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XXI. NOTES ON SOME INTERESTING LARVAE OF DRAGONFLIES (ODONATA) IN THE COLLECTION OF THE INDIAN MUSEUM.

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

ZYGOPTERA

LIBELLAGINAE.

Rhinocypha unimaculata, Selys.

Larvae 1 ♂, 1 ♀ Kalimpong, Darjiling Dist., Apr.-May, 1915. F. H. Gravely $\frac{84}{H1}$.

Determined from venational characters. The specimen is a male in the last instar, its total length is 19·5 mm. It lacks the lateral triquetral gills. In general the specimen bears a resemblance to that of the larva of *Micromerus lineatus*, Burm. (Fraser, *Rec. Ind. Mus.* XVI, 1919. pp. 197-198, pl. xxiii). From examination of this specimen I can add the following to his account. The tergite of the eleventh abdominal segment is present, unmodified as a gill, and apparently identical in structure with the appendix dorsalis of the Anisoptera.

The gizzard consists of sixteen folds. Each carries a single row of about five conical teeth, distant from each other. I cannot make out any differentiation into major or minor folds.

This larva, and equally that of *Micromerus*, exhibit certain primitive characters, especially in the mask, the gizzard, and in the possession of an unmodified appendix dorsalis.

They approach in some respects the larvae of the Calopteryginae, whilst remaining I think rather less specialized. They show no evidence of near relationship to the Epallaginae. This is rather surprising as the venation of the adult has by most students been regarded as indicating a fairly close connection between these two subfamilies.

Their structure certainly emphasized the desirability of according the group subfamily rank.

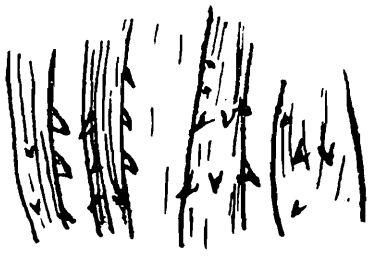
SYNLESTINAE.

Megalestes major, Selys.

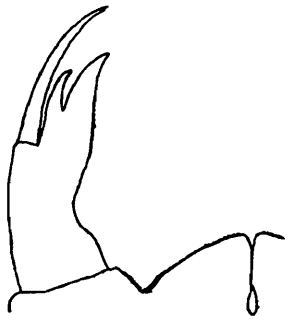
(Text-figs. 1-3.)

3 examples; Pashok, 5,500 ft. $\frac{3463}{H1}$.

Mr. Tillyard has pointed out to me that these larvae, which I had previously identified from an examination of the venation, are not Lestine but most distinctly Synlestine in their characters. He was able to demonstrate a very close similarity in structure between the larva of *Megalestes* and that of the Australian genus *Synlestes*. Hence it is necessary to remove the genus *Megalestes* from the neighbourhood of *Lestes* and refer it to the subfamily. Synlestinae as defined by Tillyard (*The Biology of Dragonflies*, p. 277). The subfamily will then include three genera:—*Synlestes* from Australia, *Megalestes* from India, and *Chlorolestes*, which is African. Needham has already described an unidentified larva of large size from India, which in important respects (*e.g.* structure of mask and caudal gills) is clearly related to *Megalestes*, though belonging to a larger insect. There is only one known Indian genus, *Orolestes* of Maclachlan, to which this larva can be assigned with any degree of probability; and in respect of details of venation, as noted by Needham, this ascription is very reasonable. Moreover, Mr. Tillyard has recently examined the type specimen of *Orolestes selysi* Macl. in the Maclachlan collection, and informs me that the species is a true Synlestine; so that when the identification of the larva is settled the genus must in all probability be added as a fourth to those of the subfamily. (See Needham, *Entomol. News* XXII, 1911, pp. 342—344, pl. xi, figs. 1—4.)



TEXT-FIG. 1.—Gizzard (4 folds shown) of *Megalestes major*.



TEXT-FIG. 2.—Labium of *Megalestes major*.

I quote here Tillyard's definition of the larva of the Synlestinae (*Biology of Dragonflies*, p. 277).

"Larva very slender and elongated, with exceedingly long spider-like legs, mask with incised median lobe, lateral lobe narrow, cleft into two sharp teeth and with a denticulate inner border; movable hook long and slender; no setae present, antennae with greatly elongated pedicel, caudal gills with secondary tracheae somewhat oblique to gill axis. Gizzard with dentition reduced to a few large teeth on each field."

This definition was drawn entirely from the larva of *Synlestes*, but it will be evident that the *Megalestes* larva (and also Needham's larva) show a close approach to the same type.

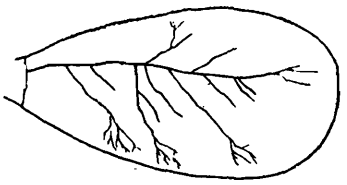
The measurements of the largest of the three larvae of *Megalestes major* (final instar ?) are as follows:—

Total length 19·5 mm.; gills 5·75 mm. additional; abdomen

14 mm.; mask 3·25 mm.; antennae 3·5 mm. Breadth of head 4 mm.; length of hindermost femur 6 mm.

The creature is smooth and slender with long legs, and is of a nearly uniform sandy colour.

Head, widest across the middle of the large eyes; hind angles rounded, not spinulose. Antennae seven-jointed, the first and second segments stouter than the remainder, the third segment is the longest. Labium elongate, with hinge reaching to between second and third pairs of legs posteriorly. Median lobe cleft by a median incision which extends just below the level of the base of the lateral lobes. Lateral lobes with a long and strong movable hook, and with two stout incurved hooks on the end; the outer hook simple and half as large as the inner. Inner margin of lobe finely serrate. *No raptorial setae.*



TEXT-FIG. 3.—Lateral anal gill of *Megalestes major*.

Legs slender, longitudinally carinate. *Wings* reaching to base of fifth segment. *Abdomen* cylindric, segment 10 slightly compressed, a dorsal ridge is present on 8-9-10, margin of the last segment entire. Lateral carinae on segments 1-9; on 6-9 these carinae each end apically in a small sharply pointed spine. Gills elongate oval, narrowed somewhat at their bases, each jointed on to a small basal segment, rounded regularly at their apices.

ANISOPTERA.

CORDULEGASTRINAE.

Anotogaster sp.

1 ♀ Dalat, Langbian Province, Southern Annam, 5,000 ft., C. Boden Kloss. March—May 1918. $\frac{1455}{H2}$.

Total length 45 mm; anal appendages 3·25 mm. additional. Head 9 mm. in width, equal to the greatest width of the body; labium 12 mm. long. Length of adbomen 33 mm; of hinder wing-case 9 mm. The specimen is a female, probably in the last instar. It is interesting geographically as it is I believe the first Cordulegastrine recorded from so far south, in Asia at any rate. I do not know of any record hitherto south of the Tropic of Cancer. Also its large size makes it remarkable and leads me to suppose that it is probably a larva of *Anotogaster sieboldi*, the largest species of the subfamily. The adult female of this Japanese species has a span of over 120 mm.

XXII. OBSERVATIONS ON A CARNIVOROUS LAND-SNAIL.

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

In the genus *Ennea*, H. and A. Adams, there are at present included a number of species which differ greatly in the complexity of the armature of the mouth of the shell. These were separated into subgenera by Pfeiffer in Vol. V of his *Monographia Helicorum Viventium* as long ago as 1859, but we have been unable to find any detailed description of the armature in any of the more complex forms that may be accepted as *Ennea*, s.s.[1] All descriptions of shells of this type that we have been able to find refer merely to the external appearance of the aperture and fail to discuss the internal structure of the folds and teeth connected therewith. As we have recently had an opportunity of examining the commonest and most widely distributed species of the genus both living and preserved, we propose to publish here an account of the structure of the shell and to add certain observations on other points of interest.

Ennea bicolor (Hutton).

1908. *Ennea bicolor*, Blanford and Godwin-Austen, *Faun. Brit. Ind., Moll.* I, pp. 19, 20, fig. 12.

For the synonomy and literature of the species see the reference cited. Published descriptions of the shell omit several particulars of interest in connection both with the aperture and with other parts. We give, therefore, as a preliminary to the description of a new insular race, a fresh description of the shell of the species.

The shell is small but somewhat variable in size, with from 6 to 8½ whorls, subcylindrical, with the apex blunt; hyaline and almost colourless when fresh but rather thick. The whorls are never more than slightly swollen. Their proportions differ somewhat in different forms of the species. The body-whorl is compressed from side to side and bears on each side a funnel-shaped depression. That on the inner aspect surrounds the umbilicus, which is completely closed. The sculpture consists of very fine, straight vertical ribs, which are strongly developed just below the

[1] H. and A. Adams in their original description of the genus, as a subgenus of *Pupa*, selected no type-species but mentioned *E. bicolor* first on their list, see *Gen. Recent Mollusca*, II, p. 171 (1858). Whether we accept *E. bicolor* (with Blanford and Godwin-Austen) as the type-species of the genus, or *E. elegantior* (Pfeiffer) with von Martens and Nevill, *Huttonella*, Pfeiffer is synonymous with *Ennea*, s.s.

suture on all but the apical whorls and give it a fimbriated or almost subspinose appearance. On the greater part of the shell these ribs are obsolescent on the lower parts of the whorls, but on the whole surface of the outer aspect of the body-whorl they are well developed. They are absent from the first two and a half whorls. The shell as a whole has a smooth and polished surface. The aperture is subquadrate but varies somewhat in outlines and proportions. It always has the angles rounded. The armature consists of two obtuse, somewhat compressed teeth and two elongate internal folds. We will describe first its external appearance and then its internal structure. The actual orifice is conspicuously trilobed owing to the unusually strong development of the armature. The three lobes are unequal. The uppermost is a narrow sinus lying between the outer lip and a strong internal fold, which projects out of the orifice for a short distance in the form of a ridge. The second lobe, which is considerably broader, lies between this ridge and the columellar margin, while the third, which is intermediate in size, is bounded externally by a blunt tooth lying inside the outer lip at the base of the first lobe. There is a second internal tooth near the inner anterior angle of the orifice, while a second internal fold lies inside the columellar part of the peristome. The peristome itself is thickened and a little expanded. It is interrupted by the upper lobe or sinus of the orifice, which is pointed and slightly curved, and is often imperfectly developed between the termination of the upper fold and the upper extremity of the columella.

The two folds and the two teeth may now be described in detail. The upper fold arises on the floor of the shell about half way up the body-whorl and runs down, following the twist of the spiral, to emerge from the aperture at the upper extremity a short distance within the outer margin. It has the form inside the shell of a highly convex crest, but on the edge of the aperture assumes that of a low ridge. It is rather thick as a whole and has a blunt, but not thickened free edge. The lower fold, although less conspicuous externally, is considerably longer and in other respects better developed. It arises on the internal column near the suture of the body-whorl and runs along the former as a convex crest, diverging slightly from the line parallel to that of the upper fold. The free margin is considerably thickened on the inner side. A broad deep gutter, which expands somewhat towards the aperture, is thus produced between the two folds. The foot slides along this gutter as the animal emerges. The outer tooth represents on the internal surface of the shell the external funnel-shaped depression on the outer aspect and is thus to a considerable extent hollow. It forms with the upper fold a narrow sinus in which the pulmonary orifice and the anus lie when the animal is expanded. The internal or basal tooth is solid and is not represented by any external depression. The depression on the inner aspect of the whorl is represented internally by a barely perceptible thickening at the outer extremity of the lower fold.

There is preserved in the Indian Museum a series of shells from the old A. S. B. collection that Nevill[1] believed to be "probably typical specimens from Hutton." These differ constantly from the figure published in the "Fauna" and cited above, in tapering less, in having the body-whorl less swollen and in the shape of the aperture, which is more elongate and has the columellar and outer margin more nearly equal in length. The specimens have the sculpture we have described above well developed, though the shell has usually been described merely as smooth and polished.

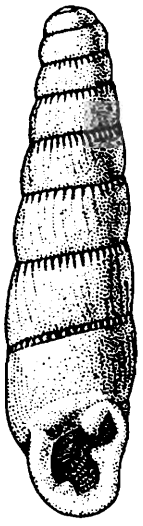


FIG. 1.

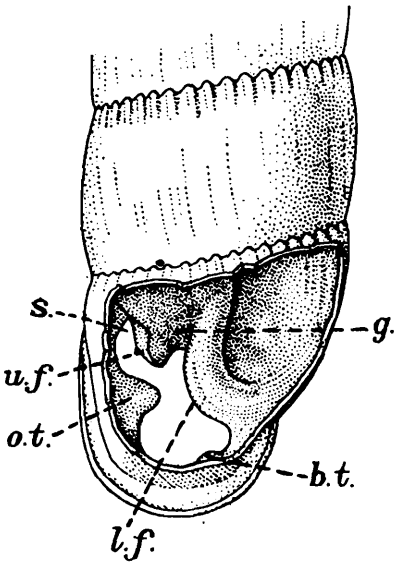


FIG. 2.

FIG. 1.—Shell of *Ennea bicolor* race *barkudensis*, Annandale & Prashad. Ventral view, x 8.

FIG. 2.—*E. bicolor* race *barkudensis*, dorsal view of the last two whorls with the shell of the body-whorl removed to show the folds and teeth, x 16.
b.t. basal tooth, *g* gutter, *l.f.* lower fold.
o.t. outer tooth, *s.* sinus, *u.f.* upper fold.

Race **barkudensis**, nov.

As we find that individuals from a small island in the Chilka Lake differ quite constantly from what we take to be the *forma typica* from the Ganges valley, and also from any of the forms already described and relegated to the synonomy of the species, we propose to describe the race as new under the above name.

The shell is considerably narrower than that of the *forma typica*, the proportions of breadth to height being 1 : 4·5; it tapers less and has when mature 8½ whorls; the apex is usually a little swollen and the aperture is relatively smaller and narrower. The strucutre and sculpture of the shell, however, are precisely similar to those of the typical form.

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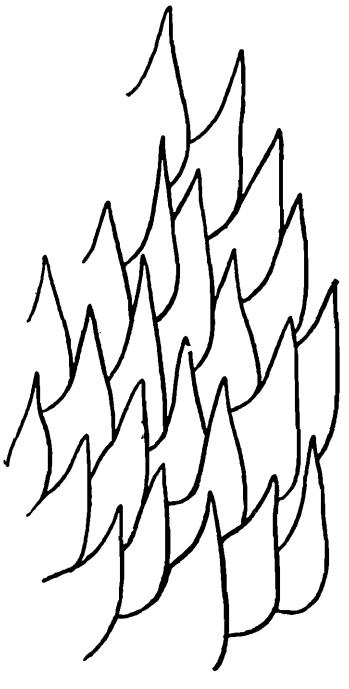
[1] *Hand List Moll. Ind. Mus.* I, p. 6 (1878).

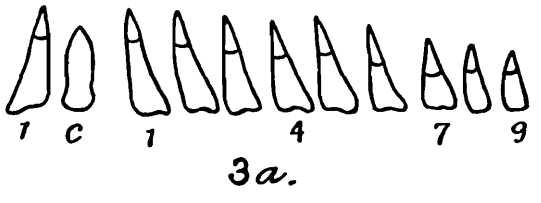
Measurements of shells (in millimetres).

	A.	B.	C.
Length	6·8	6·3	6·5
Maximum breadth	1·6	1·5	1·5
Length of the mouth	1·5	1·5	1·6
Breadth of the mouth	1·2	1·3	1·3

The animal agrees in colouration with those originally described by Hutton[1] and only differs from Stoliczka's description[2] and Semper's coloured figure[3] in that the scarlet colour of the head and body is completely restricted to the internal structures connected with the eye-stalks. The rest of the extruded parts are of a



3.



3a.

FIG. 3.—Radular teeth of *E. bicolor* race *barkudensis*, general arrangement.
,, 3a.—Radular teeth, one side of a complete row of teeth.
c. central; 1, 4, 7, and 9 lateral teeth.

bright shade of lemon-yellow and the mantle is orange-scarlet. We figure the radular teeth. Their shagreen-like arrangement is shown in fig. 3. In general facies, doubtless also in function, it has an interesting resemblance to that of the papillae on the tongue of certain carnivorous mammals.

Type-specimen. No. M $\frac{11719}{2}$, Zoological Survey of India (*Ind. Mus.*).

We found this race of *E. bicolor* fairly common, but by no means abundant, on Barkuda Island in the Chilka Lake in the

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[1] *Jour. As. Soc., Bengal*, III, pp. 86, 93 (1824).
[2] *Ib.*, XI, pt. 2, pp. 169-171, pl. viii, figs. 7, 8 (1871).
[3] *Reis. d. Philippinen*, III, p. 250, pl. viii, fig. 14 (1870-1894).

latter half of June, 1920. The snails were taken on a low flight of stone steps leading to a bungalow. They emerged in wet weather, and especially on damp evenings, from the interstices of the stone-work and the earth at its base. The largest number of individuals we saw on any one evening was half a dozen. The *Ennea* was accompanied, in much larger numbers, by an *Opeas*, which Col. Godwin-Austen [1] has identified provisionally as *O. gracilis* (Hutton). The *Ennea* was evidently preying upon the *Opeas*, for we found one or two individuals of the former attached to the foot of individuals of the *Opeas*. The attack, however, was by no means vigorous and we could discover very few fresh empty shells. Probably this was due to the fact that the carnivorous species was just recovering from its hot-weather aestivation. Godwin-Austen in the "Fauna" records another instance of the association of the two species, observed by Mr. Collet on the sea-wall at Galle, Ceylon. Semper also found *E. bicolor* in the Philippines preying on a form of *O. gracilis*.[2]

It would, appear, therefore that these two species (both of which are remarkable for their wide distribution and are often found in India in places where pot-plants are kept) or closely allied forms habitually occur together. On Barkuda the vegetarian snail is, as might be expected, very much the more abundant of the two. As Godwin-Austen points out in the "Fauna," there is a certain resemblance between the shells, and this is also so with the animals; but they are readily distinguished in life by the scarlet markings of the *Ennea*. These are entirely absent in the *Opeas*, the mantle and exposed parts of which are of a uniform bright yellow colour.

The resemblance between the gutter produced by the internal folds of the shell in *Ennea* and *Clausilia*[3] is very close and must be entirely convergent. There is, of course, no clausilium in *Ennea* and the origin of the two main folds is slightly different in the two genera. Moreover, supplementary palatal plicae are absent in *Ennea*, as are oral teeth in *Clausilia*. In other words, the internal armature has become exceedingly complex in *Clausilia*, doubtless in correlation with the production of the clausilium, while in *Ennea* the external armature is better developed. In the latter genus the armature does not suffice to close the shell completely when the animal is retracted, but seems rather to protect the more important external parts of the body in the act of and on the completion of expansion. This may perhaps be useful to a carnivorous animal which burrows into soft tissues and mucus while feeding, at any rate so far as the upper sinus and the pulmonary orifice are concerned. The walls of the gutter between

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[1] *Rec. Ind. Mus.* XIII, p. 351 (1917). Col. Godwin-Austen informs us that he proposes to describe this form shortly as a new species.

[2] Semper, *loc. cit.* pp. 137-138, where the species is referred to as *Stenogyra panayensis;* on pl. viii, fig. 15, Semper calls it *Subulina panayensis;* for synonym see Gude, *Faun. Brit. Ind. Moll.* II, pp. 355, 357 (1914).

The association of the two species is referred to by Semper on p. 250.

[3] Smith and Woodward, *Ann. Mag. Nat. Hist.* (6) V, pp. 209-213, pl. xi, A (1890).

the two main folds may also assist in cleaning the foot and head as they are retracted. It is possible, therefore, that whereas, as is clearly the case, the whole structure is protective in function in *Clausilia,* in *Ennea* it assists in active aggression. The case is all the more remarkable in that *Ennea* belongs to a family (the Testacellidae) in which the shell is often completely degenerate; but it is perhaps more common [1] than is generally realized to find animals of similar habits and related structure adopting in the course of evolution diametrically opposite methods of improving their means of attack or defence.

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[1] See Annandale, *Jour. As. Soc. Bengal* (n.s.), IX, p. 75 (1913); *Mem. Ind. Mus.* V, p. 54 (1915) and *Mem. As. Soc. Bengal,* VI, pp. 196-197 (1918) and Prashad, *Rec. Ind. Mus.* XVI, p. 401 (1919).

XXIII. REVISION OF THE INDIAN HOMALOPTERIDAE AND OF THE GENUS *PSILORHYNCHUS* (CYPRINIDAE).

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

(Plates X, XI.)

In investigating the means whereby the small fish of the mountain torrents of India adhere to rocks and stones, I have been obliged in the first instance to consider the taxonomy of the Indian species assigned by Day to *Homaloptera*. Great confusion prevails as to both the generic position and the specific limits of the species. In this paper I attempt to elucidate these questions.

Only three Indian species of the genus are described by Day in his *Fishes of India* and *Fauna of British India*, viz. *H brucei*, *H. maculata* and *H. bilineata*. Of these species in their correct interpretation the first two were figured by Gray aud Hardwicke as *Balitora brucei* and *B. maculata* in the *Illustrations of Indian Zoology* in 1832. *Homaloptera bilineata* was described later by Blyth, who distinguished it from the true *Balitora* of Gray by the following vague phrase, as Bleeker puts it:—"Homaloptera, Kuhl and van Hasselt. A form intermediate to the ordinary spineless loaches and *Balitora* of Gray." I intend to criticise this statement when discussing the relationships of the family, but it will not be out of place to point out here for the sake of clear understanding that, except Day and probably Günther, no ichthyologist who has examined specimens of *Balitora brucei*, *B. maculata* and *Homaloptera bilineata* has put them all in the same genus. The following have been the probable causes of confusion:—

(i) The publications by Gray of the figures in the "*Illustrations*" without any description.

(ii) The fact that Day confused South Indian species with those from the Eastern Himalayas and Assam, and further included more than one species under each name he accepted. There is much inconsistency in Day's earlier and later works in the descriptions of the various species he assigned to *Homaloptera*.

Vinciguerra,[1] who studied *Balitora brucei* and *Homaloptera bilineata* from specimens from Burma, found himself compelled

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[1] Vinciguerra, *Ann. Mus. Stor. Nat. Genova* XXIX, pp. 320—335 (1889—1890).

to separate *H. bilineata* from *B. brucei* and constituted a new genus (*Helgia*) to accommodate the former. *H bilineata* possesses a long, pointed snout and a slightly depressed body. In these and other characters it comes so close to the true *Homaloptera* from Java as figured in Bleeker's "*Atlas Ichthyologique*" that it cannot be separated generically. *Balitora brucei* and *B. maculata* have a broad, trenchant snout, with the head and body greatly depressed, and broad pedunculate pectorals.

I have been able to examine specimens from both Northern and Southern India. So far from those found in the neighbourhood of the Nilgiris being specifically identical with those from the Himalayas, they seem to me to be generically distinct. Further I agree with Blyth [1] and Vinciguerra (*op. cit.*) that the Burmese forms differ generically from those of the Himalayas, and that neither type agrees with the South Indian forms. I am, therefore, forced to recognise three genera, namely *Homaloptera* van Hass., *Bhavania* gen. nov. (for the South Indian forms) and *Balitora* Gray. These three genera may be distinguished by the following key:—

KEY TO THE INDIAN GENERA OF HOMALOPTERIDAE.

Pectoral fins definitely pedunculate and greatly expanded. Head short and broad; semicircular trenchant snout; short conical barbels; upper lip tentaculate. Head and body much depressed; 21 rays in pectoral	*Balitora.*
Pectorals of almost normal size, and devoid of a well-developed fleshy peduncle. Head normal; snout bluntly pointed; short thick barbels. Thick well-developed lips devoid of tentacular processes. Head and body moderately depressed; 19 rays in pectoral	*Bhavania.*
Pectorals normal. Head long and narrow, almost cylindrical; snout long and pointed; short barbels; fleshy lips. Head and body slightly depressed; rays in pectoral	*Homaloptera.*

Balitora, Gray and Hard.

Gray and Hardwicke, *Ill. Indian Zoology*, I, pl. 88, figs. 1 and 2 (1832).

Head and body greatly depressed, eyes small, situated almost on the dorsal aspect of the head; mouth crescentic with tentacular lips; six short, stout barbels; pectorals and ventrals greatly expanded, the former with 21 rays and the latter with 11 rays; pectorals provided with a definite fleshy peduncle.

The two species of the genus, recorded from the Eastern Himalayas and Burma, can be distinguished by the following key:—

KEY TO THE SPECIES OF BALITORA.

1. Pectorals just reaching the ventrals, lower caudal lobe the longer	*B. brucei.*
2. Pectorals reaching beyond the ventrals, lobes of the caudal almost equal	*B. maculata.*

[1] Blyth, *Jour. As. Soc. Bengal*, XXIX, p. 172 (1860).

Balitora brucei, Gray and Hardwicke.

(Plate XI, figs. 2—4.)

1832. *Balitora brucei*, Gray and Hard., *Ill. Ind. Zoology*, I, pl. 88, fig. 1.
1842. *Platycara anisura*, McClelland, *Calcutta Journ. Nat. Hist.* II, p. 587, pl. lxviii.
1889. *Homaloptera brucei*, Vinciguerra, *op. cit.*, p. 323.

P. 9—10/ 12—11. V 2/9.

The nature of the confusion referred to above can be fully realised on reading the description of *Homaloptera brucei* by Vinciguerra, who has recorded this fish from Upper Burma. I quote an English translation from this author which makes the whole matter quite clear:—

"It was after long hesitation, and not without reserve, that I decided to refer the many specimens of *Homaloptera* collected by Fea in the Meekalam river at the bottom of Mt. Mooleyit to *H brucei* (Gray and Hardwicke). Of this species I do not know the original except from the reproduction made by McClelland and the descriptions given by Günther and Day. Between them such a difference is to be noticed, that it made me suspect that the specimens in the hands of one were not identical with those examined by the latter author, or, to put it better, that the specimens found in the Nilgiris mountains which served for the first description of Day, one of which passed to the collection of British Museum and served for the description of Günther, are specifically different from those described in the publication the *Fishes of India.*" Vinciguerra then proceeds to point out the discrepancies in the various descriptions. I am able to confirm Vinciguerra's doubt and with collections from various parts of India before me, I am in a position to separate Day's species from the Nilgiris from those of the Eastern Himalayas. Day's *H. brucei* from Southern India is the same as Jerdon's *Platycara australis*, which I describe as *Bhavania australis* in this paper.

I have examined five specimens of *B. brucei*, one of which (No. 1509 of the Indian Museum) is in a very bad state, while four others, which were found in the same bottle with *Psilorhynchus balitora*, are from Cherrapunji in the Khasi Hills. Specimen No. 1509 is noted to have been purchased from Day, while the others were given to the Museum by Lt. Burne. All of them are very old, but still in a fairly good state of preservation.

B. brucei is a very peculiar fish with the head and body greatly depressed. The snout is semi-circular with trenchant margins. The eyes are small and approximated. On account of the depressed head and body the dorsal profile is but slightly arched, the ventral being almost horizontal. The region of the body in front of the ventral fin is devoid of scales on its ventral surface. The head is likewise scaleless, its length being contained $6\frac{1}{2}$ times in the total length. The length of the caudal fin is contained $5\frac{1}{4}$ times in the total length and the depth of the body about

11—13⅓ times. The eye is very small, situated on the dorsal aspect of the head and looks outwards and upwards, its diameter is contained 6½ times in the length of the head, which is almost as broad as long. The diameter of the eye is contained 3⅚-times in the length of the snout and 2⅔ times in the interorbital width.

Barbels :— There are six short, fairly thick barbels; four rostral and one at each angle of the mouth. The integument of the spaces between the barbels is thickened and sometimes it becomes very difficult to see them. Those near the angle of the mouth are sometimes sunk in grooves and become almost imperceptible.

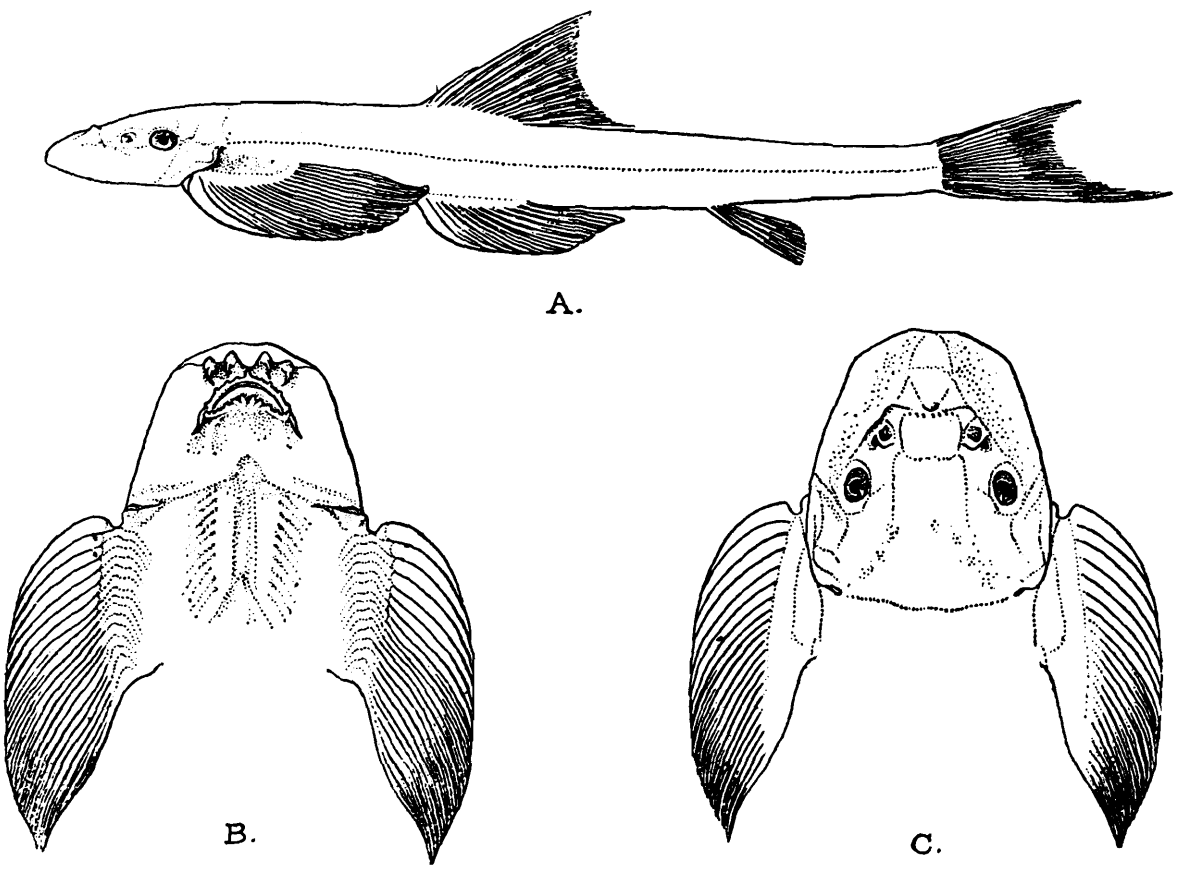

Fig. 1.—*Balitora brucei*, Gray and Hardwicke.
A. Lateral view (nat. size).
B. Ventral view of head and chest × 1⅓.
C. Dorsal view of head × 1⅓.

Fins :—The pectoral and the ventral fins are greatly expanded and have thick cushion-like longitudinal pads of muscle on the ventral aspect of the simple rays. In the pectoral fin there are 21 rays in all, and either 9 or 10 of these may be simple. The first of these simple rays is greatly expanded and horizontally striated. The two first rays of the eleven of the ventral fin are simple. The two lobes of the caudal fin are unequal, the lower lobe being much the longer.

Scales ;—Lepidosis is normal with the exception of the chest and belly. The scales are small and their number along the lateral line varies from 62 to 69.

A scale from the dorsal surface is squarish with almost central nucleus and about a dozen circular striae, which are

interrupted by 12 radii to the base and the same number to the apex. The following are the measurements of a scale from near the dorsal surface :—

Length ..	1·5 mm.
Breadth	1·5 mm.
Distance of base from the middle of nucleus	0·65 mm.

The specimen from which the scale for measurement was taken measures 85 mm. in length, excluding the caudal fin.

Pharyngeal teeth:—There are about nineteen teeth arranged in a single row. They are slightly curved near their extremities. Those at the top of the bone are longer than the others.

Air-bladder :—The air-bladder is much reduced and in general appearance resembles that of the Cobitidae. It is completely divided into two lateral portions which send small tubes inwards. These tubes come very close to each other but do not meet. Each of the lateral portions is enclosed in a bony capsule, which looks like a small bag placed on the under surface of the transverse process of the second vertebra, of which it seems to be a modification.

Colouration :—The specimens before me have lost their natural colouration, and, moreover, I do not find any detailed description given by Vinciguerra. Under the circumstances I can only refer to Gray's figures, which I think can be relied upon in this respect.

Geographical Distribution :—Eastern Himalayas (Darjiling); Khasi Hills, Assam; Eastern Tenasserim.

The following are the measurements (in millimetres) of two complete specimens:—

	A	B
Total length (including caudal)	100	100
Length of caudal	19	19
Greatest depth of body	9	7·5
Length of head	15·5	15·5
Width of head	13	15
Length of snout	9·2	9·2
Diameter of eye	2·4	2·4
Interorbital width	6·5	7·3
Length of caudal peduncle	15·0	17·5
Depth of caudal peduncle	4·0	4·2
Longest ray of dorsal	15·0	16·5
Longest ray of anal	7·5	10·5
Length of pectoral	23	23·2
No. of rays in pectoral...	10/11	9/12
No. of rays in ventral	2/ 9	2/9
No. of scales along L.L.	62	69

Balitora maculata, Gray and Hardwicke.

(Plate XI, fig. 1.)

1832. *Balitora maculata*, Gray and Hard., *Ill. Ind. Zoology*, I, pl. 88, figs. 2 and 2*a*.

1868. *Homaloptera maculata*, Günther, *Cat. Fish.* VII, p. 340.

D. 3/8. P. 9/12. V 2/9.

The true *Balitora maculata* originally figured by Gray and Hardwicke differs considerably from the fish described by Day under the name of *Homaloptera maculata*. The differences are so great that I have separated Day's species and have described it under a new genus as *Bhavania annandalei*. Apart from the characters of the mouth, jaws and barbels, the following points of differences are clear from a comparison of the figures in Day's "*Fishes of India*" (pl. cxxii, fig. 2) and in Gray's "*Illustrations of Indian Zoology*":—

Gray's species differs from Day's in the very great expansion of the pectoral fins, in their being definitely pedunclate, in the shorter and broader head and in markings. Day's figure of the

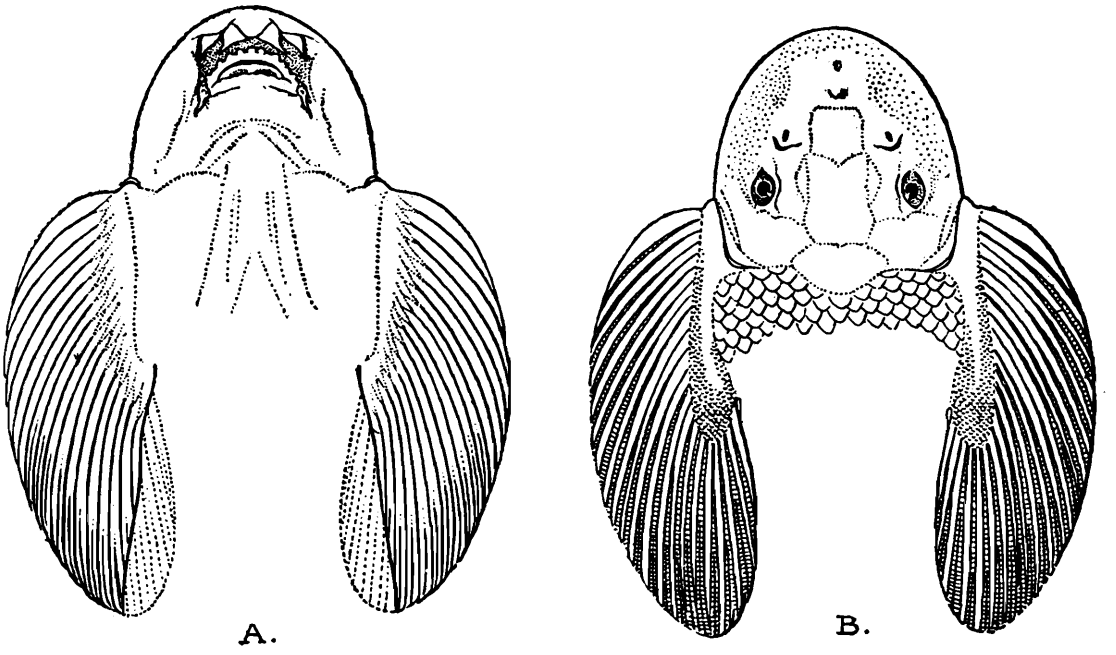

FIG. 2.—*Balitora maculata*, Gray and Hard.
A. Ventral view of head and chest × 1⅓.
B. Dorsal view of head and fleshy pectoral peduncles × 1⅓.

mouth shows only two pairs of barbels, the two at the angle of the mouth being very long; while Gray's figure shows two pairs of short, stumpy rostral barbels.

There are two specimens in the collection of the Indian Museum (Cat. No. 939), labelled by Day as *Homaloptera maculata* which can be referred to *Balitora maculata* of Gray. These specimens were collected by Dr. Wallich at Darjiling and the one figured by Gray was probably collected in Northern India as were most of the specimens figured in the "Illustrations." It is a pity that Day's South Indian specimen (No. 1510) in the Museum is in a very bad condition, as it is probably the original of his figure.

In both specimens of the true *B. maculata* I have seen the caudal fin is wanting, otherwise they are in a fairly good state

in spite of the fact that they have been preserved in alcohol in Calcutta for at least a century.

The head and body of this species is much depressed and the chest and belly are quite flat and scaleless. The length of head is contained $5\frac{1}{2}$ times in the total length excluding the caudal and the depth of the body about 10 times. The eye is very small and situated on the dorsal surface of the head ; its diameter is $\frac{1}{8}$ of the length of the head, which is almost as broad as long. The anterior border of the snout is semicircular and its margin trenchant. The dorsal profile is slightly arched, and is highest near the base of the dorsal fin.

Barbels :—There are six short and stumpy barbels, fairly broad near their bases and tapering to a point. Of these, 2 pairs are rostral and one pair just at the angle of the mouth.

Fins :—The pectoral fin is greatly flattened and is pedunculate, the dorsal surface of the peduncle being covered with scales. There are 9 simple rays, the first being flattened, and 12 branched ones. The ventral fin has two simple rays and 9 branched ones, the first simple ray being moderately flattened. The first few rays of both the pectorals and ventrals are provided with thick cushion-like muscles on the ventral surface.

Pharyngeal teeth :—It is very difficult to see the exact number of teeth because they are loose and readily fall off. However in my preparation there are about 13 long, delicate teeth arranged in a single row.

Scales :—With the exception of the chest and belly, the whole of the body is covered with fairly large scales. There are about 60—64 along the lateral line, which shows a downward curvature in front of the origin of the ventrals. Eight rows of scales are present between the lateral line and the dorsal surface and 6 rows between it and the base of the ventral fin.

A scale from the dorsal surface is rectangular in general outline, with a flat base and an arched upper margin. There is no well defined nucleus. A few circular striae (6—7) are present near the base, while on the lateral margins and near the apex there are about a dozen. The striae are not interrupted as the radii to the base are wanting and only about 5—6 radii to the apex are present. There are also a number of shorter radii. In a scale from the lateral line the base and apex are both flattened but slightly emarginate. Other characters are the large number of circular striae and a few ill-defined radii to the apex.

The following are the measurements of a scale from near the dorsal surface of a specimen 95 mm. in length :—

Length	1·7 mm.
Breadth	1·3 mm.
Distance from the centre of the nucleus to the base	0·5 mm.

Colour :—The specimens before me have completely lost their

natural colouration. I can only refer to Gray's figures, which I think can be relied upon in this respect.

Locality:—Eastern Himalayas.

The following are the measurements (in millimetres) and proportions of the specimens in the Museum:—

		A.	B.
1.	Total length of body (caudal excluded) ...	89·5	93·2
2.	Depth of body	9·5	9·5
3.	Length of head	17·3	17·0
4.	Width of head	16·0	16·2
5.	Length of snout	10·5	11·5
6.	Diameter of eye	2·3	2·3
7.	Interorbital width	8·1	9·2
8.	Length of pectoral fin	25·5	29·0
9.	Length of ventral fin	20·0	24·0
10.	Longest ray of dorsal	16·2	17·6
11.	,, ,, ,, anal	8·4	10·0

Bhavania, gen. nov.

Head moderately long and broad, becoming rather pointed towards the snout; head and body depressed, eyes on the dorsal surface, looking outwards and upwards, mouth provided with thick, fleshy lips and usually with a number of muscle-bands running outwards and backwards from the angles and the lower lip. Pectorals and ventrals of almost normal size, with 19 rays in the former and 9 in the latter.

This genus has been so indiscriminately confused with *Balitora* from the Eastern Himalayas that great difficulty has been experienced in separating its species. Day (*Proc. Zool. Soc.*, p. 348, 1867) records *Homaloptera brucei* from the Wynaad Hills in Madras. I think this is the species described by Jerdon as *Platycara australis*. In his later work Day confused it with *Balitora brucei* from the Eastern Himalayas. In the *Journal of the Asiatic Society*, XLI, p. 29, 1872, a description of *H. maculata* from Bhutan and the Khasi Hills is given, but the description does not agree with the figure of a male Wynaad specimen in the *Fishes of India*. Captain (now Major) Sewell's collection from Southern India clears up this confusion to a great extent. In it there are young of two species of *Bhavania*, in one the lower lobe of the caudal fin is slightly longer than the upper, the other has the lobes almost equal and also certain peculiarities of the lower lip and jaws. Under this South Indian genus, therefore, I have been able to distinguish two species.

Key to the species of Bhavania.

Snout broad and obtuse, lower lip interrupted, caudal lobes equal	*B. annandalei.*
Snout somewhat pointed, lips continuous, lower caudal lobe the longer	*B. australis.*

Bhavania annandalei, sp. n.

(Plate X, figs. 1—3 ; pl. XI, figs. 5—7.)

1878. *Homaloptera maculata* (in part), Day, *Fishes of India*, II, p. 526.

1889. *Homaloptera maculata* (in part), Day, *Fauna Br. Ind.*, Fish. I, p. 243.

1909. *Homaloptera maculata*, Jenkins (*nec* Gray), *Rec. Ind. Mus.*, III, pp. 289.

Day has figured in the *Fishes of India* a male specimen from the Wynaad, but his figures are far from being accurate. Instead of the usual three pairs of barbels he figures only two and does not show anything of the musculature of the lower lip. His specimen No. 1510 in the Indian Museum from the Wynaad, perhaps the original of his figure, is in a very bad state as it has been allowed to desiccate.

I have taken specimen No. $\frac{2554}{1}$ of the Zoological Survey of India from Tenmalai as the type-specimen for this species.

Like the other members of its family, the fish is highly specialised for an existence in rapid-running waters. The mouth is provided with thick lips, the lower one being widely interrupted on both sides near the angle of the mouth. Posterior to but immediately following upon the middle piece of the lower lip, there is a pair of prominent papillae which probably act as adhesive organs. The musculature connected with the lower lip is very interesting. Two bands of muscles proceed backwards from these papillae along the middle line for a short distance and then diverge from each other, thus appearing like an inverted letter **Y**. There are two more bands on either side running from the angle of the mouth outwards and backwards. The former pair pulls the middle piece of the lower lip in a backward direction, while the latter pulls the angle of the mouth outwards, thus straightening the flexure near the angle. When all the muscles act simultaneously the mouth is converted into a circular adhesive disc. The function is probably that of decreasing the air pressure in the cavity as in other adhesive organs.

The fish has a very graceful form, its ventral profile being almost straight and the dorsal slightly arched ; it is highest near the beginning of the dorsal fin and sinks gradually towards both ends. The head and body are depressed. The length of the caudal is contained $6\frac{1}{6}$, the height of the body 9, the length of head $6\frac{1}{6}$ times in the total length including the caudal. The eyes are dorso-lateral in position, their diameter being contained 5 times in the length of the head.

Barbels :—In all there are six barbels, 2 pairs rostral situated close together and 1 pair maxillary, situated slightly anterior to the angle of the mouth. All of them are well developed, the outer rostral pair being slightly shorter than the others.

Fins :—The pectoral fins have eight simple rays, followed by 9 branched ones, which are in their turn followed by two more

simple rays, bringing the total to 19 in all. The ventrals have 2 simple rays, and 5 branched ones. On the ventral surface of the simple rays, both in the pectoral and ventral fins, transverse muscular bands are developed which probably help the fish in adhering to pieces of stone. The caudal fin has almost equal lobes and is slightly emarginate.

Pharyngeal teeth :—In young individuals the pharyngeal teeth seem to be arranged in more than one row and their number is very difficult to count. In the type they are disposed in a single row, five sharp, slender teeth are present on the upper part of the pharyngeal bone, while in the lower part there are some minute teeth very difficult to count. The former are slightly curved near their extremities.

Scales :—The entire body is covered with small scales, except in the region of the belly and the chest. There are about 70 scales along the lateral line. The tubes of the lateral organs in the anterior region are very prominent. There are 10 rows of scales above the lateral line and 9 below it.

A scale from the dorsal surface is almost cycloid in appearance, with a flat base and an arched upper margin. The nucleus is eccentric and is nearer to the base. There are about 16—18 concentric striae going round the scale, evidently closer near the base than near the apex. The circular striae are interrupted by 16 radii to the base and 12 to the apex, only 5 of each lot reaching the nucleus.

The following are the measurements of a scale from the dorsal surface of the type-specimen :—

Length	0·92 mm.
Breadth	0·90 mm.
Distance of nucleus from base	0·25 mm.

Colour :—The colouration is described from spirit specimens. The dorsal and the lateral surfaces are of a chestnut brown colour, while the chest and belly are almost white. Behind the dorsal fin there are 4 bands across the dorsal surface descending to the lateral line on both sides. Just in front of the dorsal fin there is another broad band which goes to the base of the ventrals. There are two more shorter and narrower bands in front of it. The head is of a deeper colour and is spotted all over with big blotches. There are seven bands on the pectoral, three on the dorsal and ventral, one or two on the anal and 4 bands across the caudal fin. In young specimens about 24 mm. long we have indications of 7 bands on the body, though the dorsal blotches are distinct from the lateral. Three imperfectly developed bands are seen on the caudal, while the dorsal and pectorals have few spots.

Geographical Distribution :—The type-specimen was collected by Dr. Annandale on the western side of the Eastern Ghats in Travancore, while the others (young specimens) were collected by Captain Sewell in the Nilgiris and Malabar districts (mostly in the Wynaad) of Madras: three specimens in a hill stream on the

Calicut-Vayitri Road, at mile 29, at an altitude of 500 ft.; one from a branch of Kabani River below Rasselas Estate, Manantody, at an altitude of about 2,350 ft.; 4 specimens in a stream flowing through a swamp, Wentworth Estate, Cherrambadi, at an altitude of 2,750 ft. in the Nilgiris district, and one specimen in a stream on the Nellimunda Estate at an altitude of 1,800 ft. in the Malabar district.

The following are the measurements (in millimetres) of the type-specimen, which is an adult female:—

Total length including caudal	...	74 mm.
Length of caudal	...	12 ,,
Greatest depth of body	...	8·2 ,,
Length of head	...	12 ,,
Width of head	...	10 ,,
Length of snout	...	7 ,,
Diameter of eye	...	2·4 ,,
Interobital width	...	4·8 ,,
Length of caudal peduncle	...	10·5 ,,
Depth of caudal peduncle	...	5·2 ,,
Longest ray of dorsal	...	11·5 ,,
Longest ray of anal	...	7·8 ,,
Length of pectoral	...	14·2 ,,

Bhavania australis (Jerdon).

(Plate X, figs. 4—6; pl. XI, fig. 8.)

1849. *Platycara australis*, Jerdon, *Madr. Jour. Sci. Lit.* p. 333.
1867. *Homaloptera brucei*, Day, *Proc. Zool. Soc.*, p. 348.
1868. *Homaloptera brucei*, Günther, *Cat. Fish.*, VII, p. 340.
1878. *Homaloptera brucei* (in part), Day, *Fishes of India*, II, p. 525.
1889. *Homaloptera brucei* (in part), Day, *Fauna Br. Ind.*, *Fish* I, p. 243.

I have examined only young individuals of this species. I do not, therefore, attempt to describe it in detail. The fish is very much like the other species, *B. annandalei*, from which it differs in having a longer and narrower head, in having continuous upper and lower lips, in the absence of a pair of papillae on the lower lip and in the position of the mouth, which is near the anterior end of the snout in such a position that the barbels are seen even from the dorsal surface.

The mouth is a semicircular opening surrounded by uninterrupted thick lips. There are three pairs of barbels, two pairs rostral and one maxillary. The rostral barbels are situated close together at the anterior end of the snout, the maxillary pair being a short distance anterior to the angle of the mouth. The musculature for converting the mouth into a suctorial disc is very much like that of *B. annandalei*, but the papillae are not well developed.

For a detailed description Day's Monograph of Indian Cyprinidae (*op. cit.* 1867) may be consulted under the name *Homaloptera brucei*.

Young individuals were collected by Captain Sewell in October, 1919, at the following localities:—

(i) Two specimens in a stream at Nadgani at an altitude of 2,500 ft. in the Nilgiri district.

(ii) One specimen in a stream flowing through a swamp, Wentworth Estate, Cherrambadi, at an altitude of 2,750 ft., Nilgiri district.

(iii) One individual in a stream on the Nellimunda Estate, at an altitude of 1,800 ft., Malabar district.

Homaloptera, v. Hasselt.

This genus is characterised by the shape of the body, which instead of being flat, as in the other two genera, is subcylindrical. The head although a little depressed is far from having the same flattened shape. The snout is long and pointed. The eyes, which in *Balitora* and *Bhavania* look upwards and outwards, are here turned laterally. This genus, in the Indian Empire, is probably restricted to Lower Burma and especially to the Tenasserim districts. Only two Burmese species are known, *i.e. Homaloptera bilineata*, Blyth, and *Homaloptera* (*Helgia*) *modesta*, Vinciguerra. I have examined only one specimen of *H bilineata*; it probably served for the original description of Blyth and later on for that of Day's *Nemachilus serpentarius*. The specimen (No. 1226) is in a very bad state now. I have not examined any specimen of *H. modesta*.

The fish belonging to this genus are so very like *Nemachilus* and so different from the two preceding genera that an Ichthyologist of Day's standing was led to describe *Homaloptera bilineata*, Blyth, as a *Nemachilus*. I have no specimen from Java for comparison, but a short footnote on page 9 of Weber and Beaufort's *Fishes of the Indo-Australian Archipelago*, Vol. III, makes the matter clear. It runs—"Through the kindness of Dr. R. Gestro, Director of the Musco Civico di Genova, we had the opportunity to study 2 specimens of *Helgia modesta*, Vinciguerra from Burma. They are closely allied to *Homaloptera wassinki*, Blkr.," etc., etc. This note shows that *Helgia* of Vinciguerra is not distinct from *Homaloptera* as known from Sumatra and Java.

Homaloptera modesta according to Fowler [1] will go to his genus *Homalopteroides*, because the origin of the dorsal fin is behind the origin of the ventrals, while *Homaloptera bilineata* in which the origin of the dorsal is before the origin of the ventrals belongs to *Homaloptera* (*s. str.*). Weber and Beaufort do not recognize two distinct genera merely on the position of the dorsal fin relative to that of the ventral, and as I have not examined any specimen of *H. modesta* I do not feel myself justified in separating it from *H bilineata* generically.

The two Indian species are distinguished by Vinciguerra by the following key:—

Insertion of dorsal fin posterior to the ventrals. Eight pharyngeal teeth on either side. Colour grey with black spots ... ... *H. modesta.*

[1] *Proc. Acad. Nat. Sci. Phil.* (2) LVII, p. 475 (1905).

Insertion of the dorsal fin in front of the ventrals. Fifteen pharyngeal teeth on either side. Colour reddish, with a brown stripe from the margin of the eye to the base of the dorsal fin ... ... *H. bilineata.*

Homaloptera modesta (Vinciguerra).

1889. *Helgia modesta,* Vinciguerra, *Ann. Mus. Stor. Nat. Genova,* XXIX, p. 326.

Geographical Distribution :—Upper Tenasserim.

Homaloptera bilineata, Blyth.

1860. *Homaloptera bilineata,* Blyth, *Journ. As. Soc. Bengal,* XXIX, p. 172.
1869. *Nemachilus serpentarius,* Day, *Proc. Zool. Soc., London,* p. 551.
1878. *Homaloptera bilineata,* Day, *Fishes of India,* II, p. 526.
1889. *Homaloptera bilineata,* Day, *Fauna of British India,* Fish I, p. 244.
1889. *Homaloptera bilineata,* Vinciguerra, *Ann. Mus. Stor. Nat. Genova,* XXIX, p. 332.

Good descriptions of this species are given by Vinciguerra and other ichthyologists and as I have examined only one specimen in a very bad state I do not attempt to give an account of this animal except to describe a scale.

A scale from the base of the dorsal fin is pear-shaped with a central nucleus. There are a large number of circular striae running circumferentially. There are about 20 near the base and half that number towards the apex, the interspaces being consequently wider near the apex than near the base. There are only two complete radii to the apex and about 3 short ones in the other direction.

Geographical Distribution :—Tenasserim districts, Burma.

Fam. CYPRINIDAE.

Subfam. *CYPRININAE.*

Genus **Psilorhynchus,** McClelland.

As the species of this genus are often confused with those of *Homaloptera* I have included a revision of the genus in this paper.

This genus is abundantly distinct from the Homalopteridae and cannot be distinguished from the Cyprinidae by any valid character. From the former it is distinguished by the possession of an air-bladder consisting of two parts arranged longitudinally and not enclosed in a bony capsule, by the structure of the pharyngeal bones, by the possession of large well-developed scales in the adult and by the less extreme modification of the paired fins.

It may be defined as follows :—

A genus of Cyprininae consisting of small fish modified for life in mountain torrents. The head and body are but slightly depressed, but the ventral surface is flattened and the chest highly muscular. The paired fins are expanded but not greatly

so. The dorsal contains relatively few rays and commences slightly in front of the ventrals. The lateral line runs straight along the side of the body to the base of the caudal fin. The scales are large, cycloid and well-developed, but absent on the head. The air-bladder, though more or less degenerate, is relatively large and consists of two parts, one posterior to the other; it is not enclosed in a bony capsule. The pharyngeal bones are comparatively stout and the pharyngeal teeth are arranged in three rows; they are relatively long and more or less sharply pointed.

The following may serve as a key to the three species of the genus:—

1. Barbels absent.
   (*a*) Air-bladder showing signs of degeneration, fins moderately expanded, curved grooves proceeding backwards and outwards from the angles of the mouth ... ... *P. balitora.*
   (*b*) Air-bladder fairly well-developed, paired fins greatly expanded, undersurface of head flat and without any grooves ... ... *P.* sp. (juv.).
2. Pair of barbels present.
   (*c*) Lower lip bilobed, air-bladder quite normal, fins moderately expanded ... ... *P. tentaculatus.*

Psilorhynchus balitora (Ham.-Buch.).

1822. *Cyprinus balitora*, Ham.-Buch., *Fishes of Ganges*, pp. 348, 430.
1838. *Psilorhynchus variegatus*, McClelland, *Asiatic Researches*, pp. 300, 430.
1842. *Cyprinus balitora*, Cuv. and Val., *Hist. Nat. des Poissons*, XVI, p. 451.
1868. *Psilorhynchus balitora*, Günther, *Cat. Fish.*, VII, p. 343.
1871. *Psilorhynchus balitora*, Day, *Journ. As. Soc. Bengal*, p. 106.
1889. *Psilorhynchus balitora*, Day, *Fauna Brit. Ind. Fish.*, I, pp. 244, 245.

McClelland the author of the genus does not recognise any type-species. His figure of *Psilorhynchus sucatio* (=*Cyprinus sucatio*, Ham.-Buch.) looks very much like a species of *Homaloptera* on account of its elongate snout, but the absence of oral barbels removes it from that genus. Day has put it as a synonym of *H bilineata*, but as I have no specimens of this species to refer to, I am unable to confirm his suggestion. *P. variegatus*, McClelland is, as he himself states, a synonym of *Cyprinus balitora*, Ham.-Buch. I take this as the type-species of the genus.

There are only two specimens in the old collection of the Indian Museum. Both of these are very old and badly preserved and have grown very brittle. The specimen (Cat. No. 940) was presented by Mr. Beavan and is labelled as being the type-specimen of the species, but there is reason to believe that none of Hamilton-Buchanan's specimens passed into the collection of the Indian Museum. The second specimen (No. 1098) was purchased from Day and is the original of his figures in the *Fishes of India.*

The condition of these specimens does not permit of any detailed description. I have, however, partially dissected them

to see the nature of the air-bladder, which in the genus shows progressive degeneration from the normal type. Indeed even in these two specimens it shows a marked difference. In specimen (No. 1098) the air-bladder is very much reduced. The essentials of a normal Cyprinid type are retained, though they are not well marked. The posterior chamber is relatively small, while the anterior one is covered by thick fibrous tissue. The coating of fibrous tissue is incomplete anteriorly where the bladder abuts against the platform formed by the transverse processes of the second vertebra, while posteriorly it admits the passage to the posterior chamber of the bladder. The transverse processes of the second vertebra show a marked expansion near their vertebral ends, much as was noticed in describing the air-bladder of *Balitora brucei*, but in that species the vessel is not covered by a fibrous

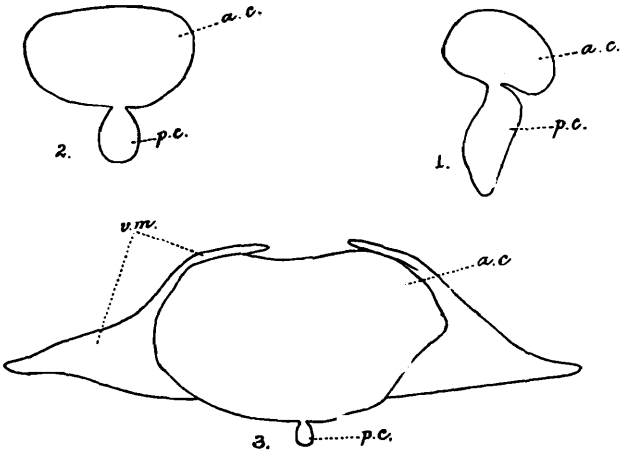

FIG. 3.—Modifications of the air-bladder in the genus *Psilorhynchus*.
1. Air-bladder of *Psilorhynchus* sp. (juv.) × 8.
2. Air-bladder of *Psilorhynchus balitora*, specimen Cat. No. 940. × 8.
3. Air-bladder of *Psilorhynchus balitora*, specimen No. 1098, (magnified).
a.c.=anterior chamber; *p.c.*=posterior chamber; *v.m.*=vertebral modifications.

tissue but by a bony capsule. In *B. brucei*, moreover, the posterior chamber of the vessel is absent and the anterior one is divided into two lateral chambers which show a tendency to separate from one another.

In the second specimen (Cat. No. 940.) the air-bladder is comparatively large and is apparently not covered by a thick coat of fibrous tissue. In this case both the chambers are well-developed, but the posterior one seems to have been pushed out of its place during development and comes to lie against the anterior chamber on the left side partly covered by it. The anterior end of the bladder abuts against the specially modified transverse processes of the second vertebra. As the specimen was already opened, I cannot be certain about the exact nature of the covering of the air-bladder in this case; but the two specimens, between which there is no reason to suspect any specific

difference, undoubtedly show a progressive degeneration as regards this organ.

A scale from the base of the dorsal fin is cycloid in outline with an irregular flat base and an arched apex. The nucleus is situated close to the base, about 9 radii going out from it to the apex. The number of circular striae is indefinite; there may be as many as twenty. Near the base they come very close to one another and are difficult to count.

Since the above description was written, I have found four well-preserved specimens (collected by Dr. Annandale, F $\frac{5605\text{-}8}{1}$) in the unnamed collection of the Indian Museum. All of these are young, the longest being 25 mm. in total length.

The chest and the belly are flat, naked and highly muscular. The upper lip is thick and muscular but not fringed, the lower lip

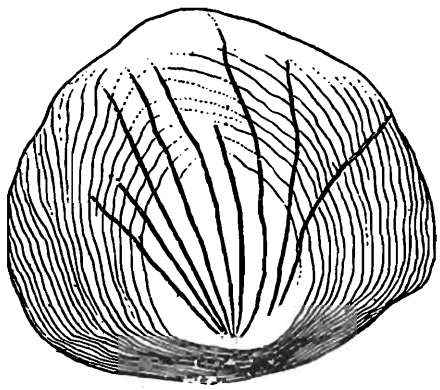

FIG. 4.—Scale from base of dorsal fin of *Psilorhynchus balitora.*

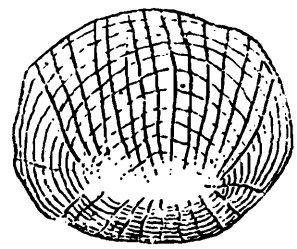

FIG. 5.—Scale from base of dorsal fin of *Psilorhynchus tentaculatus.*

and the area just behind it are tuberculated. At the angles of the mouth there are fleshy appendages.

The air-bladder is not covered by a thick fibrous coat and is quite normal except that the posterior chamber is much reduced and the anterior one slightly expanded.

Localities:—Both the old specimens are from the Khasi Hills, Assam. Those collected by Dr. Annandale are from the Mahananda River at Siliguri (alt. 200 ft.), just below the Darjiling Himalayas.

Psilorhynchus(? tentaculatus, Annandale.[1]

1919. *Psilorhynchus tentaculatus*, Annandale, *Rec. Ind. Mus.* XVI, p. 128.

The air-bladder in this species is quite of the normal Cyprinid type, the posterior chamber being larger than the anterior one.

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[1] In a paper to be published shortly I give reasons for placing this species in a separate genus.

In all probability, therefore, the species is the most primitive of those I assign to *Psilorhynchus*.

A scale from the base of the dorsal fin is almost cycloid in general appearance with a slightly irregular flat base. The nucleus is situated close to the base. There are about 15 radii to the apex and 11 to the base. The number of circular striae varies from 9—15 proceeding from the base to the apex.

Localities:—Poona and Satara districts of the Bombay Presidency at altitudes of 2000—3000 ft. A specimen from Panchmari in the Mahad Hills in the Central Provinces (*F. H. Gravely*) is also present in the collection of the Z.S.I.

Psilorhynchus sp. (juv.).

A few young *Psilorhynchus* were recently captured by myself in a hill stream at Piphima in the Naga Hills. I have not been able to refer these young individuals to either of the two known species, but I do not think myself justified in drawing up the description of a new species from them on account of their immaturity. I am including the following notes in this paper to facilitate reference in future.

D. 3/6. A. 1/5. P. 6/11. V. 2/6.

The fish has a graceful form with the head and body moderately depressed. The ventral profile is almost horizontal, while the dorsal is slightly arched, being highest near the commencement of the dorsal fin. The paired fins are greatly expanded and possess a number of unbranched rays which are provided with muscles on their ventral aspect. The dorsal commences slightly in advance of the ventral, and the pectorals when adpressed do not reach the ventrals. The mouth, which is situated on the undersurface slightly behind the anterior end of the snout, is provided with thick, almost continuous lips. The lower lip is rather interesting. It can be divided into four pieces, two prominent tubercles in the middle and relatively broad flaps adjacent to them, one on each side. The lips, the undersurface of head and its sides are covered with glandular tubercles. Probably the mouth can be converted into a suctorial disc but the muscular structures connected therewith cannot be made out in my specimens.

There are no scales, probably on account of the immaturity of the specimens.

The air-bladder in this little fish is very interesting. While in all essentials it is like that of normal Cyprinid fishes, it shows certain retrogressive modifications. The posterior chamber is small as compared with the anterior one, which is more flattened laterally than in the normal forms. The bladder lies quite free in the abdominal cavity without any thick fibrous sheath and is not otherwise abnormal.

The fish is pale olivaceous with a large number of irregular black dots scattered all over the body, the upper surface and

sides of the head. These dots are arranged in a regular row along the middle line on each side; below this they become fewer in number and totally disappear from the undersurface of the head and body. The fins are colourless.

A complete specimen measures 21 mm. in length. The length of the caudal is 4·5 mm. and that of the head about 4·2 mm. The length of the head is contained $4\frac{2}{3}$ times in the total length and about $3\frac{7}{10}$ times in the length without the caudal. The eyes are situated about the middle of the head and are directed outwards and upwards.

Locality :—Piphima in the Naga Hills, Assam, at an altitude of 3000 feet.

The specimens were captured during the month of February, 1920.

The following observations were made in the field by keeping the fish alive in water in a glass tube:—

The pectoral fins were pressed against the sides of the tube, their undivided rays being in close contact with the glass, while the divided rays were in constant motion. The fish was also observed opening and closing its mouth constantly and sometimes it was seen to dart rapidly from one place to another, probably by the help of its unpaired fins, but the movements were too rapid for detailed analysis in the circumstances.

The families of Cyprinoidea may be distinguished by the nature of the air-bladder. By most of the older authors the sub-order was divided into three families, which would be distinguished thus:—

"Air-bladder well-developed, divided into two chambers arranged longitudinally and lying free in the abdominal cavity	1. Cyprinidae.
Air-bladder divided into two lateral chambers and enclosed by a bony capsule	2. Cobitidae.
Air-bladder absent	3. Homalopteridae.

We now know that the Homalopteridae possess an air-bladder which is of the same type as is found in the Cobitidae. But whereas in the Cobitidae the two lateral chambers are still connected by a tube, and sometimes a small process may be present directed backwards from the tube, probably representing the posterior chamber of the typical Cyprinoid fishes; in the Homalopteridae the two lateral chambers show a tendency to separate off from one another and all remains of a posterior chamber are absent. The Homalopteridae are more highly specialized for a life in mountain torrents than the Cobitidae, and probably the further reduction in the air-bladder of the former is due to this adaptation. The uniserial nature of the pharyngeal teeth in both of these families points to their close relationship.

The species of *Psilorhynchus* show a marked resemblance to those of *Homaloptera* or *Bhavania*, but as is abundantly clear from dissections the resemblances are only superficial. Life in hill-

torrents has called for the reduction of the bladder, but it has not gone so far as in the two families mentioned above. In *P. tentaculatus* the air-bladder is quite normal. In *Psilorhynchus* sp. the posterior chamber is reduced while the anterior one shows lateral expansions. In some individuals of *P. balitora* (Cat. No. 940.) the posterior chamber is pushed out of its place and comes to lie close to the anterior one, partly covered by it, while an extreme phase is reached in other individuals of the same species (No. 1098), in which the bladder is much reduced but still retains the essentials of the normal form, the posterior chamber being very small while the anterior one is covered by a thick fibrous coat. Even the vertebral elements near the bladder show slight modifications.

When dealing with forms especially adapted to a particular environment it is very difficult to distinguish homologous from analogous characters and there is always a probability that fishes coming from an absolutely different stock have been similarly modified in response to a particular environment. In a former paper by Dr. Annandale [1] and the author it was pointed out that two absolutely different stocks, Schizothoracinae and Salmonidae, have come to have a close superficial resemblance to one another, owing to their life in rapid running streams which necessitates migrating up stream at certain periods in their lives. Numerous other such instances could of course be adduced.

Day in his *Fishes of India* points out that the genus *Psilorhynchus* is intermediate between *Homaloptera* and *Discognathus*. We have already seen that *Homaloptera* is closely allied to the Cobitidae, whereas *Psilorhynchus* belongs to the Cyprinidae. It will be worth while to discuss its relations with *Discognathus* at this stage. I agree with Dr. Annandale [2] that *Psilorhynchus* is not a primitive form of *Discognathus*, but that both of these genera have been evolved from a primitive form like *Crossochilus* or *Labeo* and show a parallel evolution. The specialisation in the former is due to its life in mountain streams, while that in the latter is due primarily to its peculiar mode of feeding The forms like *Garra nasutus* and *D. blandfordii*, which in all probability have come to live secondarily in hill streams, the muscles of the chest are modified like those found in *Psilorhynchus*, and thus true convergence is established.

The following has been the probable course of evolution in these different genera, so far as it can be known in the present state of our knowledge:—

Taking *Labeo* as a central type of Cyprinidae I believe that the evolution of a form like *Crossochilus* has taken place; from this evolution proceeded along two lines which ran more or less parallel to one another. One of these lines culminated in *Psilorhynchus*

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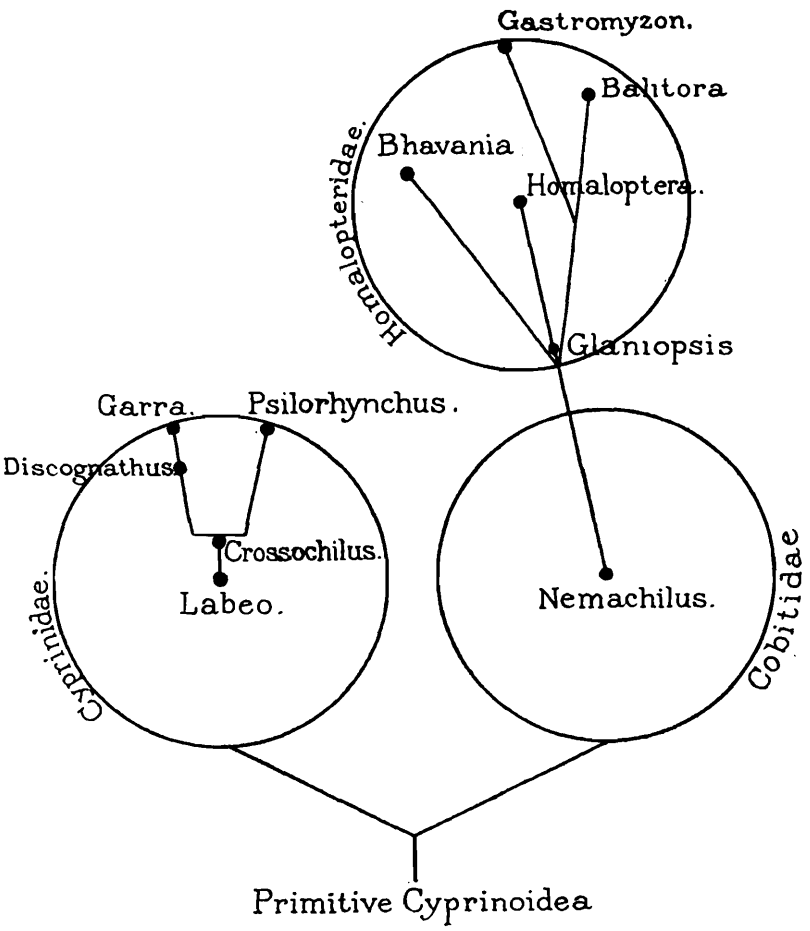
[1] Annandale and Hora, *Rec. Ind. Mus.* XVIII, p. 168.
[2] Annandale, *Rec. Ind. Mus.* XVI, pp. 113—116.

and the other in *Garra*[1] with *Discognathus* as an intermediate form.

I believe that the evolution of the Homalopteridae has occurred along the line of the Cobitidae of which we may take *Nemachilus* as a central genus. Among the *Homalopteridae*, a Bornean genus *Glaniopsis*, Boulenger,[2] is very much like *Nemachilus*,



as can be inferred from its figure in Beaufort and Max Weber's *Fishes of the Indo-Australian Archipelago*. This peculiar Homalopterid genus possesses a pair of barbels between the two nostrils and we know that a similar pair of barbels occurs in an Indian loach *Nemachilus evezardi*.[3] Of the three Indian genera of this family, *Homaloptera* is the most primitive, *Bhavania* has evolved independently from the same stock in South India and *Balitora*, the most highly specialized genus, has also been independently evolved from the original primitive stock. The extreme form of specialisation is reached in another (Bornean) genus *Gastromyzon*,[4] Günther; but the discussion of the forms outside India is beyond the scope of the present paper.

The relationships of the various genera discussed in this paper are graphically represented on the opposite figure.

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1 Annandale and Hora, *Rec. Ind. Mus.* XVIII, p. 162.
2 Boulenger, *Ann. Mag. Nat. Hist.* (7) IV, p. 228 (1899).
3 Annandale, *Rec. Ind. Mus.* XVI, p. 114 (1919).
4 Günther, *Ann. Mag. Nat. Hist.* (4) XIV, p. 454 (1874).

In conclusion I have to express my sincere thanks to Dr. N. Annandale, Director, Zoological Survey of India, for suggesting to me this interesting line of work and for the great help and valuable suggestions that he gave to me from time to time while I was carrying it out. I hope to deal later in greater detail with certain structural modifications of these and other analogous fish from mountain torrents.

EXPLANATION OF PLATE X.

Bhavania annandalei, sp. n.

FIG. 1.—Type-specimen (adult female) from Tenmalai, × 1½.

FIG. 2.—Ventral surface of head of same specimen, × 3.

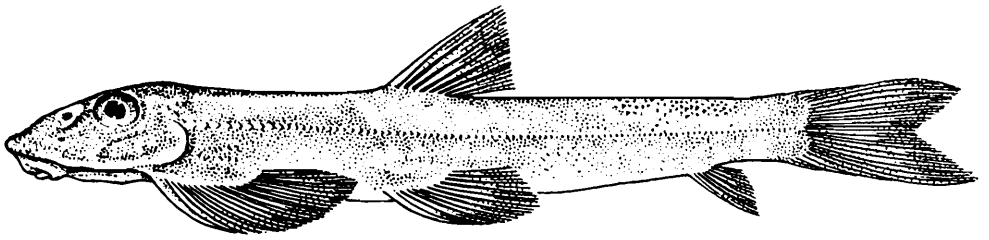
FIG. 3.—Dorsal surface of head of same specimen, × 3.

Bhavania australis (Jerdon).

FIG. 4.—Young specimen from base of Nilgiri Hills, × 3.

FIG. 5.—Ventral surface of head and chest of same specimen, × 4.

FIG. 6.—Dorsal surface of head of same specimen, × 4.



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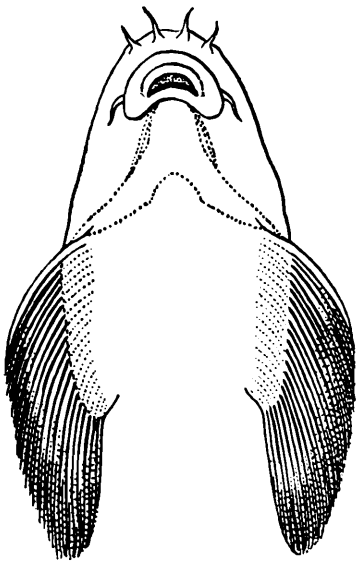

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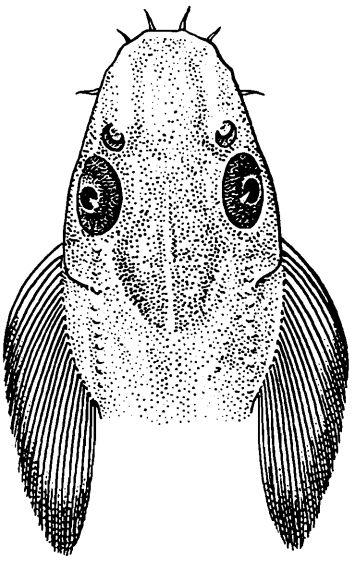

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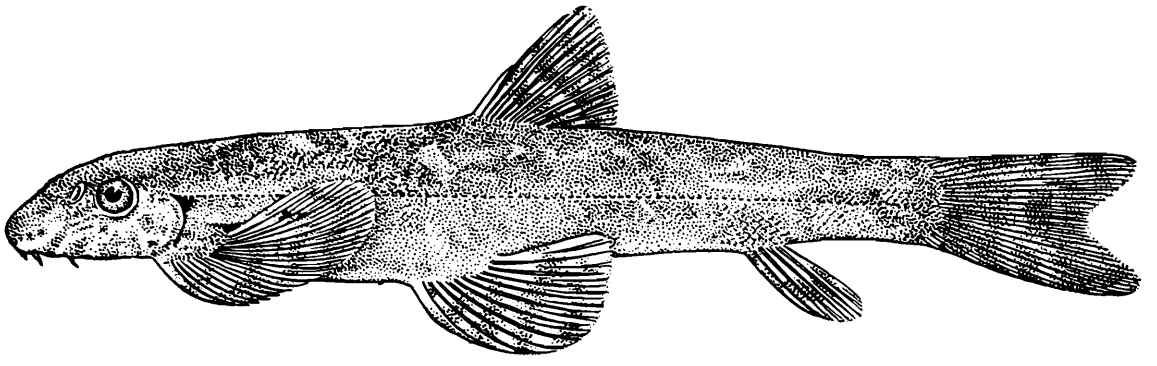

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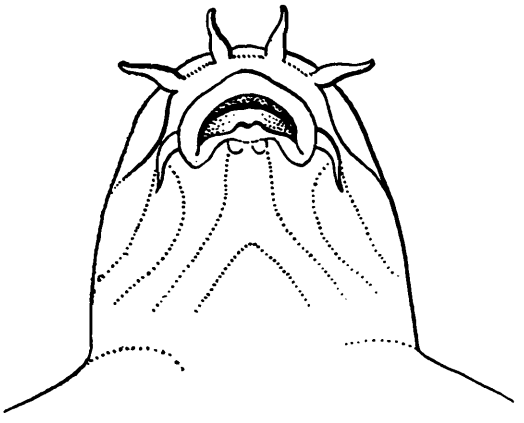

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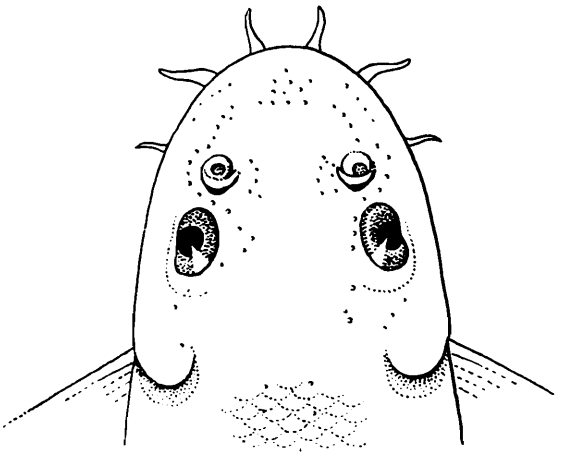

3.

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EXPLANATION OF PLATE XI.

Balitora maculata, Gray and Hard.

FIG. 1.—Scale from base of dorsal fin, × 30.

Balitora brucei, Gray and Hard.

FIG. 2.—Scale from base of dorsal fin, × 30.
FIG. 3.—Pharyngeal bone (magnified).
FIG. 4.—Air-bladder *in situ*, × 5.

Bhavania annandalei, sp. n.

FIG. 5.—Type-specimen, scale from base of dorsal fin, × 30.
FIG. 6.—Day's specimen (No. 1510), scale from base of dorsal fin, × 30.
FIG. 7.—Pharyngeal bone of same, × 10.

Bhavania australis (Jerdon).

FIG. 8.—Pharyngeal bone of a young specimen, × 30.

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