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

No. 5.—The Indian Planorbidae.

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

The Planorbidae are distinguished from their allies the Limnaeidae and Physidae by well-defined conchological, anatomical and physiological characters. In their dextral bodies they come nearest the Physidae (which are not represented in the Indian fauna) and in the sinistral more or less ovate shells of one of their two subfamilies (the Bullininae) there is also a close resemblance to the same family, but important differences are to be found in the radulae, the lateral teeth of which in the Planorbidae are simply cusped, while in the Physidae they bear a curious lateral process. A still more important difference is to be found in the colour of the blood, which is red in both subfamilies of the Planorbidae and colourless in the Physidae and also in the Limnaeidae and Ancylidae. The Bullininae, moreover, comprise comparatively few species and the much more numerous Planorbinae have disc-shaped shells quite unlike those of any of the other two families.

The genitalia of the Planorbidae show great diversity in the structure of the male organ, but otherwise conform to the same type as those of the Limnaeidae. The digestive system is also similar, allowance being made for the more elongate type of body, correlated with the difference in shell-form, in the Planorbinae. The jaws in most genera consist, as in *Limnaea*, of a central more or less lunate or sublinear upper transverse piece and of two slender vertical sidepieces; but in some species they are broken up into many horny teeth as in the Ancylidae. The radulae bear smaller teeth with shorter and often more numerous cusps than in *Limnaea*.

There is present on the left side of the body in the Planorbidae a vascular outgrowth (pseudobranch) of more complex structure in some genera than in others.

Before discussing the subfamilies and genera I wish to say a few words about the colour of the blood. In all the Planorbid genera I have examined, including *Bullinus* and *Camptoceras* among the Bullininae, it is some shade of red or pink, but its colour is much more intense in some species than in others. In certain minute lacustrine forms, indeed, such as *Gyraulus velifer* [1] it

[1] Annandale, *Rec. Ind. Mus.* XIV, p. 112, pl. xi, figs. 7-11 (1918).

appears at first sight to be colourless, but even in *G. velifer* the tentacles of the living animal have a faint pink tinge under a high power of the microscope and if the mollusc be killed suddenly, as with hot corrosive solution, a distinct pink drop can be seen in the region of the heart through the transparent shell. Intensity of colour in the blood is, however, not correlated with size, for the tint is a deep scarlet both in *Indoplanorbis exustus*, the largest, and in *Intha capitis*, the smallest Indian species known to me. It is, perhaps, correlated in some species and to some extent both with external pigmentation of the body and with habitat. *G. velifer* has as a rule very little external pigment and even in pigmented individuals from the Inlé Lake the blood is only a faint pink, though it is deep red in *I. capitis* from the same habitat; but in individuals of the former species from canals and swamps, where pigmentation of individuals of *G. velifer* is more general and as a rule more intense, the blood is slightly pinker, but still much paler than it ever is in the closely allied *G. convexiusculus* and *G. euphraticus*, species that are always pigmented. In both *Bullinus* and *Camptoceras* it is bright red.

The Planorbidae may, as a matter of convenience, be separated, as already indicated, into two subfamilies: the Bullininae (or Isidorinae) and the Planorbinae. In the former the shell is hardly to be distinguished from that of the Physidae, while in the latter it is disc-shaped or at least discoidal. These differences in the shell do not seem to be correlated with any important differences in the soft parts, which show considerable generic variation in both subfamilies.

Subfamily *PLANORBINAE*.

In dealing with the Planorbinae most European authors include the species in a single genus with many subgenera. These subgenera were founded, almost without exception, on shell-characters only, but subsequent investigations have shown that shell-characters are supported by others in the radulae and soft-parts, and it seems to me preferable to regard the "subgenera" as true genera. In his invaluable *Catalogue of the Planorbidae in the Indian Museum*, of which only a part has yet appeared (*Rec. Ind. Mus.* XXI, 1921), Germain regards *Segmentina* as distinct from *Planorbis*, in which he includes as subgenera *Gyraulus*, *Diplodiscus* and *Hippeutis*, here treated as genera; but in so doing he relies solely on conchological evidence. I have found it necessary not only to recognize the one large Indian discoidal Planorbid (*Planorbis exustus* Deshayes) as representing a distinct genus on anatomical grounds, but also to describe a new genus based both on shell and on anatomy, with a minute Burmese species as genotype.

In the structure of the soft parts the Planorbinae show much greater diversity than the allied families. In the genitalia Simroth [1]

[1] Simroth, in Bronn's *Tier-Reichs*, Mollusca III, p. 502, figs. (1912).

has recognized four distinct types of male organ. All but one of these are found in the Indian species, as well as a fifth. Slightly modifying Simroth's definitions and adding one of the fifth type, they may be defined as follows:—

TYPE I. Penis short, bulbous, asymmetrical, without a penial stylet, with an elongate, thick-walled praeputium. Sheath with two retractor muscles. (Indian genera, *Intha*, gen. nov.; ? *Planorbis* Geoffroy.)

TYPE II. Penis slender, elongate, asymmetrical at the tip, with a comparatively short, thick-walled praeputium, without a penial stylet. Sheath with a pair of ear-like processes above, with a single retractor muscle. (Indian genus, *Segmentina* Flemming.)

TYPE III. Penis cylindrical, symmetrical, without a penial stylet, with a short, thin-walled but well differentiated praeputium and two retractor muscles. (No Indian genus.)

TYPE IV. Penis cylindrical, but asymmetrical at the tip, with a horny stylet and a praeputium of complex structure. Sheath with a single retractor muscle. (Indian genera, *Gyraulus* Agassiz; ? *Diplodiscus* Westerlund.)

TYPE V. As in type III, but without differentiated praeputium and with the penis very long and sometimes coiled in the sheath (Indian genera, *Indoplanorbis* Annandale and Prashad; *Hippeutis* Agassiz.)

Type V is closely allied to type III but may for convenience be considered distinct.

The radulae of the different genera are not so distinct as the genitalia, but afford good characters in some instances. In *Indoplanorbis* the teeth are relatively large and the whole organ is broad. In *Hippeutis* the lateral teeth are arranged in pairs.

The jaws differ more markedly. In *Indoplanorbis* and *Gyraulus* they consist of a comparatively stout but almost linear transverse upper piece and of a pair of slender vertical side-pieces, which in *Indoplanorbis*, as my assistant Mr. Sri Navasa Rao has observed, are fragmented; but in *Segmentina* (at any rate in some species) and in *Intha* the three pieces are completely broken up into numerous horny teeth as in the Ancylidae.

Key to the Indian Genera of Planorbinae.

I. Shell comparatively thick and large (as a rule well over 1 cm. in diameter); whorls convex above and below without peripheral keel. No penial stylet.
  A. Young shell discoidal. Pseudobranch simple. Male organ of type I ... ... *Planorbis.*
  B. Young shell *Physa*-like. Pseudobranch when expanded ribbon-like with alternate depressions and projections, lobed in contraction. Male organ of type V ... ... *Indoplanorbis.*

II. Shell small and thin, usually less than 1 cm. in diameter, at least one surface more or less flattened
  A. Shell with internal ridges of enamel-like substance, of a flattened and truncate conoidal shape. Male organ of type II ... ... *Segmentina.*

B. Shell without internal ridges. Male organ not of type II.
1. Shell flattened and disc-like, often carinate, but never excessively so, its aperture lunate. Male organ of type IV.
a. Whorls not more than four, increasing rapidly; the body-whorl much broader than the penultimate ... ... *Gyraulus.*
b. Whorls more than four, increasing gradually; the body-whorl not much broader than the penultimate ... ... *Diplodiscus.*
2. Shell more or less of the form of a flattened conoid, with the aperture cordate. Male organ not of type IV.
a. Spire partly exposed on upper surface of shell. Male organ of type V, but with the penis coiled inside the sheath ... *Hippeutis.*
b. Body-whorl completely occluding spire. Male organ of type I ... ... *Intha*, nov.

Genus **Planorbis** Geoffroy (1776).

1921. *Planorbis* s.s., Germain, "Catalogue of the Planorbidae in the Indian Museum," *Rec. Ind. Mus.* XXI, pp. 619.

There is great doubt as to the occurrence of the true *Planorbis* (taking *Helix corneus* L. as type-species) in the Indian Empire. I include it here on the evidence of Clessin's figure of *Planorbis hindu*,[1] but both the provenance and the generic position of this species are doubtful. It may be a *Gyraulus*, and may not be Indian.

Genus **Indoplanorbis** Annand. & Prashad (1920).

1920. *Indoplanorbis*, Annandale and Prashad, *Journ. Ind. Med. Res.* VIII, p. 112.
1921. *Indoplanorbis*, *iid.*, *Rec. Ind. Mus.* XXII, p. 537.

In our recent account of this genus we failed to observe the retractor muscles of the penis-sheath, and also to recognize the fundamental agreement in structure of the male organ with Simroth's type III. The muscles are two in number, one situated at the upper end of the sheath, the other a short distance down its side, but relatively higher than in Simroth's diagram. When not distorted by the presence of spermatophores the sheath is more sausage-shaped than our figure would indicate (*op. cit.*, 1921, p. 579, fig. 14) and the penis can be much contracted, but without losing its straight cylindrical form.

The only species of the genus with which I am acquainted is *Planorbis exustus* Deshayes. Germain has discussed the variations and growth of the shell in a masterly manner (*op. cit.*, 192, pp 34–41, figs. 2–16).

[1] Clessin on *Planorbis* in Martini and Chemnitz's *Conch. Cab.* (ed. Kuster and Duncker).

Genus **Gyraulus** Agassiz (1837).

1919. *Gyraulus*, Annandale & Prashad, *Rec. Ind. Mus.* XVIII, p. 52.
1921. *Gyraulus*, Germain, *op. cit.*, p. 8.

Most of the smaller Indian Planorbidae are comprised in this genus. The species I have examined are *G. euphraticus* Mousson, *G. convexiusculus* (Hutton), *G. labiatus*, *G. cantori* and *G. rotula* Benson, but Germain also assigns to the subgenus (as he conceives it) *G. himalayanus* (Hutton). I think he is wrong in assigning *cantori* to *Segmentina*, though he follows Benson and other early Indian conchologists in so doing.[1]

The type-species of *Gyraulus* is *Planorbis albus* Müller, which is widely distributed in the Palaearctic Region.

Genus **Diplodiscus** Westerlund (1897).

1921. *Diplodiscus*, Germain, *op. cit.*, p. 7.

I have not seen any Indian species of this genus, but Germain assigns to it Benson's *Planorbis hyptiocyclos* from Ceylon. According to Simroth[2] the type-species (*Helix vortex* L.) has the male organ of the same type as that of *Gyraulus*, viz. *P. albus* Müller.

Genus **Hippeutis** Agassiz (1837).

1921. *Hippeutis*, Germain, *op. cit.*, p.
1921. *Hippeutis*, Annandale and Prashad, *op. cit.*, p. 584.

Dr. Prashad has been able to confirm our recent identification of Benson's *P. umbilicalis* as belonging to this genus by an examination of the anatomy of a European species.[3] The male organ of the latter resembles that of *Indoplanorbis* except that the penis is coiled inside the upper part of the penis-sheath. This character is still more strongly marked in *H. umbilicalis*, in which, however, the praeputium is apparently longer. The radulae of the two species also agree in general characters and in particular in having the lateral teeth arranged in pairs as if twinned.

The only Indian species I have seen is *Planorbis umbilicalis* Benson. *P. sindicus* Benson also probably belongs to the genus, but his *P. caenosus* is a *Segmentina*.

Intha, gen. nov.

In this genus the body-whorl, though relatively smaller than it is in *Hippeutis*, completely embraces and occludes the rest of

[1] See Annandale and Prashad, *Rec. Ind. Mus.* XXII, p. 583 (1921).
[2] Simroth, *op. cit.*, p 503.
[3] The specimens examined belong to a very large and well-developed phase from the mouth of the Var in the south of France. They seem to me, however, to be at least generically identical with typical shells of *H. fontanus*, the type-species, from England which Mr. Tomlin has been kind enough to give me. My French shells apparently belong to the form called *euphaeus* Bourg. by Germain in his *Mollusques de la France*, tom. II (1913).

the shell in such a way that the spire is entirely concealed, except in so far as it can be detected by transparency. The shell is very minute and has few whorls, which increases in size rapidly. Those of the spire are cylindrical, but the body-whorl is flattened below and has the form of a flattened conoid slightly truncate above. The outer lip arises in the middle of the upper surface and forms a small lobe at its point of origin. The aperture is large and very oblique but with a cordate outline. There is a well-developed simple callus on the inner lip, but internal ridges are completely absent. The lower surface is narrowly umbilicate. The external surface is practically smooth.

The animal is remarkable externally for the large upper and lower lobes into which the mantle is divided. The pseudobranch is poorly developed. The jaw is broken up into many horny teeth as in *Segmentina* and *Ancylus*. The radula is very minute but appears to be quite normal. The male organ resembles that of *Planorbis*, except that the penial bulb is relatively very large.

Type species. *Intha capitis*, sp. nov.

Intha capitis, sp. nov.

The type-species may be described here very briefly. I hope to discuss it at greater length shortly in a second paper on the Inlé fauna.

Shell minute (2·5 × 2 × 1 mm.), colourless, hyaline but rather thick, highly polished, with the upper surface somewhat convex, with about 3 whorls; a minute pinhole on the upper surface at the base of the outer lip, which bears a minute lobe at its point of origin. Aperture very large; the callus of the inner lip broad and rather opaque, extending outwards on the shell beyond the lip, but not greatly thickened. Lower surface quite flat, very narrowly umbilicate. External surface with fine curved vertical striae; no spiral sculpture.

Habitat. He-Ho and Inlé valleys (3000–3800 ft.), Southern Shan States, Burma (recent and subfossil).

Type-specimen. No. M 11998/2, *Zoological Survey of India.*

Segmentina Flemming (1828).

1919. *Segmentina*, Annandale and Prashad, *op. cit.*, p. 56.
1921. *Segmentina*, Germain, *op. cit.*, p.

The Indian species examined are *P. calathus* and *P. caenosus* Benson and an undescribed species from the Southern Shan States. Benson's *P. trochoideus* also undoubtedly belongs to it. In *P. caenosus* the internal ridges are often poorly developed and concealed by the opacity of the shell, but at least traces of them can always be detected on close examination.

The type-species is the Palaearctic *Planorbis nitidus* Müller, to which *P. calathus* is closely related.

Subfamily *BULLININAE* (*ISIDORINAE*).

The only living Indian genus is *Camptoceras* Benson, but in late cretaceous times the gigantic *Bullinus* (*Platyphysa*) *prinsepii* (Hislop) and the same author's "*Physa*" *elongata*, for which a new genus will ultimately have to be created in the same subfamily, were dominant forms in the Indian freshwater fauna.

Genus Camptoceras Benson (1843).

1919. *Camptoceras* Annandale & Prashad, *Journ. As. Soc. Bengal* (n.s.) XVI, p. 457.
1919. *Camptoceras, iid., ibid.*, XVII, p. 27.

Four Indian and one Japanese species are now known, and I have another, as yet undescribed, from the Southern Shan States, where it was found subfossil.

The external structure of the animal is very like that of *Gyraulus* except that there is a large anal siphon constructed of a leaf-shaped epipodium which is coiled up spirally to form a funnel each time the animal expands. This has been observed both in the Japanese and in one of the Indian forms. The blood is deep red. Very little is known of the genitalia, but there is no penial stylet or flagellum. The jaws resemble those of *Planorbis* and the radula is of normal Planorbid type. The pseudobranch is simple.

The type-species is *C. terebra* Benson from the United Provinces. Other Indian species are *C. austeni* and *C. lineatum* Blanford from Eastern Bengal, *C. subspinosum* Annand. & Prashad from Kashmir. *C. lineatum* has also been found in Manipur, Assam.

The genus may be divided into two groups as follows:—

CAMPTOCERATA LINEATA. Shell ovate but dissolute, with spiral lines of minute chaetae.

Species—*C. lineatum* and *C. subspinosum*.

CAMPTOCERATA TEREBRAE. Shell definitely cornucopia-shaped, without chaetae.

Species—*C. terebra*, *C. austeni*, *C. hirasei* (Japan) and an undescribed subfossil Burmese species.