# FAUNA OF THE CHILKA LAKE.

## MOLLUSCA GASTROPODA (REVISION).

*By* the late N. ANNANDALE, *D.Sc., C.I.E., F.R.S., Director, Zoological Survey of India.*

(With 16 text-figures.)

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## INTRODUCTION.

In the former report on the Mollusca, published in this "Fauna" in 1916 (pp. 329-366 by Dr. Kemp and myself, we made no attempt to revise the gastropods. With the exception of the nudibranchs, which were described by Sir Charles Eliot, the collection had been worked out in the British Museum by Mr. H. B. Preston, whose identifications we accepted. Since 1916 circumstances have compelled me to undertake the taxonomic study of the gastropods myself and I have re-examined the Chilka collection. I regret to say that I find myself unable to accept a large proportion of Mr. Preston's determinations. Out of 31 names indeed, I am able to retain only 12, and several of these belong to empty shells of which I have no new data to offer. The reasons for these changes are three :—(1) in the first place I find that the radula and soft parts do not always support the taxonomic position assigned on conchological grounds to small shells of obscure genera, (2) in the second place individual variability is seen to be much greater in larger series of shells than those examined by Mr. Preston and (3) the literature on the subject does not seem to have been consulted with sufficient care in some instances, too much reliance having been placed on the mere matching of shells with specimens "authoritatively named." In saying all this I do not wish to criticize Mr. Preston personally, but rather to animadvert on the unsatisfactory method of working out collections of molluscs which seem to be common in England and other European countries. I have, however, had access to type-specimens in the Indian Museum which were not available in Europe—and Mr. Preston was merely asked to name the shells.

The following are the actual changes proposed. In the first column I give the names approximately in the order used in our former report, the numbers after them being those of the pages in which they are cited in that paper; while the second column contains the names here used.

| | | |
|---|---|---|
| *Tornatina estriata* Preston (341) | becomes | *Didontoglossa estriata* (Preston) gen. nov. |
| *Thais carinifera* (Lam.) ( 346) | ,, | *Cuma disjuncta* Annandale. |
| *Nassa orissaensis* Preston (343) | ,, | *Pygmaeonassa orissaensis* (Preston) gen. nov. |
| *Nassa denegabilis* Preston (343) | ,, | *Pygmaeonassa denegabilis* (Preston). |
| *Potamides fluviatilis* P. & M. (344) | ,, | *Potamides cingulatus* (Gmelin). |
| *Potamides fuscum* Schum. (344) | ,, | *Telescopium telescopium* (Linn.). |
| *Vanesia rambhaensis* Preston (345) | ,, | *Turbonilla rambhaensis* (Preston). |
| *Litiopa copiosa* Preston<br>*Litiopa kempi* Preston (345) | ,, | *Fenella virgata* (Phil.). |
| *Stenothyra blanfordiana* Nev.<br>*Stenothyra chilkaensis* Preston<br>*Stenothyra orissaensis* Preston<br>*Stenothyra obesula* Preston<br>*Stenothyra trigona* Preston (346) | ,, | *Stenothyra minima* (Sow.). |

*Hydrobia miliacea* Nev. (346) becomes *Stenothyra miliacea* (Nev.)
*Chrysallida ecclesia* Preston (347) ,, *Pyrgulina ecclesia* (Preston).
*Chrysallida nadiensis* Preston (347) ,, *Pyrgulina nadiensis* (Preston).
*Neritina souverbiana* Montr. (347) ,, *Smaragdia mamilla*, sp. nov.
*Cyclostrema innocens* Preston (347) ,, *Tubiola microscopica* (Nev.).

I have to describe two new genera and a new species here, and have already described another new species (*Cuma disjuncta*) elsewhere. In only one instance (that of *Tubiola microscopica*) have I proposed a change without examining the animal. Unfortunately, however, I have not had before me in most cases either the living mollusc or even well-preserved specimens, but have been obliged to extract the dried animal from the shell. In only a few species, therefore, has any proper anatomical investigation been possible, for I have been unable for financial and other reasons to collect much new material. The radula has been examined in most species and is figured in the following pages.

The following is a complete list of the gastropod fauna of the lake, omitting shells obviously introduced from the sea by hermit-crabs, etc., into the outer part of the outer channel. I follow the order adopted by Pelseneer in his volume in Lankester's *Treatise on Zoology*.

Fam. Trochidae
*Umbonium vestiarium* (Linn.).
*Solariella satparaensis* Preston.
Fam. Cyclostrematidae.
*Tubiola microscopica* (Nevill).
*Tinostoma variegatum* Preston.
Fam. Neritidae.
*Smaragdia mamilla* sp. nov.
Fam. Fossaridae.
*Chilkaia imitatrix* Preston.
Fam. Rissoidae.
*Stenothyra minima* (Sowerby).
*Stenothyra* (*Gangetica*) *miliacea* (Nev.)
*Fenella virgata* (Philippi).
Fam. Cerithiidae.
*Potamides* (*Tympanotonos*) *cingulatus* (Gmelin).
*Telescopium telescopium* (Linn.).
Fam. Scalariidae.
*Epitonium hamatulae* Preston.
Fam. Pyramidellidae.
*Pyrgulina humilis* (Preston).
*Pyrgulina ecclesia* (Preston).
Fam. Pyramidellidae—*contd.*
*Pyrgulina nadiensis* (Preston).
*Turbonilla rambhaensis* (Preston).
*Odostomia chilkaensis* Preston.
Fam. Nassidae.
*Nassa sistroidea* G. & H. Nevill.
*Nassa marrattii* Smith.
*Nassa* (*Eione*) *labecula* A. Adams.
*Pygmaeonassa orissaensis* (Preston), gen. nov.
*Pygmaeonassa denegabilis* (Preston).
Fam. Muricidae.
*Cuma disjuncta* Annandale.
Fam. Tornatinidae (=Ratusidae).
*Didontoglossa estriata* (Preston), gen. nov.
Fam. Bullidae.
*Haminea crocata* Pease.
Fam. Eolidiidae.
*Cuthona henrici* Eliot.
Fam. Hermaeidae.
*Stiliger pica* Annd. & Prashad.
Fam. Elysiidae.
*Elysia chilkensis* Eliot.

Fifteen families, with twenty-two genera and twenty-eight species, are represented in the list. A number of species, genera and even families, however, have not penetrated into the main area of the lake. The Trochidae, Cyclostrematidae and Neritidae (all the Rhipidoglossa in fact) are found only in the outer channel and this is also true of the Fossaridae, Scalariidae, Bullidae and Elysiidae. Only eight families occur in the main area.

The genera completely at home in this area are *Stenothyra* (with its subgenus *Gangetica*), *Turbonilla*, *Potamides*, *Pygmaeonassa*, *Cuma*, *Didontoglossa*, *Cuthona* and *Stiliger*. Two other genera (*Nassa* in its subgenera *Eione* and *Pyrgulina*) frequent the outer part of the main area as well as the outer channel, but do not commonly penetrate into the further parts of the former. I take the eight genera, therefore, to represent the true semi-lacustrine Chilka fauna. It is noteworthy as illustrating the eclectic character of this fauna that six of the eight genera are represented by single species each and two by two species each. No true fluviatile or lacustrine families are represented,[1] but the genera *Stenothyra* and *Potamides* include species found occasionally or even habitually in fresh water, and *Pygmaeonassa* is, so far as we know, a brackish-water genus. The others are all marine but physiologically adaptable.

The list is remarkable as a whole mainly on account of the absence of many genera and even families characteristic of brackish water, for example the Littorinidae, Assimineidae and Auriculidae. All genera of Neritidae except the marine *Smaragdia* are also lacking, while the Cerithiidae are represented by only two species. All these molluscs are however, amphibious or almost terrestrial in habits and are at home mainly in mangrove-swamps, where they attach themselves to the roots or trunks at low water, and there are no mangrove-swamps round the Chilka Lake.

The families now best represented on the list are the Pyramidellidae, with five species belonging to three genera, and the Nassidae, also with five species which, however, belong to only two genera. The former are mud-dwellers, the latter actively predaceous or carrion-feeders.

I have nothing new to say about the nudibranchs, which have already been described adequately, or about the Fossaridae and Scalariidae, about two species of *Nassa* (*N. marrattii* and *N sistroidea*) or about the Trochid *Solariella satparaensis*, of all of which I have only empty shells.

I have to thank Dr. Baini Prashad and my assistant Mr. H. Srinivasa Rao for much help in extracting radulae and making preparations. To the former I am also indebted for valuable suggestions. Babu D. N. Bagchi has prepared the anatomical figures under my supervision with his usual skill. Those of living animals were drawn by Babu A. C. Chowdhury from molluscs brought alive to Calcutta.

## Remarks on Species.

### Fam. TROCHIDAE.

### **Umbonium vestiarium** (Linn.).

1893 (?) *Rotella vestiaria*, Troschel, *Geb. der Schencken*, II, p. 220, pl. xxi, fig. 5 (radula).

This is a common and widely spread mollusc which makes its way into the outer channel of the lake. Its radula has been figured by Troschel, whose figure, though not actually in-

[1] In the flood-season the shallow margins of the lake often contain fresh water at certain places and are even joined on to the rice-fields. In such places and occasions freshwater forms (*e. g. Indoplanorbis exustus*, *Viripara bengalensis* and *Pachylabra virens*) are to be found, but they do not enter any permanent part of the lake.

correct, is misleading owing to its insufficient magnification. The formula is approximately 37. 2. 7. 2. 37, but it is very difficult to count the marginals (fig. 1) as they are all closely

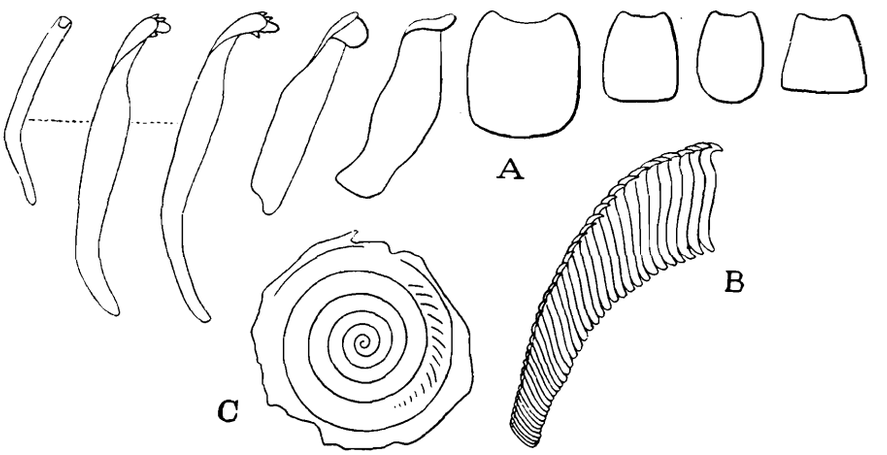


FIG. 1.—Radula and operculum of *Umbonium vestiarium*.

A, Radular teeth, ×500. B, Lateral series of teeth, ×167. C, Operculum, ×7.

pressed together in each transverse row in an oblique curved line. The centrals are simple, more or less quadrate plates without cusps and with the free upper margin concave. The two laterals on each side are considerably longer and narrower and have a simple lobe-like cusp. The marginals decrease in size and complexity from within outwards. The inner teeth of the series have four small cusps, the second of which from the outer margin is somewhat enlarged. The outer teeth are narrower and shorter and have a simple lobe-like cusp.

## Fam. CYCLOSTREMATIDAE.

### **Tubiola microscopica** (Nevill).

1877. *Valvata* (?) *microscopica*, Nevill, *Cat. Moll. Ind. Mus.*, fasc. E., p. 21.

1915. *Cyclostrema* (*Tubiola*) *innocens*, Preston, *Rec. Ind. Mus.* XI, p. 296, fig. 9.

Preston's type-specimen, as Dr. Kemp and I were inclined to think (p. 347), is a small denuded shell of Nevill's species, as to the taxonomic position of which Nevill himself was very doubtful. He collected it in a pool of brackish water at Port Canning in the Gangetic delta and noted that the operculum was horny and circular, of comparatively rather thick substance and apparently multispiral. Unfortunately I have only empty shells.

The true Valvatidae probably do not occur in the Oriental Region, although they are found in Kashmir and in other places on its northern frontiers.

### **Tinostoma variegatum** Preston.

Dr. Baini Prashad has extracted the radula and operculum from a dried specimen of this minute species and has given me much help in examining them. The operculum (fig. 2c) is nearly circular and of very thin, transparent substance. The margin is, indeed, quite membranous. There are several concentric whorls and a distinct notch occurs at one side.

The radula (figs. 2A, 2B) is so minute that it has been impossible to mount it quite straight without losing it altogether. Certain features are, however, quite clear. The teeth

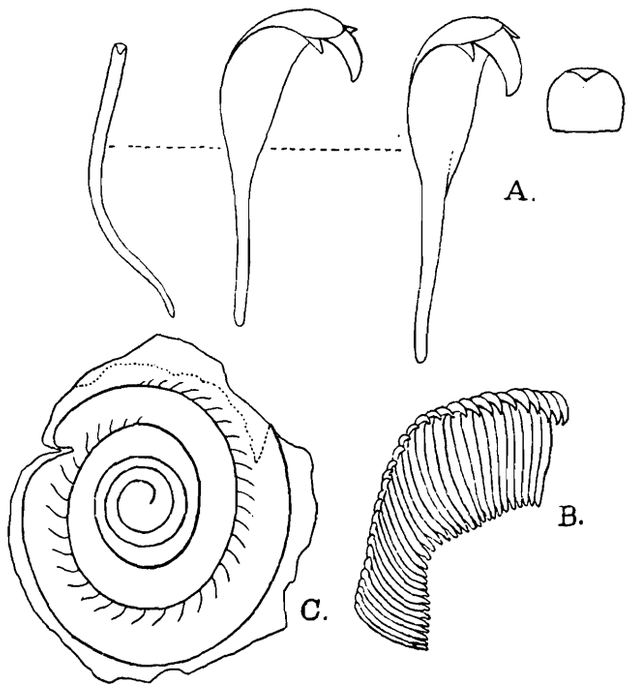


FIG. 2.—Radula and operculum of *Tinostoma variegatum*.

A, Radular teeth, ×1125. B, Lateral series of teeth, ×500. C, Operculum, ×75.

are arranged in three transverse series, two lateral and one central. There are over thirty teeth in each of the former and apparently eleven in the other. In the central series the central tooth is subcircular, but broadly truncate at the base. It has a small, simple, sharp, triangular cusp. The five teeth on each side are similar but considerably longer, becoming more elongate from within upwards. The teeth of the lateral series are curved and oblique and consist of closely adpressed, elongate, narrow processes, which show gradual differentiation from without inwards. The outermost members are almost hair-like, with a simple overturned cusp; but this cusp gradually becomes longer, sharper and more curved as the series proceeds towards the centre and a smaller cusp of similar form appears on each side of it. The shaft also becomes somewhat inflated in the middle. The exact form of the teeth is well shown in the figure.

## Fam. NERITIDAE.

### Genus **SMARAGDIA** Issel.

1869. *Smaragdia*, Issel, *Mal. Mar. Ross.* (Pisa), p. 212.

1879. *Smaragdia*, von Martens, *Conch-Cab.*, *Neretina*, p. 245.

The radulae of the type-species and of the form described here (fig. 3) are so different from those of the Neritinae of fresh and brackish-water habitat that *Smaragdia* deserves generic rank. Issel originally set up the genus to include all marine species of the facies of the true freshwater forms. He states that *S. viridis*, the type-species of his genus, differs from the freshwater forms in having completely sessile eyes.

The radula of *S. viridis* has been figured by Troschel,[1] who has, however, evidently misundertstood the relations of the different teeth and has, therefore, misrepresented their

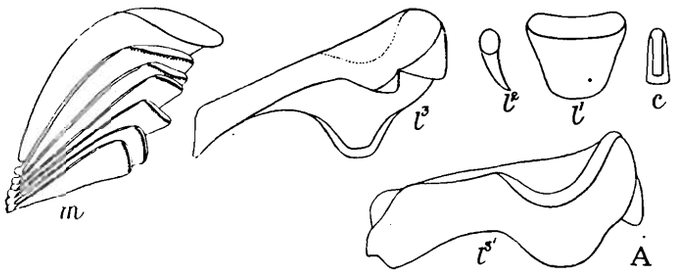


Fig. 3.—Radula of *Smaragdia mamilla* ( × 500).

A, Umbrella tooth from below. *c*, central. $l^1$ $l^2$ $l^3$, 1st. 2nd. and 3rd. laterals. *m*, marginals.

outlines. They are so closely interlocked that they must be dissected out and examined from the lower as well as the upper surface. Allowing for errors of observation, it is evident that *S. viridis* and *S. mamilla*, my new species, have important features in common. These features are the loss of one of the smaller lateral teeth of which a pair is normally present on each side, and the peculiar shape of the outermost lateral or " umbrella tooth." This tooth in *Smaragdia* is bicuspid, of large size and distinctly transverse and has not the umbrella-like outline characteristic of *Neritina*. The most interesting feature of the radula, however, lies in the manner in which the marginals combine with the outer lateral of their own row and with the corresponding teeth of the preceding and succeding rows to form a rigid structure, which we may call the outer ridge of the radula. This is brought about mainly by the modification of the umbrella tooth, which consists of three parts, *viz.*, (*a*) a thin, transverse flattened shaft, (*b*) a strong bicuspid cutting lobe and (*c*) an almost spherical highly convex lower boss or projection, which projects from the shaft outside and below the cutting lobe. Above it on the shaft there is a semicircular concavity surrounded below by a thick ridge. The boss of the tooth in each row fits into the concavity on that of the corresponding tooth in the succeeding row, while its shaft lies obliquely across those of the marginals of its own row. The marginals are further bound together by the innermost of their own series, which is broader than the rest and fits over them like a roof. This description is based on *S. mamilla*, but is, I believe, also applicable to *S. viridis*. Troschel apparently did not realize that one of the two small, claw-like laterals had disappeared and apparently thought that one of the cusps of the umbrella tooth was this missing tooth. He also confused the innermost marginal with the umbrella tooth. His figures of the upper and lower views of the umbrella tooth are, therefore, inconsistent. In my own figure, however, the apparent inconsistency between the two series of this tooth is only apparent for it depends on the fact that the upper view is oblique and the lower view direct.

## **Smaragdia mamilla,** sp. nov.

1915. *Neritina souverbiana*, Preston (*nec* Montrouzier), *Rec. Ind. Mus.*, XI, p. 296.

The shell (fig. 4) resembles that of *N souverbiana* Montrz. in some respects but differs in the form and the structure of the spire. In that species the apex is apparently acuminate

[1] *Geb. der Schencken*, II, pl. xvi, fig. 21.

and situated at the extreme tip of the shell, but in *S. mamilla* the whole spire is a rounded tubercle with the suture marked merely as a fine spiral line. This line, moreover, does not

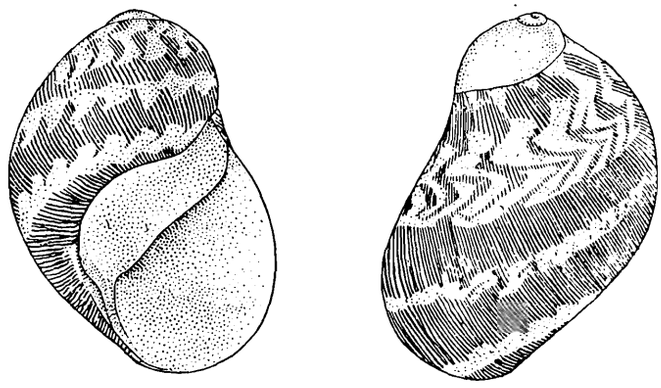

FIG. 4.—Shell of *Smaragdia mamilla*.

run in quite the same direction as the suture just above the body-whorl and the whole spire is, therefore, tilted somewhat towards the dorsal surface, so that its apex is distinctly visible when the shell is held with its main axis horizontal. There is, further, a broad, shallow depression round the body-whorl outside the suture. The margin of the columellar plate is slightly concave, not at all sinuate, and although it is minutely serrated in young shells the serrations almost disappear in the adult. The plate, moreover, narrows abruptly just above the exposed columella, thus providing a very distinctive feature. The colouration is also different from that of the shell of *S. souverbiana*. The surface is dull white ornamented with numerous fine, almost straight vertical lines of a bright green colour. These are interrupted by four spiral rows of diamond or Z-shaped white spots, the two uppermost rows sometimes combining to form a series of zig-zag vertical marks. The interior of the shell and columellar plate are white. The surface is smooth but not at all polished. The measurements of the type-specimen (M $\frac{12360}{2}$) are height 5·3 mm.; max. diam. 4·0 mm.; height of mouth 2·8 mm.; max. diam. of mouth 2·5 mm.

The operculum is unfortunately broken in the only specimen in which it remains. It is colourless and thin but only feebly translucent and has a strong fold running obliquely across its disc. The articular region is missing.

The form of the radular teeth is shown in fig. 3. Even allowing for errors in observation on Troschel's part, the central and the first and third laterals must differ considerably from those of the allied *S. viridis*, though I believe the structure of the whole radula to be very similar.

The species has been found so far only in the outer channel of the Chilka Lake, but doubtless exists also in the Bay of Bengal, and it is evidently a marine form.

## Fam. RISSOIDAE.

The limits of this family and of the closely allied if distinct family Hydrobiidae (= Paludestrinidae or Amnicolidae) are obscure. Probably the older conchologists were right in uniting the two. The only distinction appears to be ultimately one of habitat, the Hydrobiidae being fluvitile and lacustrine, the Rissoidae marine and estuarine; but there are ex

ceptions even to this. I include in the latter family the Stenothyrinae, which are mainly estuarine but are also found in fresh water.

### Subfam. *STENOTHYRINAE.*

Only one genus, including two subgenera, can with certainty be attributed to this subfamily. It is *Stenothyra* Benson with the subgenus *Gangetica* Ancey (=*Astenothyra* A. & P.). The Indian species of this genus have recently been revised by Dr. Baini Prashad and myself, but a further examination of large numbers of specimens in the field convinces me that our methods were not sufficiently drastic, some of the species, which are often markedly gregarious, exhibiting very great individual variability. All the forms found in the Chilka Lake can, in my opinion, be included in two species, one representing each of the subgenera.

### Genus **STENOTHYRA** Benson.

1921. *Stenothyra*, Annandale & Prashad, *Rec. Ind. Mus.* XXII, p. 121.

### Subgenus **Gangetica** Ancey.

1896. *Gangetica*, Ancey, *Bull. Soc. Mal. France* VIII, p. 168.

1921. *Astenothyra*, Annandale & Prashad, *op. cit.* p. 133.

I have to thank Dr. Baini Prashad for calling my attention to Ancey's name which escaped our notice when we proposed the name *Astenothyra* in 1921.

The absence of a terminal filament to the foot is not a constant subgeneric character. This structure may be either present or absent in either of the two subgenera, in both of which its absence is probably traumatic.

### **Stenothyra (Gangetica) miliacea** (Nevill).

1921. *Stenothyra* (*Astenothyra*) *gangetica* with var. *subangulata*, Annandale and Prashad, *op. cit.*, p. 134, fig. 3 and p. 126, fig. 1 b (radula).

This is a very variable form enormously abundant with *S. minima* on *Potamogeton pectinatus* in the Chilka Lake. We have figured the radula in the paper cited.

### Subgenus **Stenothyra** (s. s.).

A curious feature of this subgenus is the existence of certain forms (*echinata* and *ornata* A. & P.) which bear a spiral row of short spines in place of one of the rows of little pits with which the shells of many species are sculptured. Examination of a good series of the form *ornata*, which seems to be identical in other respects with some specimens of *S. deltae* Blf., convinces me that the character is not necessarily specific. Shells with spines are always very perfect at the apex and have been found only on a soft muddy bottom where no friction is exercised on the periostracum by foreign bodies. It seems to me at least probable that the spines are always produced on young shells, just as spiral rows of chaetae are produced on those of young Viviparidae, but are liable to be worn off, leaving only the pits from which they originated. Spines, however, have not been found on any of the Chilka shells.

### **Stenothyra minima** (Sowerby).

1921. *Stenothyra minima* and *S. blanfordiana* Annandale and Prashad, *op. cit.*, p. 129.

I now believe that all the specimens of *Stenothyra* (s.s) collected in the Chilka Lake belong to one species. Shells taken in a single handful of weed often exhibit great diversity of shape and size and it is often impossible to separate them out into the various "species" recognized by Preston. The type-specimen of *S. obesula*, which is unique, looks rather different from the others, but is perhaps abnormal.

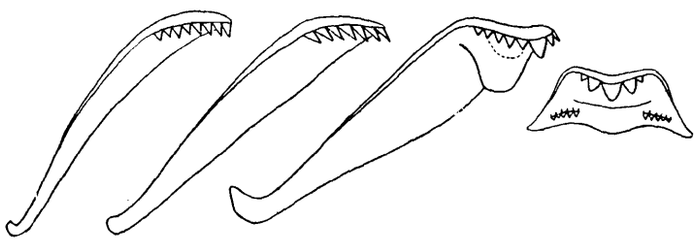

FIG. 5.—Radula of *Stenothyra minima* (×750).

I figure the radula here (fig. 5). It is distinguished mainly by the great relative breadth of the central and by the fact that the row of basal denticulations on each side of this tooth is situated only a very short distance above the basal margin. Other differences, likely to be less constant, are readily seen by a comparison with the figures of the teeth of *S. deltae* f. *ornata* and *S.* (*G.*) *miliacea* given by Dr. Baini Prashad and myself in our revision of the Indian species of the genus (*op. cit.*, *p.* 126).

## Subfam. *RISSOINAE.*

### Genus **FENELLA** A. Adams.

1860. *Finella*, A. Adams, *Ann. Mag. Nat. Hist.* (3) VI, p. 336 (*lapsu*).
1864. *Fenella*, *id. ibid.* (3) XIII, p. 39.
1902. *Alabina*, Dall, *Nautilus* XV, p. 127.
1923. *Alabina*, *id. ibid.* XXXVII, p. 33.

Dall (1923) proposes to change the name of this genus to *Alabina* on the ground that *Fenella* was preoccupied, but he gives no particulars.

Very few of the numerous species have been figured and it is probably impossible to recognize some of them without reference to Adams's original collection. I have to thank Lt. Col. A. J. Piele and Mr. Tomlin for naming the species here discussed. Their identification agrees with Nevill's.

### **Fenella virgata** (Philippi).

1885. *Fenella virgata*, Nevill, *Hand. List. Moll. Ind. Mus.* II, p. 115.
1914. *Litiopa* (*Alaba*) *kempi*, Preston, *Rec. Ind. Mus.* X, p. 300, fig. 3.
1915. *Litiopa* (*Alaba*) *copiosa*, Preston, *ibid.* XI., p. 292, fig. 2.

This is an extremely variable species, of which I have examined large series of shells not only from the Chilka Lake, in which specimens are somewhat dwarfed and decoloured, and the Ennur backwater near Madras, but also from various parts of the Indian Ocean.

I figure the protoconch (fig. 6A). Nevill is certainly wrong in suggesting that it is identical with Adams's *F. pupoidea*, the type-species of the genus, and it does not agree with any other species from Adams's collection with which I have been able to compare it. The colouration is distinctive, though it may be obscured in dead or worn shells, I can find traces of it even in those from the Chilka Lake. Two forms of shell occur commonly in the same series, one considerably shorter and broader than the other.

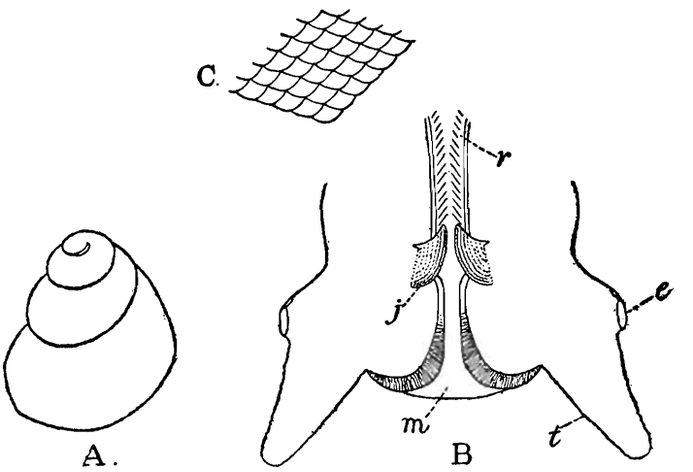


Fig. 6.—*Fenella virgata* (×50).

A, Protoconch, ×75. B, Head seen in optical section (×50), with part of surface of jaw further enlarged (×233). *e*, eye. j, jaw. *m*, mouth. *r*, radula. *t*, tentacle.

The animal is not that of a Litiopid, but conforms to Adams's description of *Fenella* (1864). Dr. Gravely, who has sent me large number of specimens from the Ennur backwaters, tells me that the exposed parts are bright green in life but become rose-pink in formalin. He also informs me that the anterior part of the pharynx can be thrust out in the form of a proboscis. This is confirmed by the position of the jaws (fig. 6B) in contracted specimens. They lie far within the head at the base of a tubular passage leading from the mouth. Their form and position are shown in the accompanying figure ; they are composed of numerous columnar bodies and thus have a tesselated appearance on the surface.

Fig. 7.—Radula of *Fenella virgata* (×500).

The radula (fig. 7) is probably characteristic of the genus. The central is transverse and has a complicated outline, the upper margin being biconvex and the base, which is truncate as a whole, having distinct lateral angles and a small projection in the centre. There are five large denticulations above, of which the central denticulation is considerably enlarged. The disc is sculptured vertically. There appear to be two laterals on each side,

each with an enlarged cusp as well as several smaller but comparatively large denticulations. The lobe of the marginals is finely and evenly serrated.

## Fam. CERITHIIDAE.

The radula of the members of this family, a considerable number of which I have examined, has two outstanding peculiarities:—(1) each of the two marginals on each side is produced externally into a membranous flap or lobe which originates a short distance below the cusp and extends down the edge of the tooth almost to the base and (2) the lateral consists of two parts, (*a*) a horizontal basal plate and (*b*) an oblique shaft which bears the cusps at its upper extremity. The basal plate varies in shape in the different species but in the larger forms is a thickened leaf-shaped structure. It is connected with the base of the shaft at one end by a fine membranous band, only visible if the tooth is properly displayed.

Major R. B. Seymour Sewell has discovered that in one species of the family (*Pyrazus palustris*) interesting changes take place in the radular structure with the growth of the individual, but this does not occur in the two species discussed here.

I am doubtful about generic limits in the family but regard *Telescopium* as distinct.

### **Telescopium telescopium** (Linn.).

It is not impossible that Troschel (*op. cit.* 1, pl. xii, fig. 2) has figured the radula (fig. 7) of a young individual of this species as that of *Potamides fluviatilis* (=*cingulatus*). The central is remarkable for its produced triangular base, which contains a concavity into which the corresponding tooth of the next series fits. There are 5 denticulations on the cusp

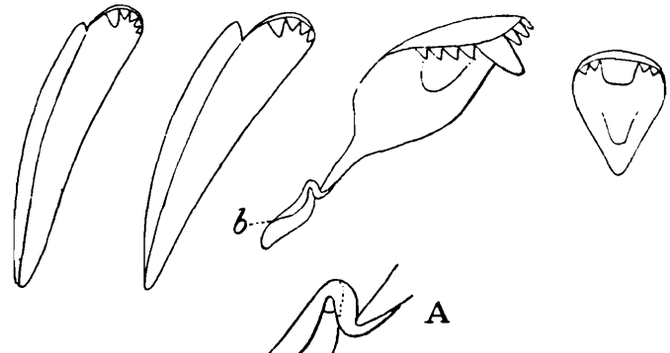


FIG. 8.—Radula of *Telescopium telescopium* (×150).
A, Basal part of lateral (×250)

of this tooth and the central denticulation is quadrate and enlarged. The laterals have 8 denticulations, the fifth from the outer margin being enlarged, elongate and bluntly pointed. The inner marginal has four and the outer marginal five denticulations, the outermost in each being slightly enlarged. The connection between the narrow shaft of the lateral and its basal plate (*b*) is shown in fig. 8A.

*T. telescopium*, which is usually an inhabitant of mangrove-swamps, is found in one or two of the muddy islands of the outer channel.

**Potamides (Tympanotonos) cingulatus** (Gmelin.)

This species, which is found in suitable localities in Rambha Bay as well as in the outer channel of the lake, frequently exhibits an abnormality of the shell, the body-whorl of which is rendered coarsely angulate in a vertical direction by the formation of a thick, more or less polished varix.

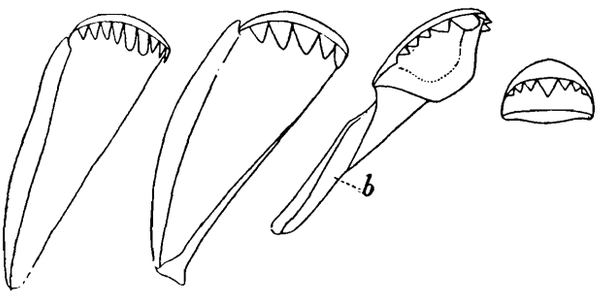


FIG. 9.—Radula of *Potamides cingulatus* (×166).

The radular teeth (fig. 9) differ considerably from Troschel's figure. The base of the central is transverse and only slightly sinuate and there are three small denticulations on each side of the enlarged, triangular central denticulation. The cusp of the lateral is much wider than in *T telescopium* and the large denticulation is quadrate, but the arrangement and number of the denticulations is the same. The connection with the basal plate (*b*) is obscure and I am not quite convinced that the structure is precisely that shown in my figure, which represents only the apparent structure. The marginals are rather broad, the inner with five or six and the outer with nine denticulations. The outermost of these in both teeth is rather smaller than those that follow.

## Fam. PYRAMIDELLIDAE.

Fischer in his *Manuel de Conchyliologie* (p. 786), after pointing out the superficial nature of the generic characters in this family, observes " Il n'est done pas étonnant que quelques auteurs. .aient ces genres sous le titre commun de *Turbonilla* ou *Odostomia*" Both genera and species, indeed, stand in need of revision. Large numbers of the latter continue to be described, often without figures or with figures of little practical utility, and many of the descriptions are quite useless for purposes of identification. It seems not improbable that some species are polymorphic in shell-characters and the absence of a radula renders precise determination still more difficult. I am obliged to recognize no less than five species among the Chilka forms and to place them in three genera, but cannot feel by any means sure that they are really distinct one from another or from forms previously described.

### Genus **TURBONILLA** Leach.

This genus seems to be in particular need of revision from an anatomical point of view. Two types of shells occur among the species commonly referred to it, one much thicker than the other, with a more contracted mouth and with a thicker collumella, in which there is a slight twist. The European *T lactea* (= *elegantissima*) is an example of this type, to which I also assign a species from the Chilka Lake.

### **Turbonilla rambhaensis** (Preston).

1914. *Terebra rambhaensis*, Preston, *Rec. Ind. Mus.* X, p. 297, fig. 5.
1915. *Vanesia rambhaensis*, *id.*, *ibid.* XI., p. 289.

The shell of this species is not dissimilar to that of *T lactea* (Linn.). There is a slight fold in the columella as there is in that species. The apex is eroded in all the specimens examined.

I have extracted the dried animal from a shell from Rambha Bay and after due treatment have been able to detect the following characters :— (*a*) the tentacles are broad and flat, (*b*) an introverted proboscis exists, (*c*) the eyes are situated between the tentacles and (*d*) there is no trace of a radula or jaws. In a rough sketch of the living animal by Dr. Kemp the tentacles are shown as broadly triangular and situated so close together that their bases almost meet in the middle line of the head. The mentum is long and narrow, extending beyond the foot and rounded at the tip. The antero-lateral angles of the foot are angulate but not produced.

## Genus **PYRGULINA.**

To this genus I assign three of the Chilka " species " which I would not be surprised to find ultimately merging into one another. The shells differ considerably in shape and sculpture but exhibit considerable individual variability. The only one of which I have seen the living animal (fig. 10) is *P. humilis*, of which I dredged a specimen in Rambha Bay. The following is a description of it. The figure was drawn in Calcutta from the living specimen.

" The snout (mentum) is broad, bilobed and extended beyond the foot. It is slightly expanded and bilobed in front and deeply grooved on the surface. The eyes are small, black and sessile, situated close together between the tentacles, which are short, pointed and directed somewhat backwards. The foot is comparatively short, pointed behind and expanded and truncate in front with the lateral angles acute but not produced." Later examination shows that the mouth is situated at the base of the mentum in a deep groove. I have not seen the proboscis extruded. The colour of the animal is described in my notes thus, " Foot and head opaque white, with black markings on snout," *i.e.* on the mentum.

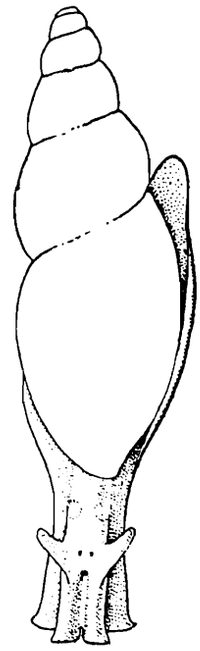

FIG. 10.—Living animal of *Pyrgulina humilis* (enlarged).

I have nothing further to say about the species assigned to this genus or to *Odostomia*.

## Fam. NASSIDAE.

This family is represented in my list by no less than five species, all of which have been placed in the genus *Nassa*. Two of these (*N. denegabilis* and *N. orissaensis*) are among the most abundant and most generally distributed of the members of the lake-fauna, while one (*N. labecula*) is not uncommon in the outer channel and the outer part of the main area.

The other two (*N. sistroidea* and *N. marrattii*) are rare and have been found only in the outer channel.

The classification of the unwieldy genus *Nassa* and its close allies is in a most unsatisfactory state. Various conchologists have set up a number of subgenera and divisions and some attention has been given to the form of the operculum but none of the attempts at subdivision have been altogether satisfactory and it is clear that no permanent arrangement will be achieved until some attention is given to the anatomy of the different forms. Even in external structure there is a great difference between the animal of such a species as *Nassa stricta*[1] and that of any of the three discussed here. These three are *N. denegabilis*, *N. orissaënsis* and *N. labecula*. The animals of all three are very similar externally. The foot is comparatively small, the antero-lateral angles are little produced and the postero-lateral angles not at all. The posterior extremity is, indeed, almost truncate, with merely a slight excavation. The opercula of *N. orissaënsis* and *N. denegabilis* on the one hand and of *N. labecula* on the other are very different. Those of the two former species are ovate with the nucleus near the inner border, paucispiral and very thin, with smooth margins, while that of *N. labecula* is more elongate, much thicker, serrated on its outer margin and anterior extremity, marked with stout curved longitudinal ridges and having the nucleus on the outer margin. A difference is also to be observed in the shells. Those of *N. orissaënsis* and *N. denegabilis* are small, comparatively thin, with the lip thin and the callus little developed, while that of *N. labecula* is much larger and thicker, with a thick lip and an exceptionally well developed callus. There is even a certain difference in the radula, for while in *N. labecula* the central is that of a typical *Nassa*, in the other two the number of denticulations is reduced and the lateral processes of the tooth feebly developed.

The peculiarities of the shell, operculum and radula and especially those of the operculum seem to me amply sufficient for the separation of the two small Chilka species (with *N. ennurensis* Preston, a closely allied form) from the genus *Nassa*. I propose for them the new generic name:

**Pygmaeonassa,** gen. nov.

The animal has a comparatively long and narrow foot with parallel sides and not expanded anteriorly. Its antero-lateral angles are produced into short filaments and its posterior extremity is truncate or broadly rounded with a slight excavation. The siphon is as long or nearly as long as the shell. The anterior margin of the head is broadly truncate; the tentacles are comparatively short and slender and have the eyes situated on their external surface at some distance from their base.

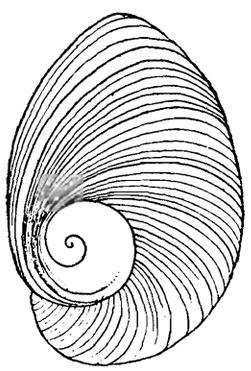

FIG. 11.—Operculum of *Pygmaeonassa orissaensis* (×33).

The operculum (fig. 11) is thin, horny and paucispiral resembling that of many Rissoidae and Melaniidae. It is relatively large.

The radula is normal, but the number of denticulations on the central is relatively small and the lateral projections of its base feebly developed. The laterals resemble those of *Nassa*.

[1] Fischer, *Man. Conchyl.*, p. 655, fig. 389. Compare this figure with the one of *Nassa orissaënsis* here reproduced.

The shell is small[1] and comparatively fragile but strongly sculptured, with vertical ribs, of a narrowly ovate form. The mouth is large, narrowly ovate and a little contracted above; the outer lip is sharp but thickened within, the columella devoid of folds but sometimes with a slightly developed tubercle. The callus is narrow and confined to the columellar margin.

*Type-species.*—*Nassa orissaënsis* Preston.

*Geographical Range.*—Many small species assigned to *Nassa* may belong to this genus, but the only three that can at present be referred to it are known only from brackish water on the Indian coasts.

*Pygmaeonassa* is perhaps allied to *Canidia* Adams, but there are distinct differences[2] in the radula and operculum.

## Genus **NASSA** Martini.

### Subgenus **Eione** Risso.

The subgenus is distinguished by the great development of the callus. I have already referred to the peculiarities of the foot and operculum. The radula is in every respect normal.

### **Nassa (Eione) labecula** A. Adams.

This is a common species on the east coast of India, mainly in brackish water. The radula (fig. 13) and opercula (fig. 12) are figured from specimens taken in the Ennur back-

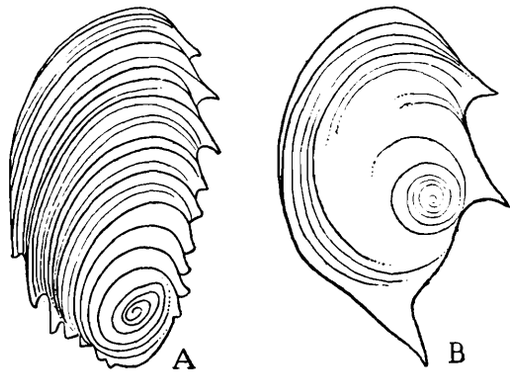


FIG. 12.—Operculum of *Nassa* (*Eione*) *labecula*.

A, Operculum of adult, ×12. B, Operculum of half-grown individual, × *ca.* 14.

water near Madras. The foot is broader than in *Pygmaeonassa* but its extremities are similar. The siphon is relatively shorter.

The operculum undergoes a remarkable change in the course of growth. Fig. 12A shows that of the adult. In the young (fig. 12B) it is much thinner and more transparent,

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[1] The best figure of the shell is that of *N. ennurensis* var. *depauperata*, A. & P., *Rec. Ind. Mus.* XVI. pl. xx. fig. 9 (1919). For the radula see the same paper, p. 253, text-fig. 6 (c).

[2] See Brot, *Journ. Conchyl.* XXIV, p. 346, pl. xii (1876).

the anterior extremity is smooth and the outer margin bears only three relatively large serrations, which are situated near the posterior extremity. This is the condition in a half

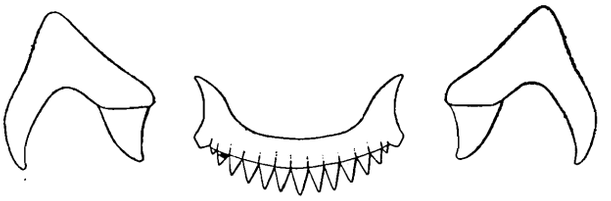

FIG.13.—Radula of *Nassa* (*Eione*) *labecula* (×166).

grown individual ; in still younger individuals there would probably be no serration at all, for they are correlated with the curved ridges on the surface and these are apparently growth-lines.

## Fam. MURICIDAE.

### **Cuma disjuncta** Annandale.

1916. *Thais carinifera* Preston, *Rec. Ind. Mus.* x. p. 299.

1922. *Cuma disjuncta*, Annandale, *Mem. Asiat. Soc. Bengal* VII, p. 266, fig. 2.

This is probably the representative in brackish water of *C. carinifera* Lam., from which the main structural difference in the shell lies in the change in direction of the spiral above the body-whorl. This results in the production of a conspicuous notch in the profile as seen in dorsal view. In the normal form of the species, which I have seen from both the the Bombay and the Madras coasts and also from the Andamans and the Maldives, the notch is to some extent obscured by the great development of the upper row of prominences on the body-whorl. It can, however, always be seen in ventral view and is quite constant in a very large series of specimens. The form found in the Chilka Lake is usually smaller and has the prominences and other sculpture much less well developed. For this form (B in the figure cited) I propose the name:

var. **obliterata,** nov.

Dead and probably subfossil shells, usually of small size, are very abundant on the shore of Barkuda and I have seen similar shells, inhabited by hermit-crabs, in the Ennur back-waters near Madras. For some time after the unusually low salinity of the water in 1919 to 1920 (*v.* Sewell, *antea*, p. 688) had disappeared the species remained very scarce as a living mollusc in Rambha Bay, if it was not altogether exterminated, but in August, 1923 and January, 1924 I found living young individuals at Barkuda.

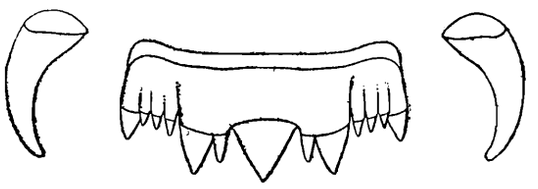

FIG. 14.—Radula of *Cuma disjuncta* (×500).

The radula, here figured (fig. 14) from a young individual, offers no point for special comment. It differs from that of the allied *C. kiosquiformes* as figured by Troschel (*op.*

*cit.*, II, pl. xiii, fig. II) chiefly in the much shorter central cusp of the central. The laterals are also narrower at the base.

## Fam. TORNATINIDAE.

### **Didontoglossa,** gen. nov.

The new genus consists of small species with a cylindrical shell very much like that of *Tornatina* (=*Ratusa*) but differing considerably in anatomy. The shell is smooth on the surface and bears a thin colourless periostracum.

The cephalic disc (fig. 15A) is of moderate size and narrower than the foot. It is rounded in front and produced behind into a pair of narrow, flat, truncate processes. The eyes are small but conspicuous. The foot is rounded behind, without parapodia or epipodia extending over the shell, into which the whole animal can be retracted, but with the anterior margins slightly retroverted.

The jaws are large, thin, angular and serrated. The radula (fig. 15B) is of moderate length and resembles that of *Philine*. It has two rows of teeth, the formula being 1. 0. 1. The laterals (fig. 15B) are relatively large, uniform and serrated, the central is absent or extremely vestigial.

The gizzard (fig. 15C) is compressed and armed internally with two large valve-like reniform plates containing some calcareous matter and bearing small tubercles on their internal face. There is a mere vestige of a third plate between them.

There is no penial stylet.

*Type-species.* *Tornatina estriata* Preston.

I leave the genus in the Tornatinidae in spite of its possessing a radula because the shell and the external structure of the animal are very similar to those of *Tornatina*. The structure of the gizzard is, moreover, in some respects similar, though very different in others.

It is probable that other small species with a shell like that of *Tornatina* will be found to belong to this genus, for example Nevill's *Cylichna lactuca* and *C. involuta* from Indian seas. These species, so far as the shell is concerned, come very near *T estriata* but are much larger.

### **Didontoglossa estriata** (Preston).

1914. *Tornatina estriata & soror*, Preston, *Rec. Ind. Mus.* X, p. 303, figs. 7, 8.

1916. *Retusa estriata, id. ibid.* XII. p. 27.

The minute size of the species and the fact that my specimens were preserved in a highly contracted condition makes a detailed anatomical study difficult and hardly worth the time it would involve. The points noted in the generic description are, however, quite clear. I have been unable to find any central tooth in the radula but there is perhaps a vestige of it in the form of an extremely thin irregular plate between the two laterals.

The gizzard is relatively very large and reniform in outline (fig. 15C). The œsophagus enters it in a depression on the ventral surface (fig. 15D) in the middle, while the exit of the intestine (fig. 15E) is subterminal on the dorsal surface. The muscles are arranged in two fan-shaped fascicles one on each side of the compressed organ. These meet on the dorsal

surface towards the middle. On the ventral surface they are broadly excavated to admit of the entry of the œsophagus. Their outline is similar to that of the calcareous plates,

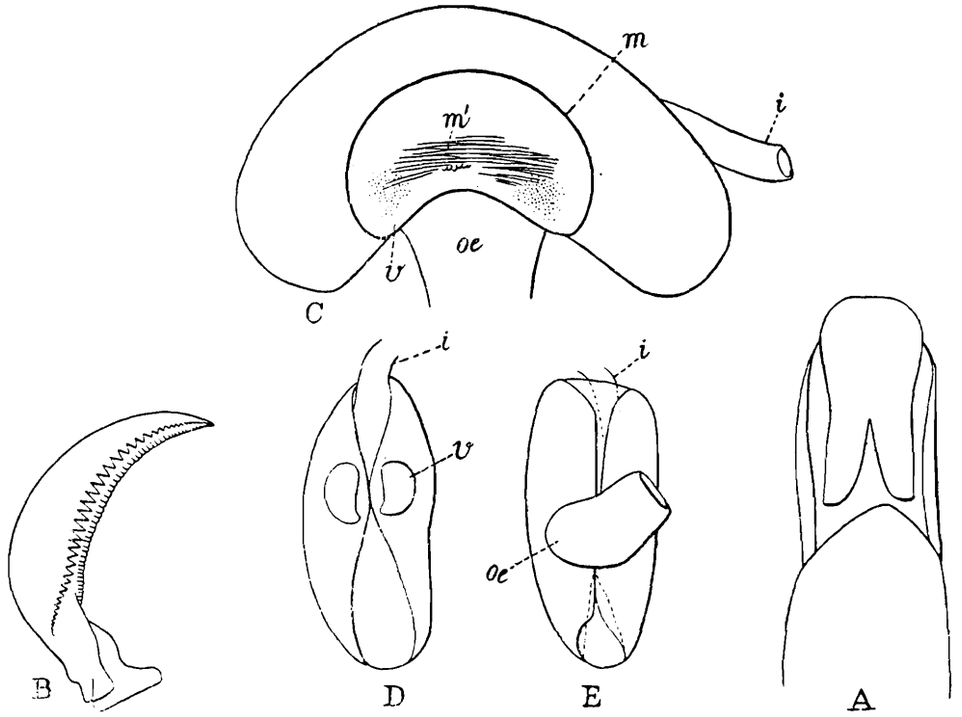


FIG. 15.—*Didontoglossa estriata.*

A, Anterior part of living animal (enlarged). B, Radular tooth, ×500. C, D, E, Gizzard (enlarged). *i*, intestine. *m*, radiating muscles. $m^1$, longitudinal muscles. *oe*, œsophagus. *v*, calcareous plate.

which lie one on each side of the œsophagus and are considerably smaller than the fascicles. The vestige of a third plate, which lies between the convex margins of the other two, consists of a fine ridge which forms one side of an ill-defined triangle. Transverse muscles are attached to a roughened area on the external surface of each of the two plates. The type of gizzard seems to be derived from one of the type found in *Tornatina* by a compression in the transverse axis and a rotation in the longitudinal plane and by an increase in size and slight change of shape of the two lateral plates with a reduction of the median plate.

The external characters of the living animal (fig. 15A) agree in most respects with those of *Utriculus* as figured by Sars,[1] by Fischer,[2] Kobelt[3] and other authors; but the cephalic disc is smaller and narrower and its tentacular processes are closer together and truncate instead of pointed. In 1885 Vayssière[4] placed *Utriculus* in the Scaphandridae, but in his later work[5] follows Fischer in placing it with *Ratusa* (=*Tornatina*) in the Tornatinidae. Moreover, he removed the species (*truncatula*) figured by Kobelt from *Utriculus* to *Ratusa*. It seems to be clear that in this family the anatomy as well as the shell and the external characters of the animal must be examined for a satisfactory diagnosis.

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[1] Sars, *Moll. Asit. Norvegiae*, pl. xi, figs. 6-9 (Christiania, 1878).

[2] Fischer, *Man. Conchyl.*, pp. 550, 555, figs. 307, 308, 314 (1887).

[3] Kobelt, *Conch. Cab., Bullidae*, pl. A, fig. 3 (1896).

[4] Vayssière, *Ann. Mus. Hist. Nat. Marseilles* II, p. 30 (1885).

[5] Vayssière. *Moll. France* I in *l'Encyclop. Scient.*, p. 157, pl. xviii, fig. 2 (1913).

Fam. BULLIDAE.

Genus **HAMINEA** Leach.

1913. *Haminea*, Vayssière, *Moll. France* I, p. 163.

**Haminea crocata** Pease.

1860. *Haminea crocata*, Pease, *Proc. Zool. Soc.*, p. 19 (shell) and p. 432 (animal).

1896. *Haminea crocata*, Kobelt, *Conch. Cab., Bullidae*, p. 109, pl. xvi, fig. 1.

The animal agrees, so far as can be seen from highly contracted specimens, with Pease's brief description. It appears to be that of a true *Haminea*, but the radula (fig. 16 C) does not altogether agree with Vayssière's description. Its formula may be stated as 5. 1. 1. 1. 5, but the outer marginal is rather more differentiated than the single lateral and it would be almost equally correct to state the formula as 1. 5. 1. 5. 1. The form of the teeth is best shown in the figure. The gizzard (fig. 16A) is more normal, but the three horny plates with which it is armed internally are very large and have a peculiar sculpture, while the three pairs of narrow horny ridges at their base are somewhat obscure. The plates (fig. 16B) have the usual cornucopia-like outline and bear a number of transverse-shaped ridges. Behind each ridge is a parallel row of minute spines and at the base of the plates these spines replace the ridges. The genitalia and nervous system are not well preserved in my material, but there is certainly no penial stylet.

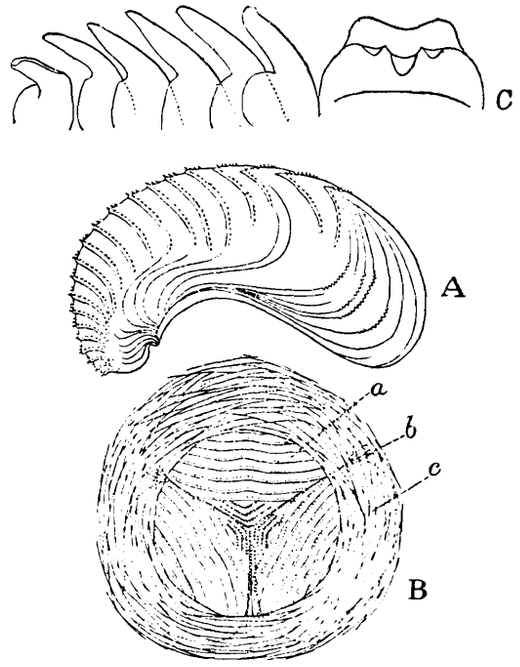


FIG. 16.—*Haminea crocata.*

A, Gizzard as seen from below after being rendered transparent (× *ca.* 26). B, Horny plate in lateral view (×50). C, Radular teeth (highly magnified).

Shells from the Chilka Lake are rather larger than those from the Sandwich Is. and have the spiral striae better developed and the columellar callus thinner and less porcellaneous In these respects, however, they differ also from specimens from Natal and Ceylon. and the differences are probably due to local conditions.