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 $\frac{1}{3}$ 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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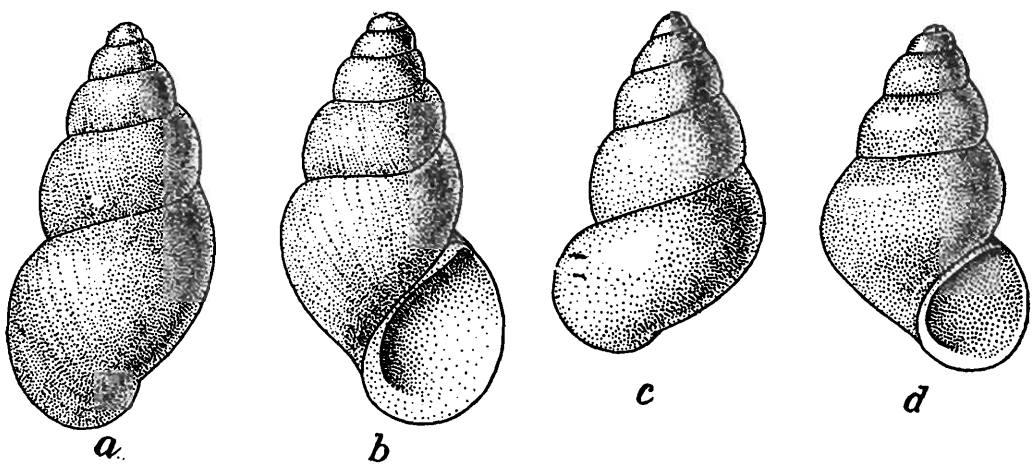
[1] Prashad, *Rec. Ind. Mus.*, XVIII, pp. 221, 222 (1921).
[2] Annandale and Prashad, *Rec. Ind. Mus.*, XXII, p. 3 (1921).
[3] Annandale, *Ind. Journ. Med. Research*, VIII, p. 103 (1920).
[4] Nevill *Hand List Moll. Ind. Mus.*, II, p. 64 (1885).

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 5½–6 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 2½ 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.

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[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

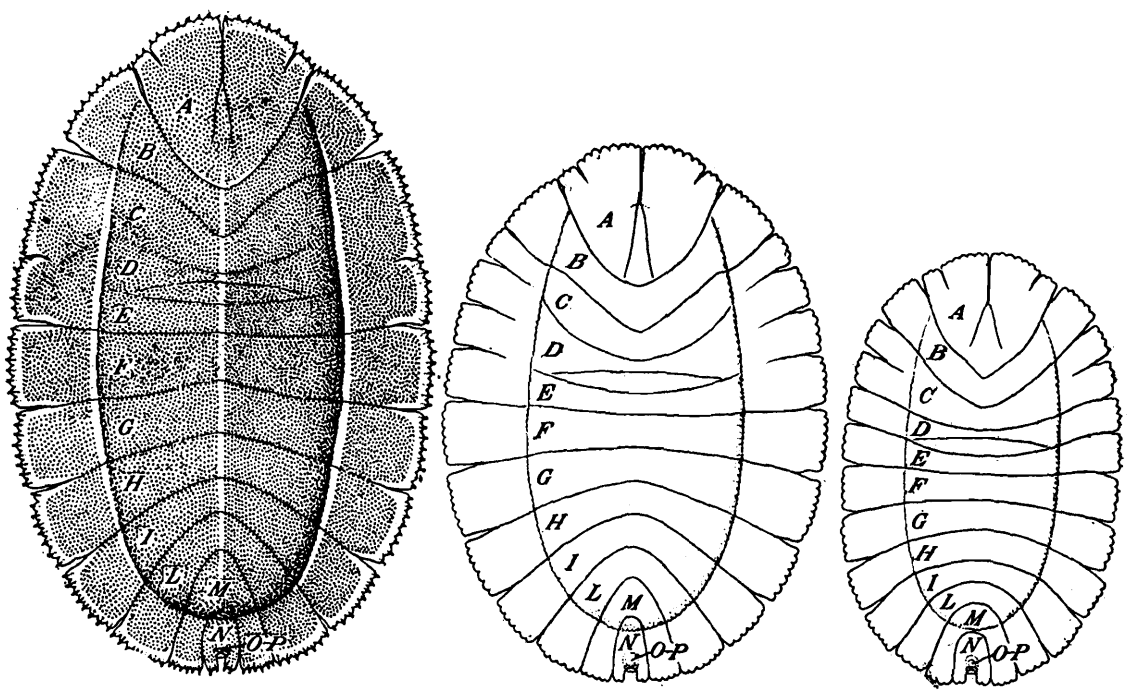


FIG. I.—*Termitaphis annandalei*: 1. femina adulta; 2. larva ultimae aetatis; 3. larva (?) secundae aetatis.

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

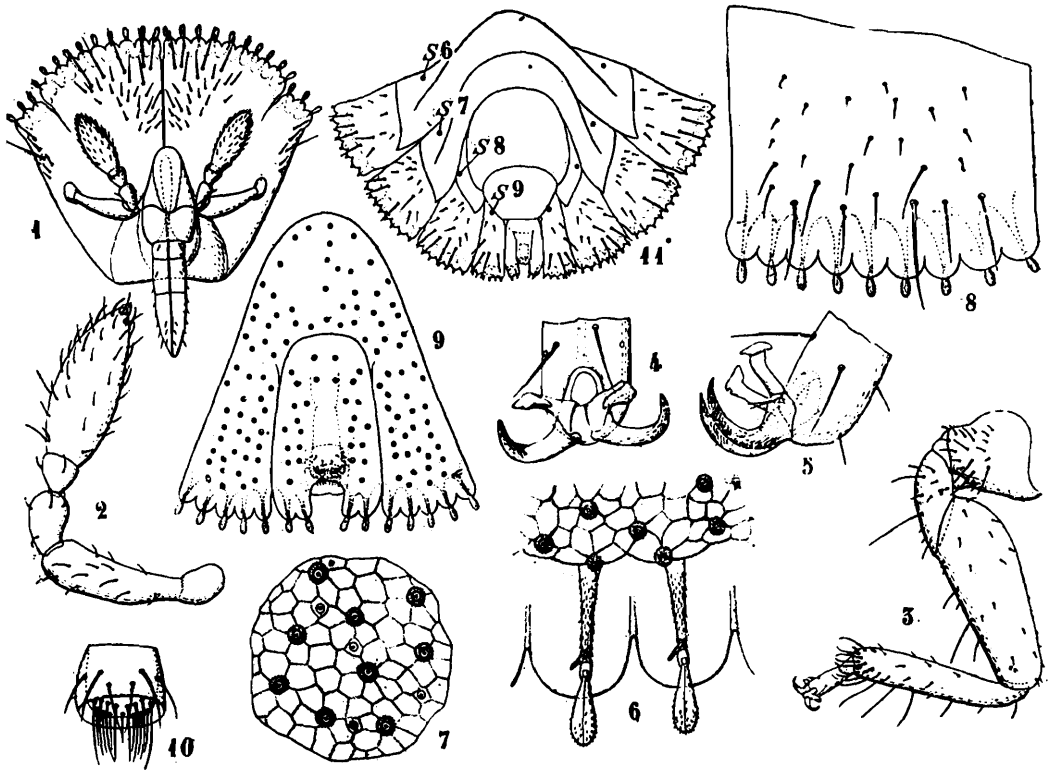


FIG. II.—*Termitaphis annandalei*: 1 caput pronum; 2. antenna; 3. pes paris tertii; 4. tarsi apex et praetarsus subtus inspecti; 5. idem lateraliter inspecti; 6. corporis particula marginalis cum lobulis duobus supra inspecta; 7. corporis superficiei particula submediana; 8. carina abdominis segmenti 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.

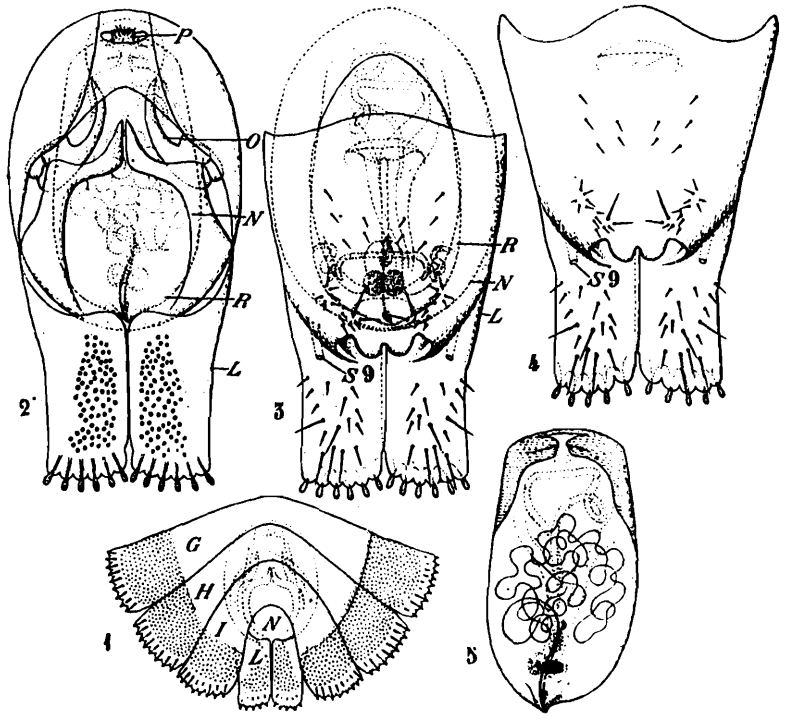


FIG. III.—*Termitaphis annandalei*, mas: 1. abdominis segmenta 4-10 supina; 2. abdominis segmenta 7-10 prona; 3. eadem supina; 4. segmentum septimum separatum; 5. penis. G-P abdominis segmenta 4-10, R penis, S stigma segmenti septimi abdominalis.

et decimum (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 absense 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 $\frac{8-17}{8\ \ 9}\Big|\frac{16-7}{11\ \ 10}$ 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.

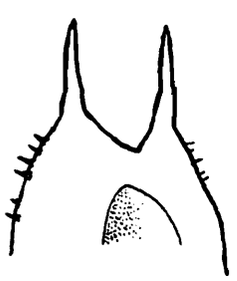
1 ♀ Cherrapunji, Assam. 4066/H2.

Wings relatively short and broad, with open venation. Pterostigma very short, well braced. Nodal indicator $\frac{9—19}{13—15} \mid \frac{19—12}{16—13}$. 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 posses-'sion 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, prob-"ably 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.

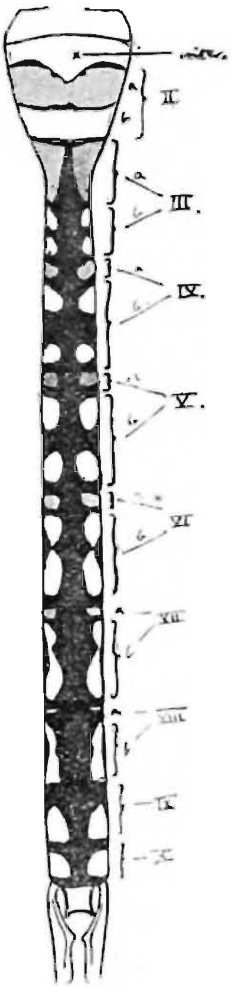
In some species of *Anax*, for example in *A parthenope*, this development of the inter-segmental membrane is much less, but the character probably occurs to some extent in all, and is possibly of generic value.

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).

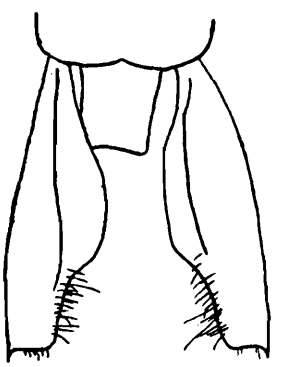
Wings smoky especially at the apices. Membranule entirely gray black. No yellow tinge on hinder wings.

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-

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[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.

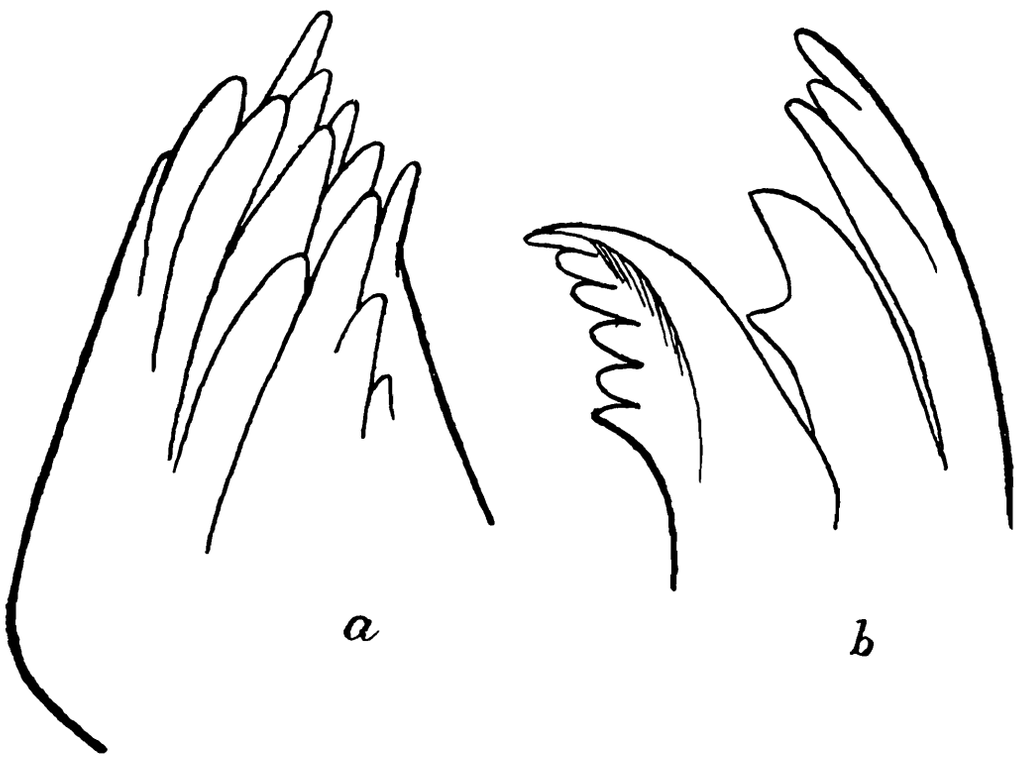
Total length 20.2 mm., *length of abdomen* 11·5 mm., *breadth of head across eyes* 5·3 mm.; *greatest breadth of abdomen at seventh segment* 5·4 mm.

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

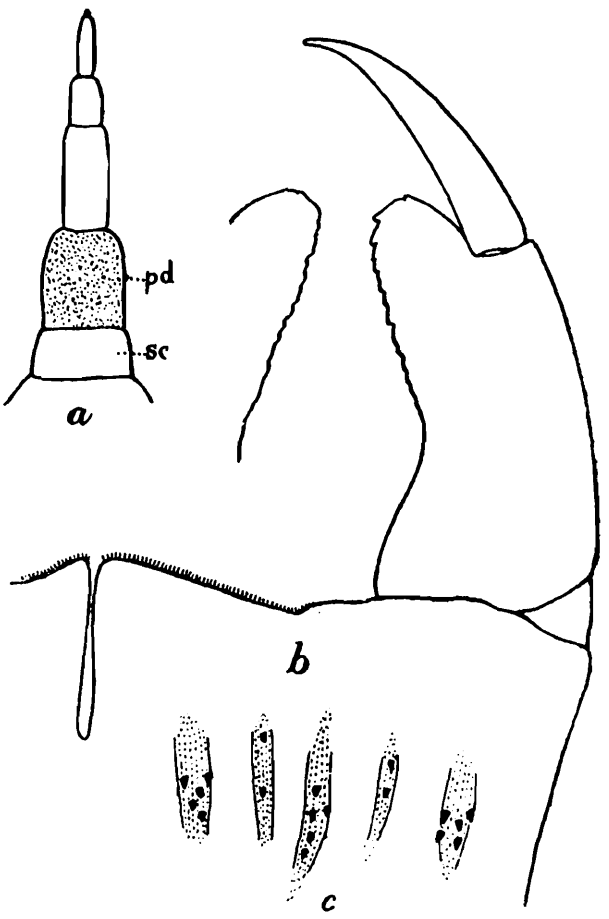


TEXT-FIG. 1.

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.

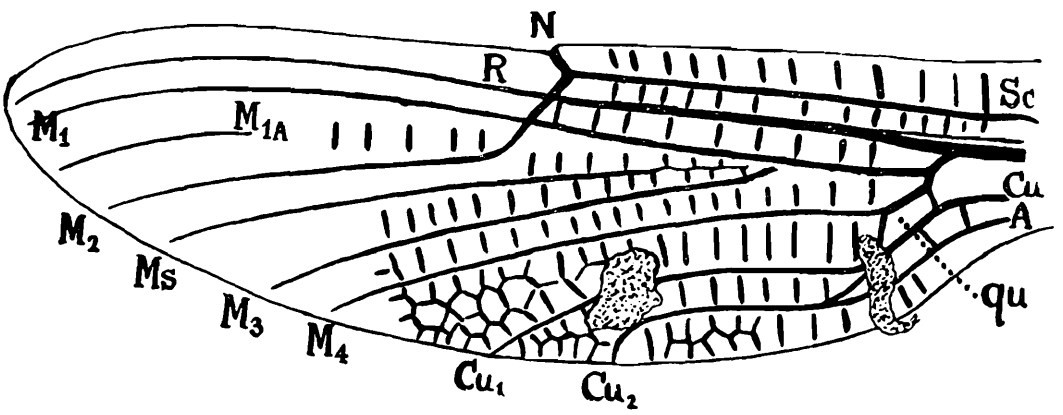
Wing-sheaths laid parallel along the middle line, those of the hindwing projecting backwards to about the middle of the second abdominal segment. This probably indicates that the larva was in the penultimate instar. The sheaths are hairless, but with some patches of dirt adhering to them; the sheath 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_2 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_{1A}, 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.

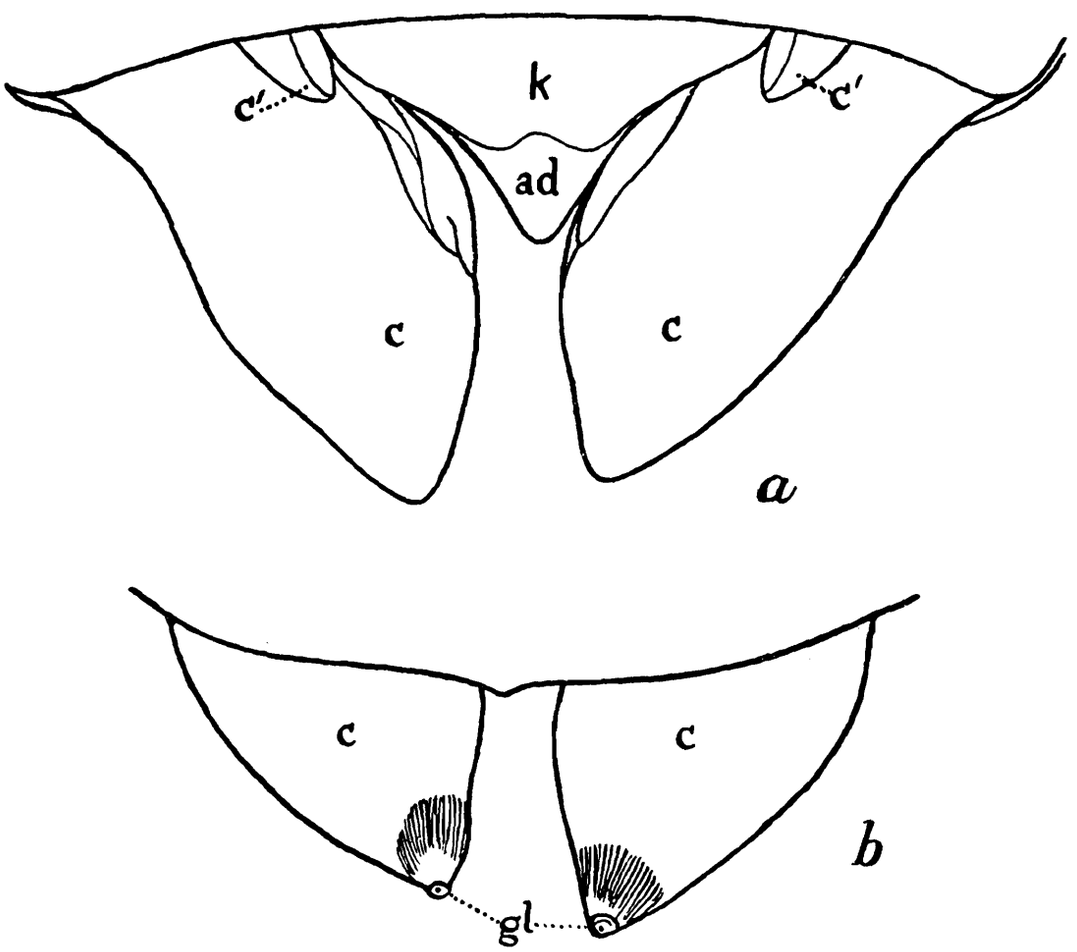
Anal Appendages:—Caudal gills are not present. The appendages may be said to be generally similar to those of the Anisoptera, but possess at least one feature not before noted in any type of anal appendage within the Odonata (text-fig. 4).

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.

Anal 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:—

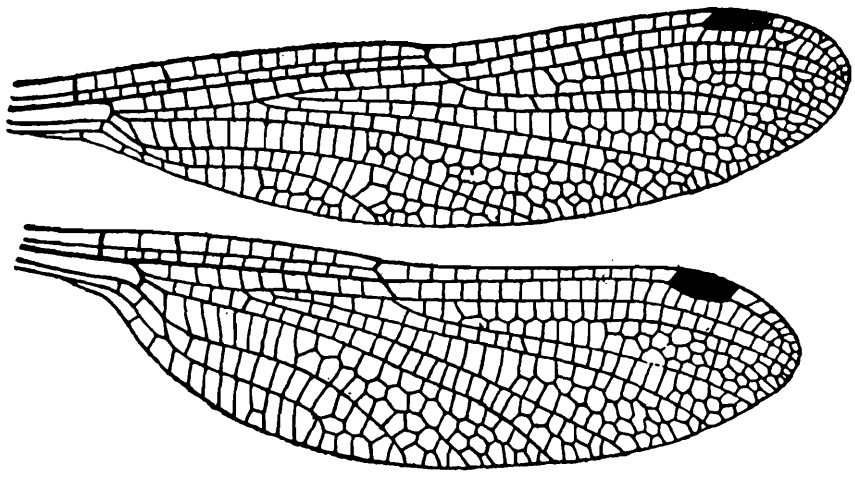
Anisopterous Characters.	*Zygopterous Characters.*
General build and facies of the larva.	Wing-venation.
Labial mask.	Gizzard.
Anal appendages.	

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_{1A}; 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.

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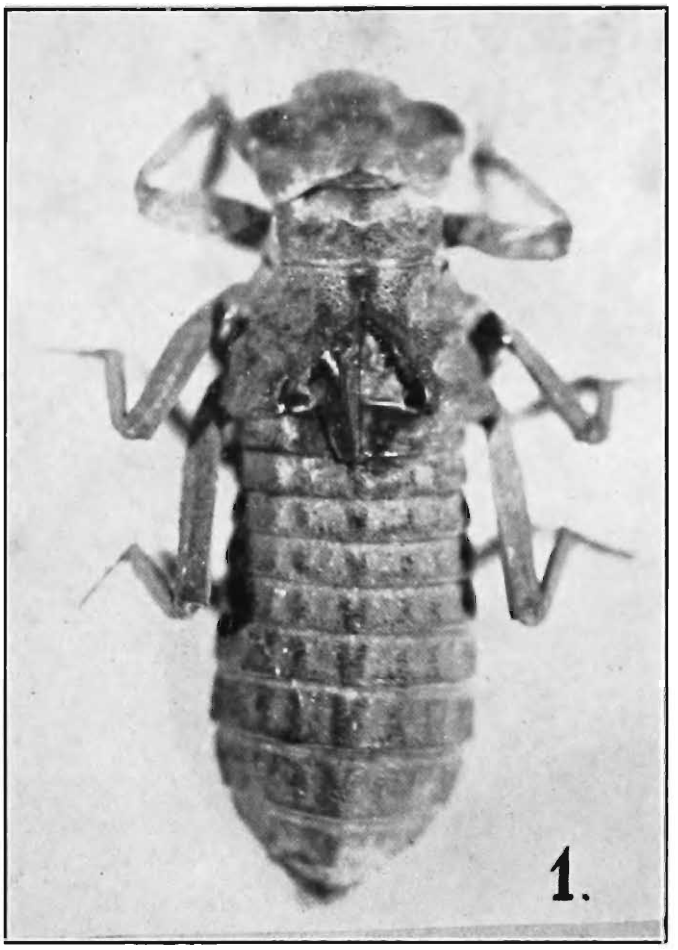
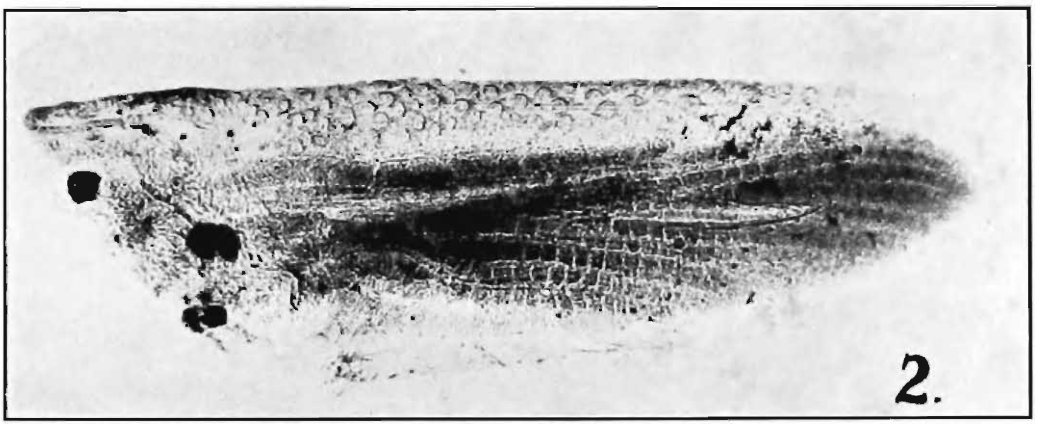
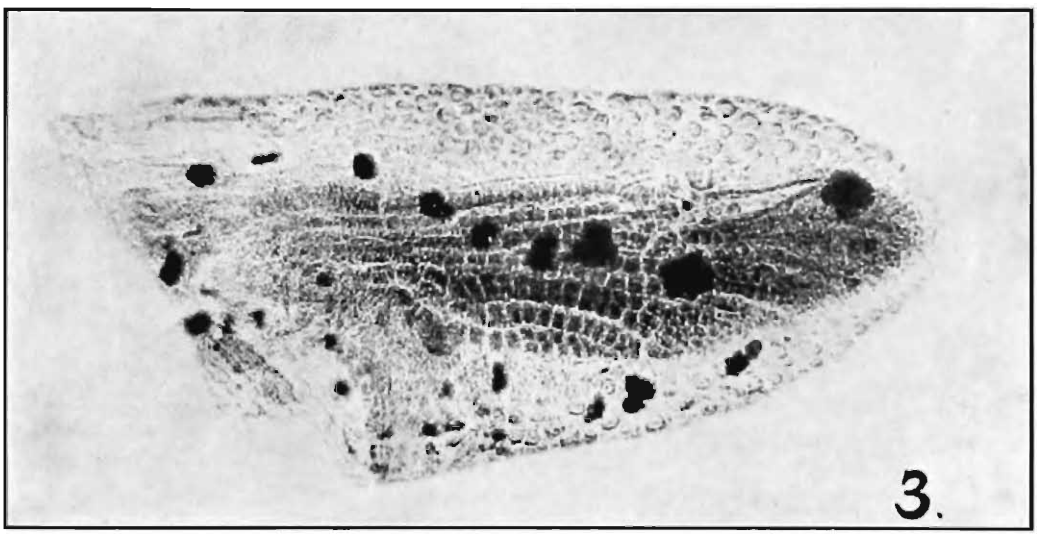
[1] *Amer. Journ. Sci.* (4) XX, pp. 249-258 1906.

EXPLANATION OF PLATE XIII.

FIG. 1.—Larva of *Epiophlebia laidlawi* n. sp. (× 4½).
„ 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-

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[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*

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[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 1½ 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.

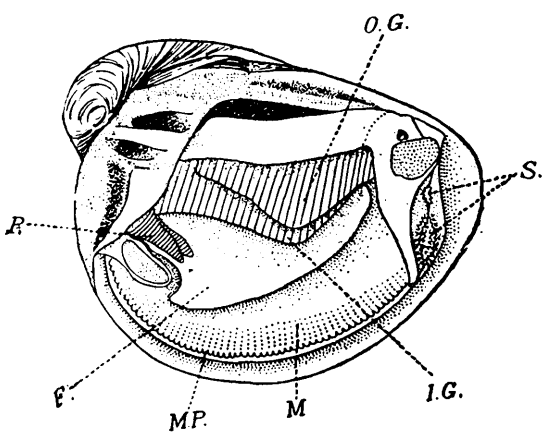
Shell fairly large, somewhat trigonal, cordate, very oblique; swollen in the umbonal and middle regions of the shell, greatly compressed below, umbones lying near the anterior margin being recurved anteriorly and somewhat inwards, hollow, separated from the hinge and one another by a narrow chink only, 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).

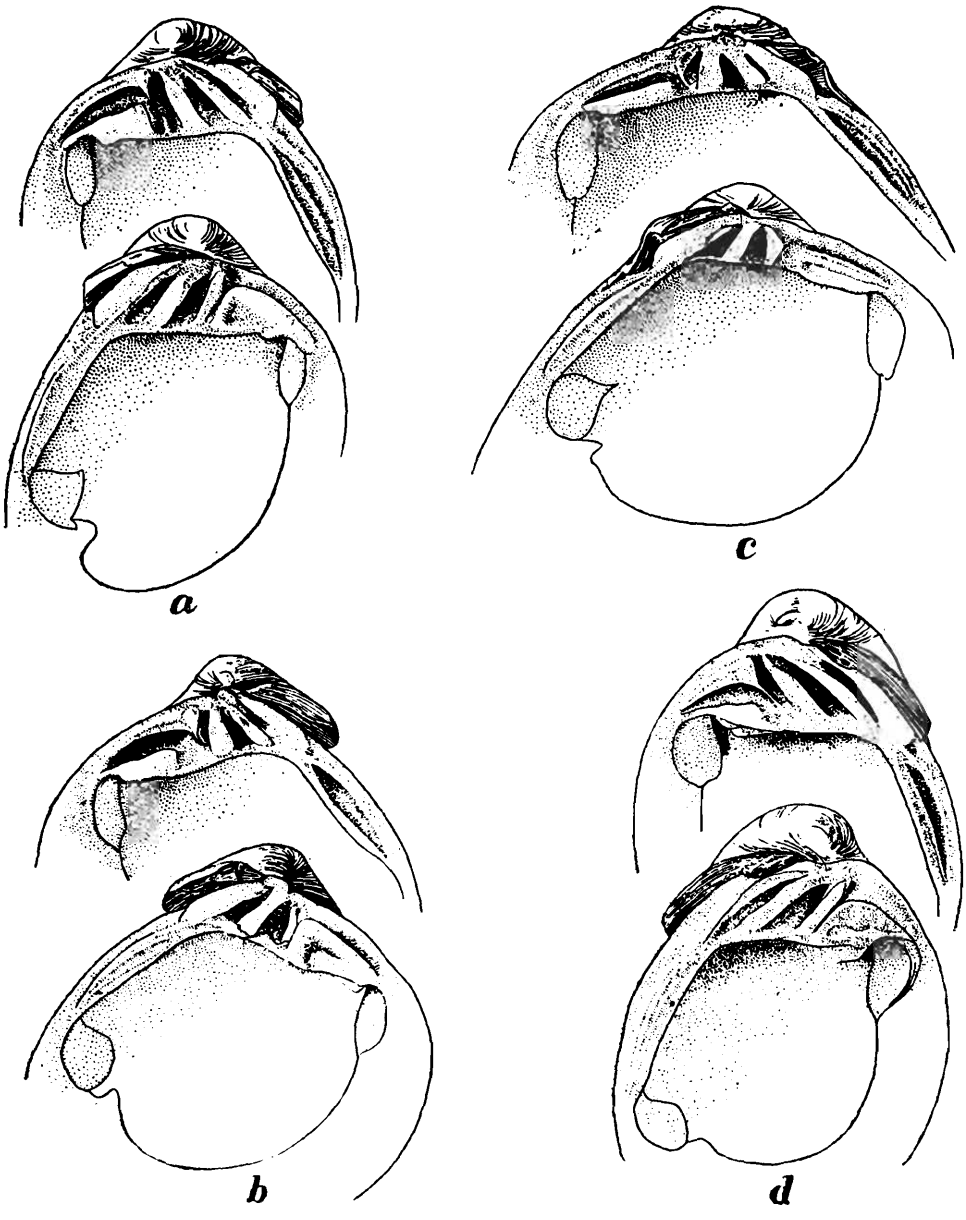
Plate XV, figs. 5—8.

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. 6c.
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)

12

10

14

11

9

13

4

3

6

8

2

5

7

1

S. C. Mondul, photo.

VILLORITA.

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

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]

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[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 :—

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[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 ($4\frac{1}{3} \times 3$ 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.

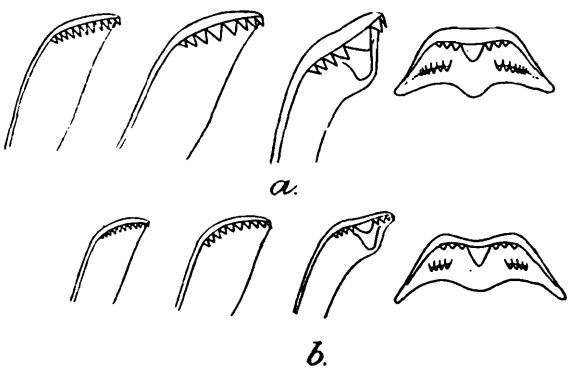
The shell in this species is relatively large, conoidal-ovate in form, and of a brownish colour. The apex is acutely pointed, and the shell has $5\frac{1}{2}$ whorls. The suture is moderately impressed, somewhat oblique but irregular. The whorls of the spire are distinctly keeled in the middle and a 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).



TEXT-FIG. 1.—Radular teeth of *Stenothyra*, Benson.

(*a*) *S.* (*S.*) *ornata*, sp nov. × 250.
(*b*) *S.* (*A.*) *miliacea* (Nevill) × 500.

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.

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. 346.

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.

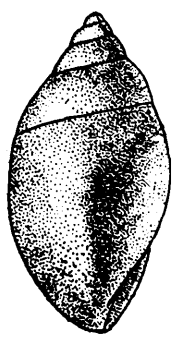
The species belongs to the group of *S. deltae*, but differs in its very small size, in having a very short spire with a rounded apex and relatively larger aperture.

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.*

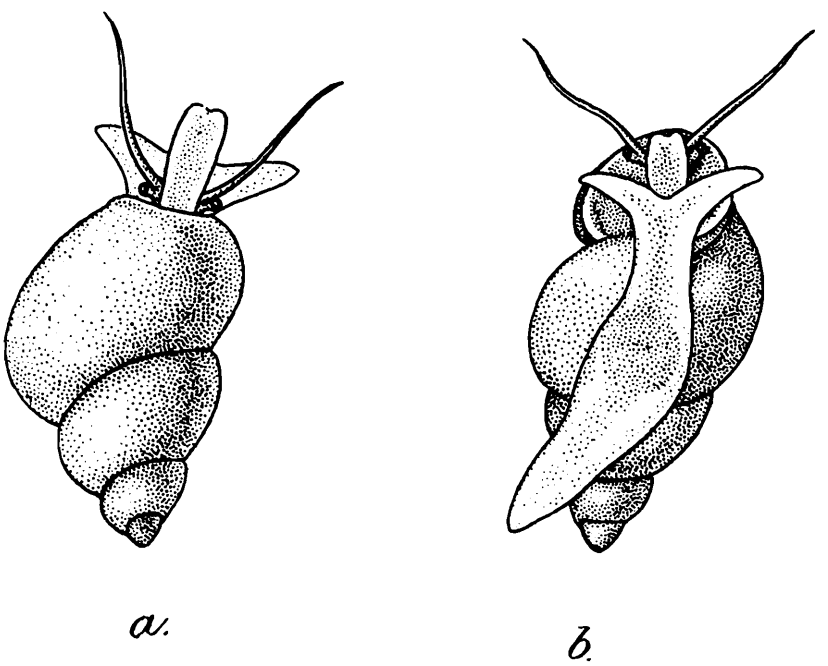
[1] Adams, *Proc. Zool Soc. London*, p. 226 (1851).

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. 346.
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.

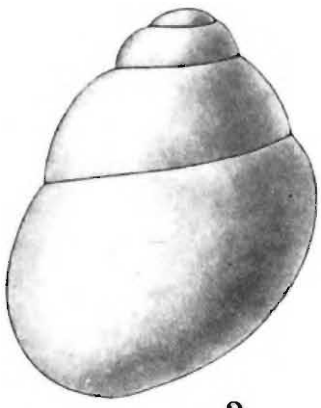
FIG. 7.—Dorsal view of the type-shell.
,, 8.—Ventral view of the same.

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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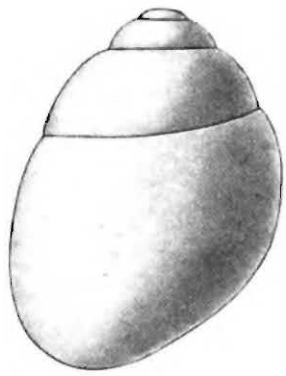

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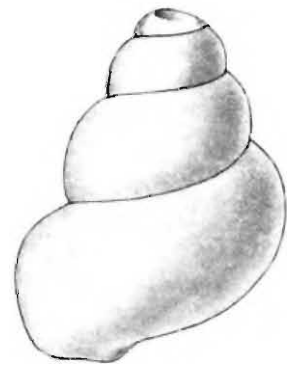

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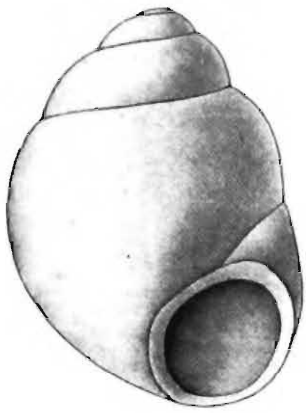

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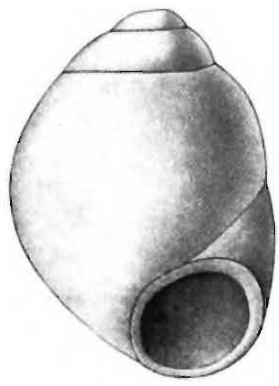

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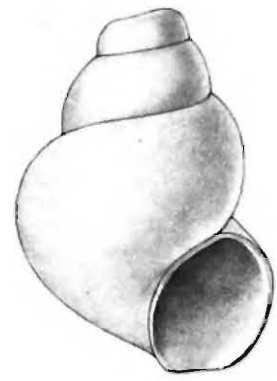

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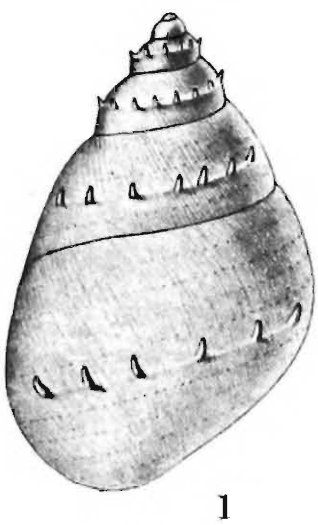

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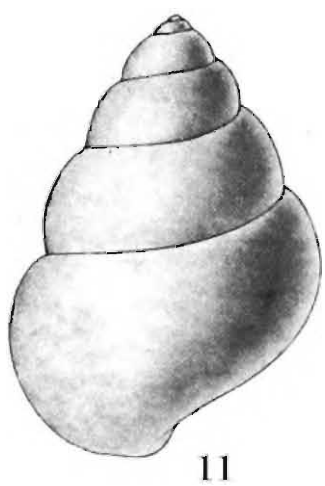

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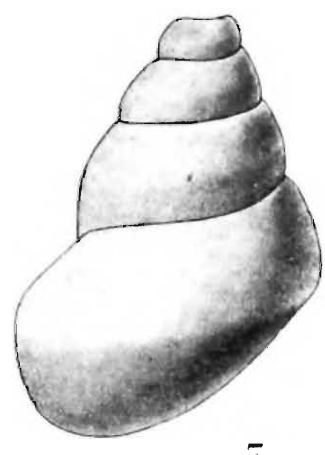

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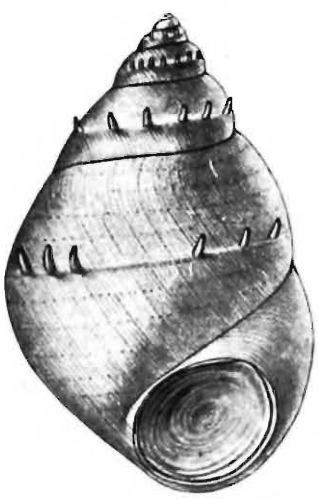

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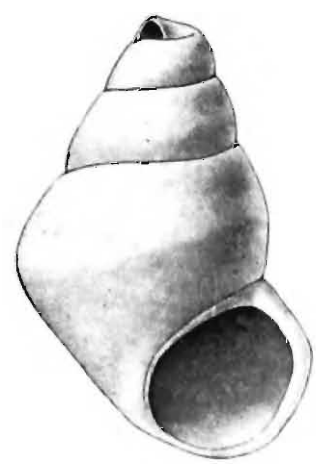

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S. C. Mondul, and D. Bacchi, del.

STENOTHYRA.

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

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

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[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. 144.
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.

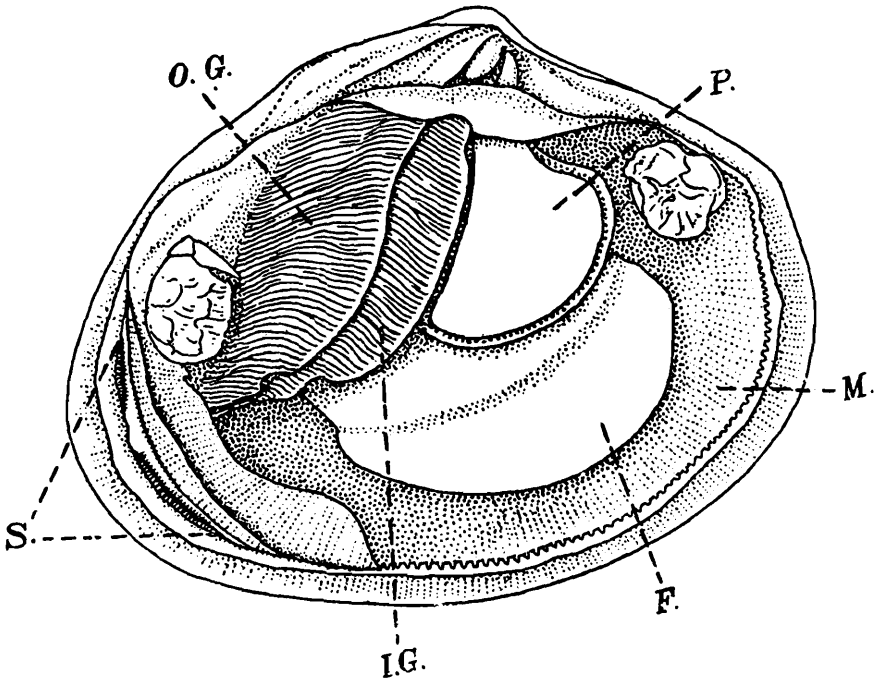
Of the adductor muscles, the posterior is much larger than the anterior and both are nearly subquadrate in outline. The pallial muscle-fibres have already been mentioned, in these the siphonal retractors are not distinctly indicated.

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.

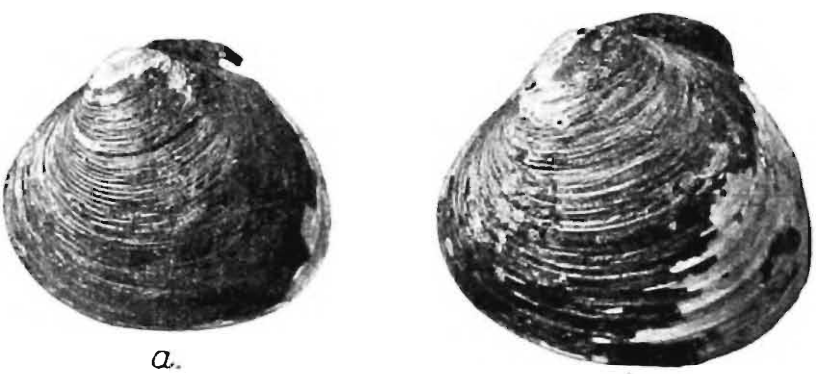
Batissa similis, Prime.

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).

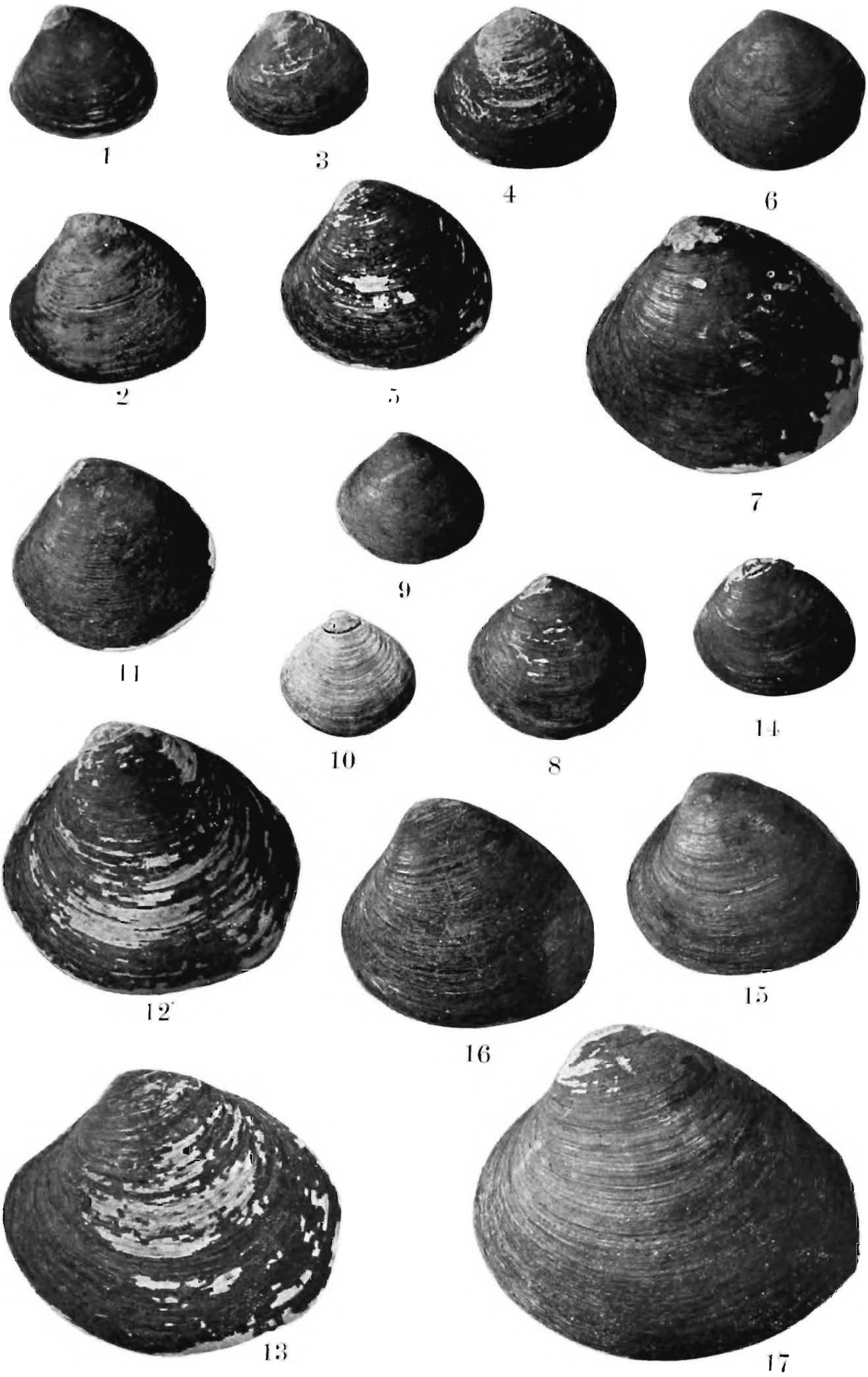
FIGS. 11—13.—Shells of different sizes, all from Ceylon.

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. 365 and 366; 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. ($1\frac{2}{3}\frac{0}{2}\times\frac{1}{2}$ 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 3½ 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 8¼ 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 colyphodont. 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."