are truly singly pointed even in the anterior dorsal bundles; in one specimen, mounted in glycerin and therefore showing details of setae more easily than the balsam preparations, I was unable to convince myself with the oil immersion lens that any of the dorsal setae which were in a favourable position for examination were certainly singly pointed.

The ventral setae are singly or doubly pointed needles, the bundles consisting of as many as nine in the anterior, and six or seven in the posterior region. In length they are about 86μ in the anterior, and 51μ in the posterior segments. Some setae in segments ii, iii and iv are singly pointed; with this exception all have a slight second outer prong (fig. 5); one, in an anterior segment, appeared to have two small outer prongs (fig. 6).

The pharynx extends back to the hinder end of segment iii; the oesophagus is narrow, and occupies segments iv to vii; then a sudden dilatation occurs, and thenceforward the tube is wide and occupies most of the available space in the segments. A pair of hearts are present in segment vi. The dorsal vessel is ventral in position, lying to the left side of the ventral vessel throughout most of the body; at the anterior limit of segment vii it mounts dorsalward, and becomes dorsal in vi. There are large parietal vessels, in complicated loops on the inner surface of the body-wall, in the posterior segments.

There was no trace of sexual organs.

Remarks.—The present form is at once distinguished from the two other species of the genus by the possession of the remarkable oar-like setae in the dorsal bundles.

Fam. MONILIGASTRIDAE.

Gen. **Drawida**, Mich.

Drawida raui, sp. nov.

(Pl. XXVIII, fig. 7).

Forests of Shemoga and Kadur Districts, Mysore, S. India May, 1920. A. Subba Rau. Several specimens.

External Characters.—Length 45 mm. Diameter 1·75 mm. Colour dark bluish grey to olive, somewhat lighter ventrally. Segments *ca.* 159. Anterior end of the body rather bulbous.

Prostomium prolobous.

No dorsal pores.

Setae closely paired, beginning in ii; remarkably large and prominent for so small a worm, especially in the ventral bundles of segments iii–xii. In the pregenital segments *aa* is rather greater than *bc*, or may be about equal to it; in the middle of the body *aa*=*bc*; *dd* is equal to half the circumference.

The clitellum was not present.

Over the ventral surface of segment xi, extending to its posterior limit, and encroaching anteriorly on the hinder end of x, is a thickened patch, with a definite and slightly swollen margin, rather rectangular in shape with rounded ends. It extends laterally on each side to not far from the line of seta *c*, and is thus broad from side to side and narrow antero-posteriorly. The male apertures are situated on small papillae in the antero-lateral corners of the patch, and are thus over the situation of furrow 10/11 and midway between *b* and *c*, rather nearer *b* (fig. 7).

Over furrow 9/10, and taking up the posterior third of segment ix and the anterior third of x, are a pair of transversely oval papillae, narrower at their internal ends and slightly sunk in their centres, while the periphery of each is swollen and definitely marked. Each extends from a point between *b* and *c* but rather nearer *b*, to not far from the middle line (fig. 7).

Neither the female nor the spermathecal apertures were visible externally; from internal dissection the latter open in the line of setae *ab* in groove 7/8.

Internal Anatomy.—Septum 5/6 is thin; 6/7, 7/8 and 8/9 are considerably thickened; 9/10 is somewhat strengthened; 10/11 11/12 and perhaps 12/13 slightly so.

There are two gizzards, in segments xiii and xiv.

Some of the nephridiopores are in *cd*, but I think not all.

The testis sacs are large, extending into both segments ix and x,—equally into both, or with the larger part in ix; they are not constricted by the septum. The vas deferens, narrow and coiled, lies on both sides of septum 9/10. The prostates are elongated, somewhat cylindrical or pear shaped, rather narrowed towards their insertion in the body-wall. There is no distinct duct; the vas deferens, joining the gland below, can be seen running up its surface towards the free upper end. The surface of the glands is soft, and minutely papillated.

A second pair of prostates occurs in segment ix, of the same size, shape and appearance as the former in x. They are inserted into the body-wall near or in the situation of furrow 9/10, between the lines of setae *b* and *c*, though nearer, almost in *b*.

The ovaries are in segment xi; the septa here are quite normal, and there is no ovarian chamber, as occurs in so many species. The ovisacs extend back to segment xv; they are tubular as they pass through segments xii, xiii and xiv, and swollen in xv; or they may be moniliform, constricted by the septa.

The spermathecal ampullae are small and spherical, in segment viii; the duct is narrow and coiled, lying on the posterior face of septum 7/8. The atrium is a relatively large ovoid structure in vii, the duct entering near its base; it pierces the body-wall in the line *ab*.

Remarks.—The well-developed second pair of prostates, and the genital markings, are characteristic, and serve at once to distinguish the present species.

Fam. MEGASCOLECIDAE.

Subfam. *MEGASCOLECINAE.*

Gen. **Plutellus**, E. Perrier.

Plutellus aquatilis, sp. nov.

(Pl. XXVIII, fig. 8).

Small stream below Kotagiri, Nilgiris; *ca.* 5700 ft. N. Annandale and R. B. S. Sewell. A single specimen, broken into two.

External Characters.—Length of both pieces together 115 mm. Diameter 1·75 mm., near anterior end 2 mm.; a long thin worm. Unpigmented, colour grey, due to the intestinal contents; at anterior end quite pale. Segments 162; segment iv biannular, v–viii triannular, the rest simple.

Prostomium small, proepilobous.

Dorsal pores are present from furrow 8/9.

The setae are paired; in the middle of the body $ab = 2/5\ aa = 1/2\ bc = 2/3\ cd$; behind the genital region $ab = 1/3\ aa = 2/5\ bc = 1/2\ cd$; in front of the genital region $ab = 2/5\ aa = 1/2\ bc = 1/2\ cd$ (*i.e.* the lateral setae are not paired in front of the genital region); *dd* is less than half, and in the middle of the body is only one-third of the circumference, the setae *d* being above the lateral line of the body.

No clitellum was visible.

The male pores are on segment xviii, on small papillae which take up the interval between the lines of setae *a* and *b*; these papillae are connected across the middle line by a transverse ridge.

The female and spermathecal pores were not visible externally; from internal dissection the latter are found to open at the middle of the length of segments viii and ix, in the setal zone, and rather outside the line *b*.

There were no genital papillae or other markings.

Internal Anatomy.—Septum 5/6 is very thin; 6/7—13/14 are all present and all slightly thickened, the first few perhaps a little more than the rest.

The gizzard in segment v is large, firm, elongated, and barrell-shaped. There is a slight swelling of the oesophagus in segment xii, with close-set transverse vascular striations. The intestine begins in xv.

The last heart is in xii.

The excretory system consists of rather small meganephridia.

The testes and male funnels are free in segments x and xi. Seminal vesicles occupy segments xi and xii; they are small, those in xi smaller than the posterior pair, are much divided up into small lobules and thus have a racemose appearance; in both segments they are arranged in the form of a transverse band, continuous across the middle line, on the posterior surface of the septum (10/11 and 11/12).

The prostates are relatively large; the twisted tubular glandular portion occupies segments xviii–xxi or xviii–xxii. The duct is very thin, and much shorter than the gland; it is confined to segment xviii, and pursues a twisted course to pierce the body-wall in line with setae *b*. There are no penial setae.

The female organs have the usual situation.

The spermathecae are two pairs, in segments viii and ix (fig. 8). The ampulla is of an oval or inverted pear-shape. The duct is about as long as the ampulla, moderately stout, of an equal diameter throughout, and either straight or rather twisted in its course. The single diverticulum is tubular, as long as the main pouch (ampulla plus duct), and arises from the ectal end of the duct; in one of the four spermathecae its ental half is rather twisted, and showed three small rounded seminal chambers as irregularly arranged swellings; this is the organ illustrated in the figure, which I take to be the fully developed form. Of the other three spermathecae, one appeared to have no diverticulum, and in the remaining two the diverticulum was simply tubular and transparent.

Remarks.—This species bears a considerable resemblance to *P. indicus*, Mich.; the latter differs however in having the setae *cd* paired in the preclitellar region, the posterior spermathecal apertures in groove 8/9, the seminal vesicles in ix and xii, a straight prostatic duct, and a shorter spermathecal diverticulum with a single seminal chamber.

Gen. **Megascolides**, McCoy.

Megascolides annandalei, sp. nov.

(Pl. XXVIII, fig. 9).

Dowlaishweram, Godaveri Dist. 29·viii·1918. N. Annandale. Five specimens, all sexual.

External Characters —Length 95 mm. Diameter 5 mm. Colour pale, unpigmented, no difference between dorsal and ventral surfaces Segments 130; segment v is triannular, vi triannular and partially (ventrally) 4-annulate; segments vii and onwards to the clitellum are triannular, or triannular with one or two secondary rings; while behind the clitellum the segments show three annuli with some secondary annuli in addition.

The prostomium, withdrawn under segment i, appears to be prolobous. There is a short median groove dorsally on segment i, which extends backwards from the prostomium over two-thirds of its length or more, or even to the hinder end of the segment.

Dorsal pores begin in groove 12/13.

The setae are paired; in the middle of the body *ab* = 1/3 to 2/7 *aa* = 1/2 *bc* or slightly less = *cd*; behind the clitellum *ab* = 2/7 *aa* = 2/5 *bc*=*cd*; in front of the clitellum *ab* = 1/4 *aa*= 1/3 *bc* and is slightly less than *cd*; in the anterior segments *ab* = 2/5 *aa* = 1/2 *bc*=*cd*. The median dorsal distance *dd* = 2/3 of the circumference.

The clitellum is swollen, smooth, without annulation, and comprises segments xiii–xvii (= 5).

The male genital field is a transverse depression on segment xviii which extends from a point outside the line *b* on one side to a corresponding point on the other, and includes the whole length of the segment. The male pores appear as pits in line with setae *b*; in front and behind the pores are curved grooves, with the concavities facing each other, so that the region of the pore has an eye-like appearance.

The female area is a transverse oval depression on segment xiv just in front of the setal zone; the actual apertures were not distinguishable.

The spermathecal apertures are one pair, in groove 7/8, in line with *b*, or between *a* and *b*.

Internal Anatomy.—Septum 4/5 is slightly thickened, 5/6—8/9 considerably, 9/10 and 10/11 moderately and 11/12 and 12/13 slightly so.

The gizzard, in segment v, is of moderate size, firm and rounded. There are calciferous glands in xi and xii, stalked, and lamellated internally. The intestine begins in xv.

The last heart is in xii. In segment xiii is a large vessel, not bulged after the manner of a heart, which runs on each side from the middle line in front in a backward, outward and downward direction.

The excretory system is micronephridial. Behind the clitellum the micronephridia are arranged on each side in a transverse row of about six, the inner two or three on each side being smaller than the rest; in the clitellar region they are considerably more numerous, about ten on each side in each segment, and in less regular rows than behind the clitellum. Towards the hinder end of the body there are about seven or eight on each side, and of these the inner three or four are smaller than the rest, except the

innermost of all; this increases in size, and forms a more compact coil than the dorsally situated nephridia of the row, though it is not so elongated in a transverse direction as these.

The testes and male funnels are free in segments x and xi. Seminal vesicles occupy segments ix and xii, those in the latter segment being large, contiguous in the middle line dorsally, and slightly bulging back septum 12/13; the pair in ix are slightly, those in xii considerably lobed.

The prostates are tubular, of moderate size, closely coiled, and cause the septa bounding segment xviii to bulge apart somewhat. The duct is much narrower than the glandular part, is bent on itself, short, slightly shining, the ectal part wider than the rest.

Ovaries and female funnels are present in segment xiii.

The spermathecae (fig. 9) are one pair only, in segment viii. The ampulla is moderately large, of an inverted pear-shape, and marked by a number of slight annulations. The duct is short, one-third to a quarter of the length of the ampulla, bulged in its upper portion, narrowed at its ectal end, with a row of four or five small seminal chambers on its inner side which take up the greater part of its length.

The penial setae are apparently two in each bundle. In length they are ·66 mm.; in form tapering, slightly bowed, the curve more marked towards the distal end, the tip slightly hooked and rounded; there is no ornamentation except a few very fine transverse markings or slight notches on the distal portion a little distance from the tip,—so slight that they might be accidental.

Remarks.—The nearest ally of the present form appears to be *M. duodecimalis*, from Parambikulam; but the presence of only one pair of spermathecae distinguishes the present species. The penial setae, and the curious row of seminal chambers sessile on the spermathecal duct, are also characteristic.

Gen. **Megascolex**, Templeton.

Megascolex mauritii (Kinb.).

Dowlaishweram, Godaveri Dist. 29·viii·1918. N. Annandale. Two specimens.

Amini, Laccadive Islands. 21·x·1920. Madras Fisheries Dept. Three specimens.

Kalpeni. Laccadive Islands, 18·xii·1920. Madras Fisheries Dept. Four specimens.

Agatti, Laccadive Islands. 3·xii·1920. Madras Fisheries Dept. Five specimens.

Kavarti, Laccadive Islands. 11·xii·1920. Madras Fisheries Dept. Three specimens.

Androth, Laccadive Islands. 23·xii·1920. Madras Fisheries Dept. Four specimens.

In addition, three specimens of which the label was lost, probably from Androth.

Megascolex konkanensis, Fedarb.

Agatti, Laccadive Islands. 3·xii·1920. Madras Fisheries Dept. A single specimen.

A single specimen, probably from Androth, Laccadive Islands (label lost.)

Gen. **Pheretima**, Kinb. em. Mich.

Pheretima hawayana (Rosa).

The Residency, Imphal, Manipur. 2·iii·1920. Four specimens.
Same place. No date. Two specimens.

Pheretima heterochaeta (Mich.).

The Residency, Imphal, Manipur. 2·iii·1920. Three specimens.
Small stream running from swamp below Kotagiri, Nilgiris; *ca.* 5700 ft. 3·iv·1919. N. Annandale and R. B. S. Sewell. A single specimen.

Gen. **Perionyx**, E. Perrier.

Perionyx sp.

Khandala, Bombay, under stones and masses of weed at bottom of wet rocks near waterfall. July, 1919. R. B. S. Sewell. Several specimens, immature.

Perionyx excavatus, E. Perrier.

Langol Hills near Lamphal Pat (Lake), close to Bishenpur, Manipur, Assam; 2600 ft. 1·iii·1920. Two specimens.
The Residency, Imphal, Manipur. 2·iii·1920. Numerous specimens.
Same place. No date. Numerous specimens.
Paddy fields, Potsengbham, N. of Loktak, Manipur. No date. Manipur Survey Party. Numerous specimens.
Swamps round about Thanga Island in Loktak Lake, Manipur. 21·ii·1920. Very numerous specimens.

Perionyx saltans, A. G. Bourne.

Small rocky stream below Kotagiri, Nilgiris; *ca.* 5700 ft. 4·iv·1919. N. Annandale and R. B. S. Sewell. Two specimens, immature.

In 1886 Bourne (2) gave a description of a small *Perionyx* from Ootacamund and Naduvatam in the Nilgiris, in which, as in *P. sansibaricus* subsequently described by Michaelsen (4), the nephridiopores alternated in position in successive segments. Though the resemblance between the two is considerable, Michaelsen refrained from uniting his specimens with Bourne's species, since *P. saltans* has two spermathecal diverticula while *P. sansibaricus* has only one.

Though the present specimens are immature, in one there are signs of the male pores. This was accordingly opened, and three of the spermathecae, still very small, examined microscopically; of these two showed two diverticula each, the third a single one, which was however bilobed. It appears therefore that the specimens belong to *P. saltans*; the species had not previously been found since Bourne's original discovery.

The specimens being immature scarcely allow of an extension of Bourne's description. The more advanced of the two was 31 mm. long, and comprised 66 segments, but the hinder end was regenerating; it was 2 mm. in diameter. The other had a length

of 40 mm., a diameter of 1·75 mm., and 108 segments. Bourne's data are rather unusual,—length 60 mm., segments 61; it is uncommon, in a small worm such as this, to find the segments on an average 1 mm. long; his specimens must have been unusually relaxed. The prostomium is epilobous 2/3. The dorsal pores begin in one specimen in groove 3/4, in the other in 4/5.

The numbers of the setae correspond to Bourne's figures. I found 50 in an anterior segment, and 46 and 47 in the middle of the body; the ring is closed ventrally, and almost so dorsally ($zz = 2yz$).

It is not always the case, as Bourne says, that a segment which has the outer (dorsal) position of the nephridiopore on one side has the inner (ventral) on the other; the alternation of the position in successive segments is not strict, and hence the above statement of Bourne's sometimes holds and sometimes does not; the rule however is as given by Bourne. The nephridia end in considerable end-sacs, as in *P. sansibaricus*.

The male pores, as noted by Bourne, are situated in a median depression; this has sloping sides, and takes up the whole length of segment xviii.

Perionyx sansibaricus, Mich.

Small jungle streamlet, Bandy Shola, near Coonoor, Nilgiris; *ca.* 5500 ft. 8·iv·1919. N. Annandale and R. B. S. Sewell. Eight specimens.

Small jungle stream, Longwood Shola, near Kotagiri, Nilgiris. 4·iv·1919. N. Annandale and R .B. S. Sewell. Three specimens.

I append a few notes which serve to amplify previous descriptions.

The dorsal pores in a number of specimens examined begin as far forwards as groove 2/3; in one the pores appeared rudimentary in 2/3 and 3/4, and were well marked behind this.

The small male field varies in appearance; it is always depressed, but the depression may be rectangular, oval, or nearly circular, the bottom flat or marked by a transverse groove at the ends of which the pores probably lie; the sides may be steep or gradually sloping. I did not in these specimens observe, as I did in a previous batch (15), that the setal ring was continued across the ventral surface immediately behind the male pores.

The clitellum, not well marked, extended over segments xiv—xvi (=3).

No septa are noticeably thickened. The gizzard, in vi, is extremely rudimentary. I found no calciferous gland-like swelling of the oesophagus in segment xii. The last heart is in segment xii. The position of the alternating nephridiopores is about 2/5 of the half-circumference from the midventral and 1/5 of the half-circumference from the mid-dorsal line.

The spermathecal diverticulum consists of three or four closely aggregated seminal chambers.

There are no penial setae.

Perionyx mysorensis, sp. nov.

(Pl. XXVIII, fig. 10).

Forests of Shemoga and Kadur Dists., Mysore, S. India. May, 1920. A. Subba Rau. A single specimen, incomplete behind, not fully mature, in poor condition.

I at first decided against describing the present species; but the various parts of the sexual apparatus are present (except the clitellum) though small, and the penial setae, in conjunction with the other characters, will allow of the species being recognized when it is met with again.

External Characters.—Length 38 mm. (incomplete posteriorly). Diameter 2 mm. Segments present 90. Colour light brownish purple dorsally, pale ventrally.

Prostomium rather broad, prolobous or slightly epilobous.

Dorsal pores present.

Setae in rings, closed dorsally and ventrally. In segment xix they were about 54 in number, in the middle of the body about 62.

The clitellum was not distinguishable.

The male pores, in segment xviii, are situated close to the middle line, each in a small depression, the depressions themselves lying on a transverse ridge across the middle of the segment. This ridge is not elevated above the general surface, and comes into existence through the presence of two depressions, which have the form of short transverse trenches and occupy the anterior and posterior fourths of segment xviii, in front of and behind the pores; the trenches are continuous with the intersegmental fissures (17/18 and 18/19), and in transverse extent are about equal to the antero-posterior length of the segment.

The female apertures were not seen.

The spermathecal pores are small, in grooves 7/8 and 8/9, near the middle line.

Internal Anatomy.—Septa 6/7–9/10 are somewhat thickened, and also 12/13–15/16.

The gizzard,—hardly to be called a gizzard,—is quite vestigial, in segment vi. There are lateral swellings of the oesophagus in xiii, and to some degree in xiv, but they cannot be called calciferous glands.

The last heart is in segment xii.

Testes and funnels are free in segments x and xi. Seminal vesicles occupy segments xi and xii; they are moderately large, but do not meet dorsally in the middle line.

The prostates are small, and confined to segment xviii; each is a squarish mass, cut into deep lobes. The duct is short, straight, moderately stout relatively to the size of the gland, of the same diameter throughout, and passes transversely inwards.

Ovaries and funnels are present in segment xiii.

The spermathecae are two pairs, small and perhaps not fully developed; they are spherical, sessile on the body-wall, to which

they are attached by a rather broad base; there is no hint of a diverticulum.

The penial setae (fig. 10) are ·44 mm. long and 8μ thick at the middle, slightly bowed, the curvature being more marked at the proximal end; the tip is tapering and fairly sharply pointed. The ornamentation consists of a few transverse markings irregularly distributed and each composed of a row of extremely fine teeth.

Subfam. *OCTOCHAETINAE.*

Genus **Octochaetus**, Bedd.

Octochaetus barkudensis, Steph.

Barkuda Island Chilka Lake, Ganjam Dist., Madras Pres. Aug., 1919. F. H. Gravely. A single specimen.

On old brick-field in the same locality. 10·x·1920. N. Annandale. Three specimens.

The variations in the arrangement of the micronephridia in this and allied genera are of some interest. In the present species the nephridia in the anterior part of the body are small and scattered, not arranged in a single row per segment. Towards the hinder end they are arranged in two fairly definite rows in each segment, one behind the anterior and one in front of the posterior septum; there is no constant difference in size between the nephridia of different parts of the row.

The gizzard in these specimens is an obliquely placed muscular ring, which leaves the posterior part of the ovoid oesophageal swelling quite soft above, and similarly the anterior part of the dilatation is quite soft below.

Gen. **Eutyphoeus**, Mich.

Eutyphoeus manipurensis, sp. nov.

(Pl. XXVIII, fig. 11).

Swamps round about Thanga Island in Loktak Lake, Manipur. 21·ii·1920. Three specimens.

External Characters.—Length 120 mm. Diameter 5 mm. Segments 162; segment iv is biannular dorsally, v and vi biannular, vii triannular but with four annuli dorsally: subsequent segments as far as the clitellum are multiannular, the number of annuli varying, but as a rule three chief annuli can be distinguished; behind the clitellum the segments are triannular. Colour dark grey throughout, rather lighter ventrally.

Prostomium tanylobous, with a slightly marked transverse furrow behind the prostomial lobe, and another similar one half way along segment i. Segment i. is fissured radially round its anterior border.

The dorsal pores begin in groove 10/11.

The setae are paired. In the middle of the body ab=2/5 aa =1/2 bc=2/3 cd (or sometimes =1/2 cd, *i.e.* the lateral setae are

then not paired); behind the clitellum *ab*=2/5 *aa*=2/5 *bc*=4/7 *cd*; in front of the clitellum *ab*=1/2 *aa*=1/2 *bc*=3/5 *cd*; *dd*=4/7 of the circumference.

The clitellum includes 2/3 of xiii–2/3 xvii (=4 1/3).

The male pores are on xvii, on prominent round papillae which take up the interval between the lines *a* and *b*; round each papilla is a deep trench, the outer margin of which is slightly swollen and indented. The ventral surface of segment xvi is much depressed and fissured; genital markings were present as follows:—In one specimen there were none, beyond the irregular fissuring. In a second there were a pair of eye-like markings, each an oval rather depressed area with raised margin, behind the setal zone and corresponding to the interval *ab*, and in addition a similar but circular marking midventrally and in front of the setal zone. In the third specimen the paired markings were present as above; and in addition a transverse row of four circular markings, touching each other, across the ventral surface in the setal zone.

The female pores were not made out.

The spermathecal pores are one pair, in groove 7/8, slit-like, with their centre in *ab*, rather nearer to *a* than to *b*. The middle annulus of segment viii may be raised and "glandular," and small papillae occur variously in this region; in one specimen there was a small papilla just behind the spermathecal aperture of the right side, and another in the midventral line on the glandular swelling of segment viii; in another specimen there was a small papilla midventrally on segment ix; in the third there were no papillae.

Internal Anatomy.—Septum 4/5 is slightly, 5/6 much thickened; the next septum is 8/9, which is somewhat strengthened; 9/10 is considerably thickened, and 10/11 very stout; septum 11/12 is present, though thin (unlike most species of the genus, in which it is absent), and the rest are thin. Septum 8/9 is attached to the parietes a little in front of groove 9/10; septa 9/10 and 10/11 are confluent at their insertion into the body-wall, which is situated in the middle of segment x as determined externally,—*i.e.* midway between furrows 9/10 and 10/11; septum 11/12 is normally situated.

The gizzard occupies the middle of the interval between septa 5/6 and 8/9; it is large, round and firm; and the oesophagus in front of the gizzard, between the gizzard and septum 5/6, is also strengthened. There are large dark lateral swellings of the alimentary tube in segment xii, but they are not set off from the side of the canal. The intestine begins in xv.

The last heart is in segment xiii; that of segment xi is normally situated with reference to septum 11/12,—on its anterior face. There are two transverse vessels in front of septum 8/9 and behind the gizzard (belonging to segments viii and vii), one at the anterior border of the gizzard (segment vi), one in front of septum 5/6 (segment v), but none in front of septum 4/5. The dorsal vessel is continued forwards on to the pharynx much diminished in size

The micronephridia are somewhat sparsely scattered. Behind the clitellum they form a single transverse row in each segment, which consists on each side of a number set pretty close together ventrally, with four more dorsally placed at considerable intervals.

Testes were not identified; there are two pairs of funnels apparently free, in segments x and xi. Seminal vesicles of moderate size, lobed, are present in segment ix, and also in xii or xii—xiii, much lobed and larger than the anterior pair.

The tubular prostates form a close coil occupying segments xvii—xix or xx. The duct is also much coiled, of moderate length, narrower than the glandular part, of the same diameter throughout, and only slightly shining.

The female organs have the usual situation.

The spermathecae are one pair, in the anterior part of the interval between septa 5/6 and 8/9. Each is an ovoid sac, sessile on the parietes by a considerable portion of its under surface. There is a single diverticulum on the outer, or posterior and outer, side, of some size, also practically without stalk, slightly lobulated, one-third as broad and half as high as the ampulla.

The penial setae (fig. 11) are 1·5 mm. long and 47μ thick at the middle, with straight shaft and slightly curved tip tapering to a blunt point. The ornamentation consists of a number of fine triangular teeth on the curved tip.

Remarks.—The present species comes near *E. mohammedi*, from which however it is distinguished by the genital marking and the character of the spermathecal diverticulum.

Gen. **Eudichogaster** Mich.

Eudichogaster barkudensis, sp. nov.

(Pl. XXVIII, figs. 12, 13).

Barkuda Island, Chilka Lake, Ganjam Dist., Madras Pres. Aug. 1919. F. H. Gravely. Several specimens.

External Character.—Length 57 mm. Diameter max. 1·75 mm. Segments 130; first segment very short. Colour pale, unpigmented, appearing grey from intestinal contents showing through.

Prostomium proepilobous.

Dorsal pores begin from furrow 11/12.

The setae are paired. The ratios are nearly the same through out the body; in the middle of the body $ab=1/2aa$ or nearly so$=2/3bc=3/4cd$; further back bc and cd may be almost equal; behind the clitellum $ab=2/5aa=1/2$–$4/7bc$; dd=half the circumference in the middle of the body and behind, and 4/7 the circumference in the anterior part of the body.

The clitellum extends over xiii–$\frac{1}{2}$xvii ($=4\frac{1}{2}$); it is yellowish brown in colour, and constricted.

The prostatic pores are one pair, on segment xvii, situated on round papillae which take up the interval between the lines *a* and *b*; they are slit-like, and obliquely placed, diverging from each other backwards.

The female apertures are minute pores in a circular white patch on the anterior part of segment xiv.

The spermathecal apertures are represented by a pair of very minute white points on segment viii, just in front of setae *a*.

Internal Anatomy.—Septum 4/5 is thin, 5/6 extremely tenuous. 6/7 and 7/8 also very thin; 8/9 is thin, 9/10 and 10/11 slightly strengthened; 11/12, 12/13 and 13/14 are thin, but slightly strengthened by comparison with those that follow (the specimen was in a poor state of preservation, and possibly the septa are normally somewhat thicker than the above description would lead one to suppose).

There are two gizzards, in v and vi, of comparatively large size, firm and rounded. Calciferous glands are present in segments x, xi and xii, not stalked, and diminishing in size backwards. The intestine begins in segment xv.

The last heart is in segment xii.

The excretory system is micronephridial. The organs are of relatively moderate size; in front of and in the clitellar region they are scattered; behind the clitellar region they form a transverse row of four (three to five) on each side in each segment, those towards the ventral end of the row being smaller and closer set. About 27 segments from the hinder end the innermost nephridium of each row enlarges and the arrangement comes to be as follows:—one nephridium, a long thin loop, between seta *d* and the middorsal line; one small, lying in line *c*; and one, the largest and thickest extending from *a* outwards to between *b* and *c*; the series thus consists of three on each side.

There is a pair of large and conspicuous male funnels in segment x, and a smaller pair in xi. On the other hand testes were identified in xi, but not in x. No seminal vesicles were present.

The prostates are one pair, in xvii, small, tubular, and placed transversely in the segment. The duct, also transversely placed, is thin, and in length equal to the glandular portion.

The female organs have the usual situation.

The spermathecae (fig. 12) are one pair, situated in segment vii; they open externally as described above, on segment viii, septum 7/8 being rather obliquely placed. Each is a narrow elongated somewhat cylindrical tube, ·66 mm. long, slightly curved, and rather wider in its ectal portion; a short terminal section which narrows to its insertion into the body-wall, may be described as the duct. A small sac-like diverticulum is given off from the junction of ampulla and duct.

The penial setae (fig. 13) are ·53 mm. long, and very slender, 2·5μ in thickness; they are bowed towards the distal end, where the shaft is twisted and somewhat sinuous in outline; the tip however is straight, and ends in a small rounded flat expansion which al-

most appears bifid, owing to the thinness of the expansion between its thicker margins.

No copulatory setae were discovered in the spermathecal region.

Fam. LUMBRICIDAE.

Subfam. *MICROCHAETINAE.*

Gen. **Glyphidrilus,** Horst.

Glyphidrilus annandalei, Mich.

Forest of Shemoga and Kadur Dists., Mysore, S. India. May, 1920. A. Subba Rau. A number of specimens.

Most of the present specimens appear to have undergone autotomy a little distance behind the genital region, or in some cases further back, near the hinder end. Two specimens in which the characteristic ridges and papillae were only just beginning to appear had not broken; possibly the worms are more liable to fragmentation at the time of sexual maturity.

The clitellum begins in these specimens in xvii or even xvi, and ends indistinctly about xxxv or xxxvi. The "wings" begin in xxv (*i.e.* rather in front of the usual place); but they are not in any of the specimens continued further forwards as lower ridges.

The midventral series of papillae are almost constant in position, on segments xiii–xxi (once xii–xxi); they regularly diminish in size posteriorly. The anterior lateral series also begin constantly on xiii, and show in every case a peculiar arrangement, not noted in any previous account of the species; the first papillae of the series are situated between the lines *b* and *c*, succeeding ones rapidly become more dorsal, so that the fourth and fifth, on segments xvi and xvii, are between *c* and *d*; the series then returns even more rapidly to its original alignment, so that the seventh papilla, on segment xix, is again between *b* and *c*. This anterior lateral series ends on segment xxiv; there is another short series, as usual, behind the "wings."

In contrast to previous data for the species, the whole papillar arrangement is very constant, and peculiar in the respect noted above; but it does not seem worth while establishing a variety for the present specimens.

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EXPLANATION OF PLATE XXVIII.

FIG. 1.—*Nais paraguayensis* var. *barkudensis*; distal end of dorsal needle seta; × 800.

,, 2.—*Aulodrilus remex*; hinder end, showing zone of proliferation some distance in front of anus; × *ca.* 70.

,, 3.—The same; dorsal hair seta; × 230.

,, 4.—The same; *a*, usual form, and *b*, exceptional form of distal end of oar-shaped setae of dorsal bundles; × *ca* 1150.

,, 5.—The same; tip of ventral seta; × *ca.* 1200.

,, 6.—The same; tip of an exceptional form of ventral seta; × *ca* 1200.

,, 7.—*Drawida rauti*; genital field; × 18. ♂, male pore.

,, 8.—*Plutellus aquatilis*; spermatheca.

,, 9.—*Megascolides annandalei*; spermatheca.

,, 10.—*Perionyx mysorensis*; penial seta; *a*, general form, × 130; *b*, distal end, more highly magnified; × *ca.* 400.

,, 11.—*Eutyphoeus manipurensis*; distal end of penial seta; × *ca.* 150.

,, 12.—*Eudichogaster barkudensis*; spermatheca.

,, 13.—The same; penial seta; *a*, general form, × 125; *b*, distal end more highly magnified, × 500.

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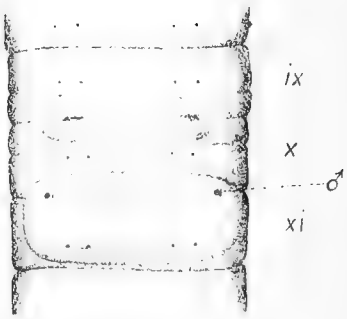

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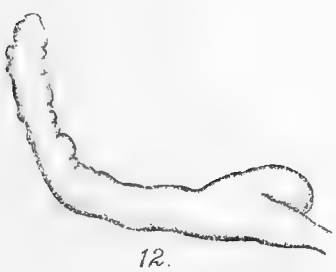

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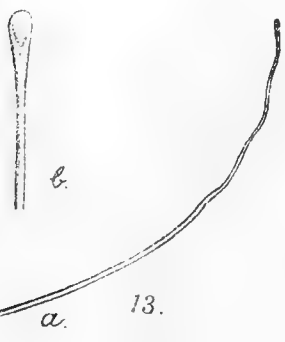

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J. Stephenson del. A. Chowdhary lith.

NEW INDIAN OLIGOCHAETES.

LIST OF LITERATURE REFERRING TO INDIAN ZOOLOGY (EXCLUDING INSECTA) RECEIVED IN CALCUTTA DURING THE YEAR 1921.

Compiled by BAINI PRASHAD, *D.Sc., and* SUNDER LAL HORA, *M.Sc., Assistant Superintendents, Zoological Survey of India.*

[It has been decided that the lists of scientific literature hitherto published in the Reports of the Board of Scientific Advice shall in future be issued separately by the Departments represented on the Board.

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