

We retain this species as distinct provisionally for the animal and radula are very like those of *A. (F.) verruca*, a species also found in Ceylon, and we are not entirely convinced that it may not be simply a very old phase of the latter species, perhaps only attained occasionally. Much smaller specimens of *A. (F.) verruca* are sexually mature, but this does not preclude the possibility we have suggested.

***Ancylus (Ferrissia) baconi*, Bourguignat.**

1882. *Ancylus baconi*, Clessin, in Mart. and Chem., *Conch.-Cab., Ancylinen*, p. 61, pl. vii, fig. 7.

Among the specimens assigned by Nevill to *A. verruca*, we find a small series from Orissa that differs considerably from shells of that species and agrees well with Clessin's figure and with the original description of *A. baconi*. The species was originally described from Bengal and has since been recorded from the Philippines and Japan.

The following observation is interesting as illustrating a possible mode of dispersion. Some years ago one of us captured in the canal at Cuttack in Orissa a large Dysticid beetle the elytra of which were covered with a species of *Ancylus* in considerable numbers. The specimens were sent to the late Dr. Gwatkin and were apparently lost in transit. We are unable to say whether they belonged to this species or some other.

***Ancylus (Ferrissia) tenuis*, Bourguignat.**

1862. *Ancylus tenuis*, Bourguignat, *Spic. Mal.*, p. 208.

No figure of this species appears to have been published but large numbers of specimens that agree with the original description were recently found by one of us in small streams at the base of the Nilgiri Hills, from which the species was originally described. The specimens from South India assigned by Nevill to *A. (F.) verruca* are similar, but seem to have been completely bleached.

The species probably differs somewhat in habits from other Indian representatives of the genus. It was found on dead leaves in the pools of small hill-streams, specially those just above waterfalls.

THE AMPHIBIOUS PULMONATA (SUCCINEIDAE).

By AMIN-UD-DIN.

Genus *Succinea*, Drap.

The Indian species of *Succinea*, so far as our knowledge extends, seem to fall both anatomically and biologically into two groups; but no separation between these groups can be based on the shell-characters. Until we know more of the anatomy

and habits of the species it seems best not to propose taxonomic names for the groups, but they may be distinguished as follows:—

I. AMPHIBIOUS GROUP.—Species that live at the edge of marshes and lakes and are amphibious in habits. The dorsal wall of the lung is opaque. The radula is comparatively narrow and the number of longitudinal rows of marginals never exceeds 40. The prostate does not show a spiral torsion and the vas deferens is always long and turns up at the end to open at the tip of the penis. The penis possesses a single retractor muscle. There is a vagina and the male and the female ducts open in a common atrium. This group is known to include the following Indian species, *S. indica*, *S. elegantior* and *S. rutilans*.

II. TERRESTRIAL GROUP.—Species found living on the leaves of trees and bushes, at any rate in rainy weather. The dorsal wall of the lung is thin and translucent. The radula is broad and has over 80 longitudinal rows of marginal teeth. The vas deferens is rather short and straight. The penis is small and without a retractor muscle. The prostate has a spiral torsion. There is no distinct vagina or atrium, but the ducts of the receptaculum seminis, the penis and the vagina open separately in a shallow slit-like common aperture on the surface of the body. The only Indian species of this group so far known anatomically is *S. semiserica*.

Of the anatomy of most species of *Succinea* very little is known and practically no work has been done on the Indian species. Von Rieper¹ has given a full description of the genitalia and physiology of *S. putris*, while Ihering² gives a general account of the genitalia of the same species. Jacobi in his paper on Japanese Pulmonates³ also gives a few notes on the anatomy of *S. horticola*, Reinh. Both of these Palaearctic forms belong essentially, at any rate as regards the radula and the generative apparatus, to my Amphibious Group. The small number of marginals, the presence of a retractor muscle and the large thick penis-sac are very alike, but Jacobi in his figure shows the different sexual ducts as having separate external openings.

At first it was intended to describe only the anatomy of *S. elegantior*, but as many interesting points came out in the dissection of other species it was decided to include short notes about them also for comparison and further reference.

Succinea elegantior, Annandale, sp. nov.

A species resembling *S. semiserica*, Gould, externally but with the shell smaller and narrower and having the spire still further reduced.

The shell is rather small, thin but less fragile than in some species, of narrowly ovate form, of a bright golden brown

¹ *Ann. Soc. Roy. Malac. Belgique* XLVII, pp. 125-191 (1912).

² *Fahrb. Dent. Malakozool. Ges.* IV, pp. 136-142 (1877).

³ *Fourn. Coll. Sci. Tokyo* XXI, pp. 82-85 (1898-1900).

colour, highly polished and sculptured with moderately strong, curved and sinuate, somewhat irregular striae. The spire is reduced to a mere tubercle but consists of two distinct whorls and is set on the body-whorl at a slight angle and directed outwards. The apex is minutely rounded and the penultimate whorl, though very small, swollen and oblique. The body-whorl is not at all tumid, but subcylindrical with nearly parallel sides and about twice as high as broad; its anterior extremity is broadly rounded. The aperture, which is almost straight, is narrowly ovate, pointed above and about twice as high as broad. The outer lip is sharp and nearly straight, as is also the columella, which is slightly folded and ridged above. There is a feebly developed callus joining the outer lip to the columella. The shell is imperforate. All these characters are very uniform in a large series of shells.

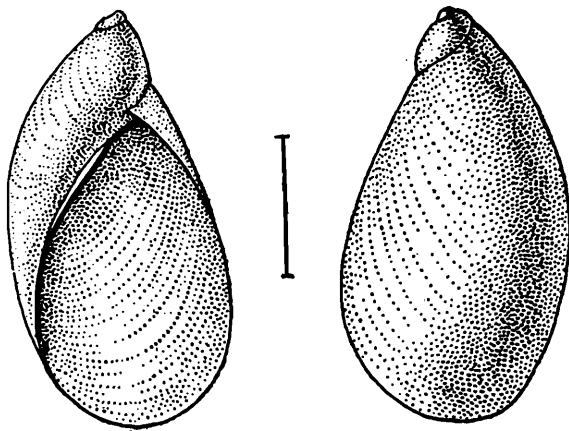


FIG. 20.—Shell of *Succinea elegantior*, Annandale, from Manipur.

Measurements of Shells (in millimetres).

	A (Type).	B.	C.	D.	E.	F.
Height ...	13·3	12·5	14·0	12·9	10·5	11·4
Maximum diameter ...	7·7	7·1	7·1	6·8	5·2	6·2
Height of spire ...	2·0	1·3	1·8	2·5	1·0	1·3
Height of mouth ...	11·4	10·8	11·0	10·0	8·5	9·2
Maximum diameter of mouth ...	5·6	5·4	5·8	5·6	4·2	5·1

Type-specimen.—No. M 11861/2 Zool. Surv. Ind. (*Ind. Mus.*).

The species is, so far as we know, confined to Manipur Valley. It is found in abundance round the Loktak Lake and has also been met with sparsely at other places in the valley. It lives in damp localities, at the edge of the lake and other swamps and attached to various floating objects. Being lighter than water, it was frequently observed floating on the surface of water with its shell downwards and carried about by wind. Living specimens are sluggish on dry land and leave a trail of mucus behind them.

Our station-book gives the following particulars:—“Very common on damp mud. Shell fragile and easily removed. Foot narrow, extending for some distance behind the shell and bluntly pointed posteriorly. Eye-stalks moderately long, tentacles reduced

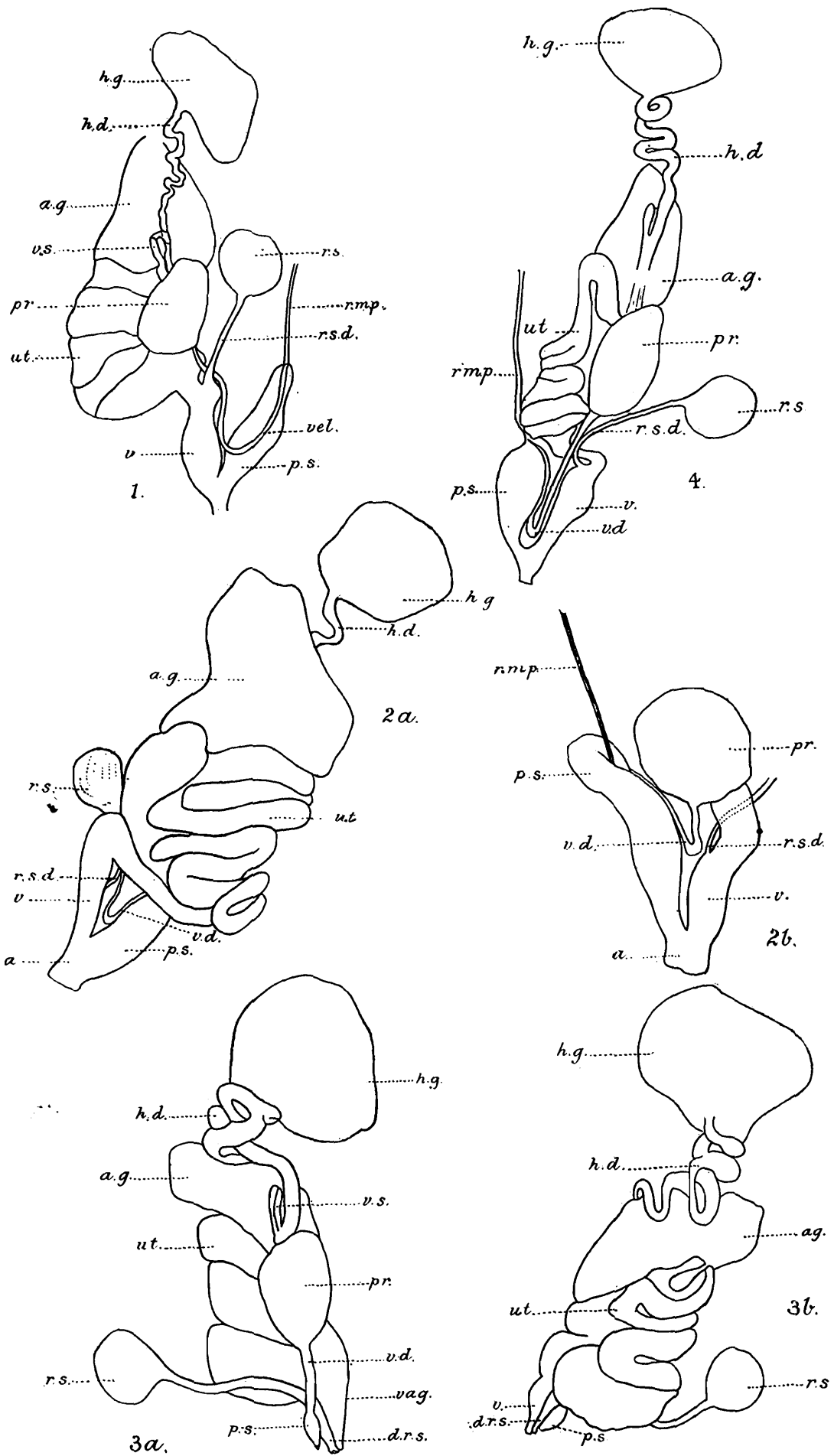


FIG. 21.—Genitalia of different species of *Succinea*.

1. *S. elegantior*, ventral view. 2. *S. rutilans* (a) dorsal view, (b) ventral view of the terminal portion only. 3. *S. semiserica*, (a) dorsal view, (b) ventral view. 4. *S. indica*, ventral view.

a.g. albumen gland; h.d. hermaphrodite duct; h.g. hermaphrodite gland; p.r. prostate; p.s. penis sac; r.m.p. retractor muscle penis; r.s. receptaculum seminis; r.s.d. duct of the receptaculum seminis; ut. uterus; v. vagina; v.d. vas deferens; v.s. vesicula seminis.

to rounded tubercles. Edge of mantle not extending over the shell. Dorsal surface and sides of the body infuscated, with a pale irregular reticulum. A pale groove extending along the body below each eye-stalk. Eye-stalk internally black. Foot whitish with a dark reticulum or spots round the upper margin. Edge of mantle with black specks or spots."

The walls of the mantle are moderately thick and quite dark owing to a suffusion of black pigment. The mantle edge is thick and muscular.

The pulmonary opening is situated a little behind the middle of the body, on the right side. It is placed on the edge of the

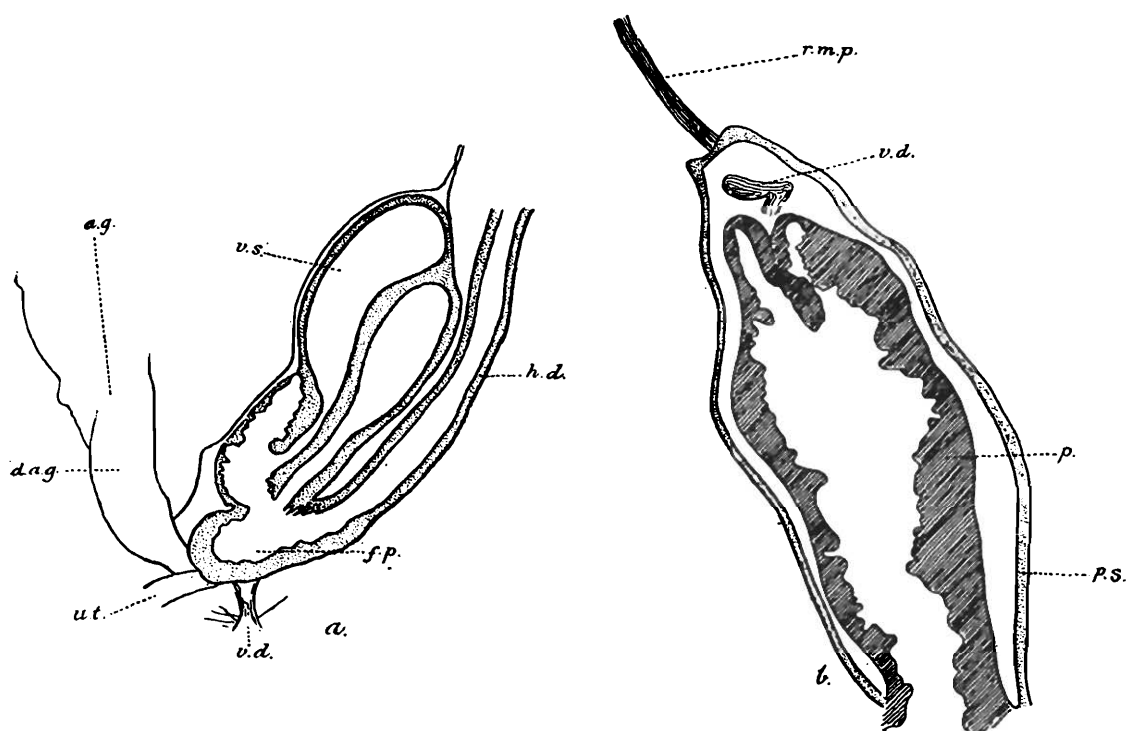


FIG. 22.—*Succinea elegantior*, Annandale.

(a) Horizontal longitudinal section of the vesicula seminalis and adjoining structures.

(b) Longitudinal section of the penis-sac.

a.g. albumen gland; d.a.g. duct of the albumen gland; f.p. fecundation pouch; h.d. hermaphrodite duct; p. penis; p.s. penis sheath; r.m.p. retractor muscle of penis; ut. uterus; v.d. vas deferens; v.s. vesicula seminalis.

mantle and is a circular aperture with prominent edges incomplete below and with a horseshoe-shaped black band outside it. The opening of the ureter is slit-like and lies dorsal to the anus, which opens obliquely under the mantle edge.

It will be convenient to describe the genitalia from above downwards. Within the apex of the shell we find firstly the hermaphrodite gland, a yellowish white mass of irregular shape, embedded in the liver and occupying the greater part of the spire. The hermaphrodite duct is a long tube, much convoluted and made conspicuous by its dark colouration, which is derived from the superimposed pigmented cells of the connective tissue. At the point at which the duct enters the albumen gland two club-shaped

structures open into it. These are the so-called seminal vesicles: they have thick muscular walls, and a narrow lumen containing spermatozoa. The hermaphrodite duct at this place swells up into a small pouch called by Ihering (*loc. cit.*) the fecundation pouch. Its internal walls are thrown into complicated folds. On its exit from the albumen gland the hermaphrodite duct is continued as the uterus on one hand, and the male duct on the other.

Taking first the female elements, we find the uterus descending in numerous coils. Its walls when immersed in water assume a transparent gelatinous appearance. Distally it is somewhat dilated and at the point of its junction with the duct of the receptaculum seminis becomes considerably contracted. It is then continued forwards as a muscular vagina. The receptaculum seminis is subcircular and has a long slender duct. The vagina is short but thick.

The male duct on its exit from the albumen gland bears immediately a rather large, elliptical gland, the prostate, which lies on the right side below the uterus. The vas deferens runs close to the inner side of the vagina and at the point where vagina and penis meet together, it turns up sharply, and, running internally to the walls of the penis-sac, opens finally at the tip of the penis. The penis is a thick muscular organ, the internal walls of which are thrown into complicated folds and are glandular. The penis-sheath is thin and consists mainly of longitudinal muscle-fibres. The retractor muscle is attached close to the point where the vas deferens enters the penis.

The male and the female ducts open separately into the short common atrium, which communicates with the exterior by a narrow slit-like aperture.

The Alimentary System.—The mouth is situated on the lower surface of the extreme anterior end of the snout and is bounded by fleshy lips. The buccal-sac is thick and globular.

The jaw is black and stout. Its cutting edge is broadly concave and has a rounded projection in the middle. The accessory plate is rounded posteriorly and quite broad. The radula is a broad ribbon and has approximately the formula 40.(10-12).1.

(10-12).40. The central tooth has a greatly developed median cusp but the side cusps are sub-obsolete. Its base is horizontal and slightly concave. The margins of the basal discs are thickened or probably folded in, so as to form a vertical ridge on each side. They disappear on the upper part of this region of the tooth. The laterals are tricuspid, the inner cusp being long and nearly reaching the base. Their bases are not horizontal but obliquely truncate, the inner angle being at a considerably higher level than the outer.

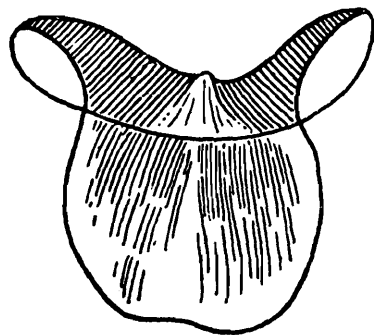


FIG. 23.—Jaws of *Succinea elegantior*, Annandale.

The outer basal angle is lobate and the basal margin bears at least two narrow incisions separating blunt processes. The incisions are sometimes continued upwards on the side of the tooth as vertical grooves. The marginals are relatively small and have four denticulations. The outer cusps are comparatively longer. Their bases are very much reduced.

Opening into the dorsal portion of the buccal mass are the ducts of the salivary glands. These glands are of irregular shape

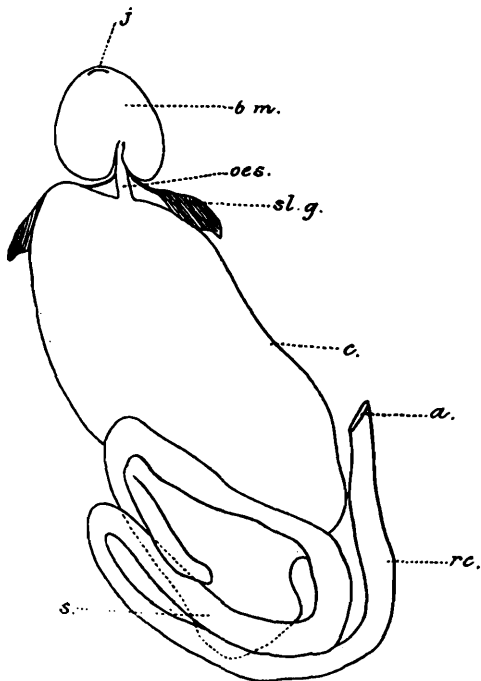


FIG. 24.—Alimentary canal of *Succinea elegantior*, Annandale.

a. anus; b.m. buccal mass; c. crop; j. jaw; oes. oesophagus; r. rectum; s. stomach.

and lie one on each side of the oesophagus. Their ducts are slender and, passing underneath the cerebral commissure, open dorsally into the buccal-sac. The oesophagus arises from the dorsal aspect of the mass. Its proximal portion is quite short and muscular, while distally it becomes dilated and takes on the structure of the crop. The crop is a long, straight and thin-walled wide tube, filling the greater part of the body cavity. Its distal end is constricted and is in continuity with the bulbous stomach. The stomach turns sharply to the left and upwards. The intestine and the rectum form a narrow tube and lie dorsal to the

crop and stomach embedded in the substance of the liver. They form a double loop. The rectum bends down towards the right side and opens by a slit-like opening just under the edge of the mantle, near the middle of the body on the right side.

The excretory system does not show any peculiarity. The ureter is closely applied to the dorsal surface of the rectum and opens by a separate aperture dorsally to the anus.

Succinea rutilans, Blanford.

The range of this species also appears to be restricted. It has so far been recorded only from the Khasi Hills in Assam. During our recent tour in the Manipur Valley it was occasionally found, occurring with the more abundant species *S. elegantior*, with which it is identical in habits and habitual environment.

The animal resembles *S. elegantior*, but its tentacles are less developed and the body is white, spotted with irregular black blotches. A black streak runs on each side of the head extending along the eye-stalks.

The male portion of the genital system is somewhat different. The prostate is sub-circular and the vas deferens moderately thick. The penis is elongate and has a recurved tip, which is in continuity with the vas deferens. The retractor muscle is attached at the point of curvature.

In the female organs the uterus is much coiled on itself and becomes considerably narrowed at the point where the duct of the receptaculum seminis joins it. The duct of the receptaculum seminis is long and narrow. The vagina is elongate and thick. The male and the female ducts open in a common vestibulum, which is quite short.

The jaw is slender and has blunt ends. Its cutting margin is without any irregularities, smooth and evenly concave. The quadrate accessory plate is as broad as the jaw itself and rounded posteriorly.

The radula is a long narrow ribbon with only about 35 teeth in a transverse row. The dental formula is 6.II.I.II.6. The teeth are normal as regards shape and structure; it is the small number of marginals that is noteworthy. In the single available radula a very interesting abnormality was noted in that the seventh lateral tooth on the right side throughout the length of the ribbon has assumed to all appearances the form of a central tooth.

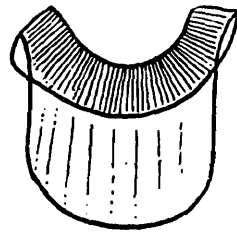


FIG. 25.—Jaw of *Succinea rutilans*, Blanford.

Succinea semiserica, Gould.

This species has a fairly wide distribution. It has been found in Eastern Bengal, at Calcutta, in Pegu in Burma and in the Amherst and Tavoy districts of Tennasserim. Dr. H. H. Marshall of Rangoon, who has kindly sent the preserved specimens on which this study is based, has supplied the following information about its habits and environment:—

“This species is very common during the rains round Rangoon in the islands in Hlewa-ga Lake and in Mr. Taylor’s Island in the Kokim Lake. They are generally found living on the leaves of various plants, bushes and in moss-grown localities. They seem to prefer mangoe, plantain and palm leaves.”

From the above statement it will be seen that the animal lives mainly on fresh leaves and does not frequent dirty marshy places like those of the other group, which seem to prefer decaying vegetable matter as food. This species was found, moreover, in the rainy season, from June to September, while those of the other group have been commonly met with during the months of December to March.

The animals I have examined are very much contracted and probably bleached owing to preservation in strong spirit. The body is bulky and the foot is narrowly tongue-shaped. The ven-

tral surface of the foot is white. The dorsal surface of the body is speckled with black blotches, which are absent on the left side. The dorsal wall of the pulmonary chamber is thin and transparent and the cavity itself is large. The edge of the mantle thins down on the side of the body and lies on it as a thin flap-like membrane. This may be a useful adaptation for the storage of moisture.

The reproductive organs are interesting in many respects, and belong essentially to a different type from those of the other species examined.

The prostate as a whole appears to be sub-elliptical and to have an oblique cleft across its dorsal surface. This is due to the

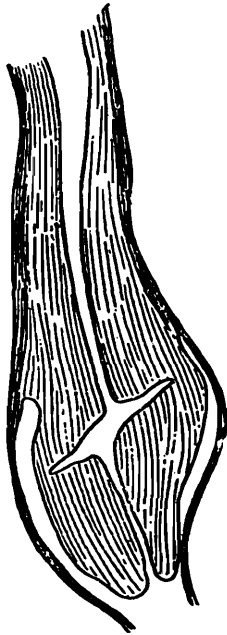


FIG. 26.—Penis of *Succinea semiserica*, Gould.

fact that the gland is twisted spirally round the vas deferens which issues from the cleft and, proceeding forwards as a stout, straight tube becomes swollen distally to form the penis. The penis when retracted lies obliquely in a thin-walled sac. It is a short muscular organ, sub-triangular in longitudinal section. Its lumen is narrow but swells up in the middle and again continues its course as a narrow tube, so that a cross-like appearance is produced. The penis has a thin muscular sheath but there is no retractor muscle. It opens into the shallow slit on the right side of the body common to it, the duct of the receptaculum seminis and the female duct.

The female organs are also somewhat peculiar. The uterus is much coiled and at its distal end becomes constricted and narrow. The receptaculum seminis has a long stout duct, as thick as the terminal portion of the uterus. The pores of the ducts of the male and female organs and of

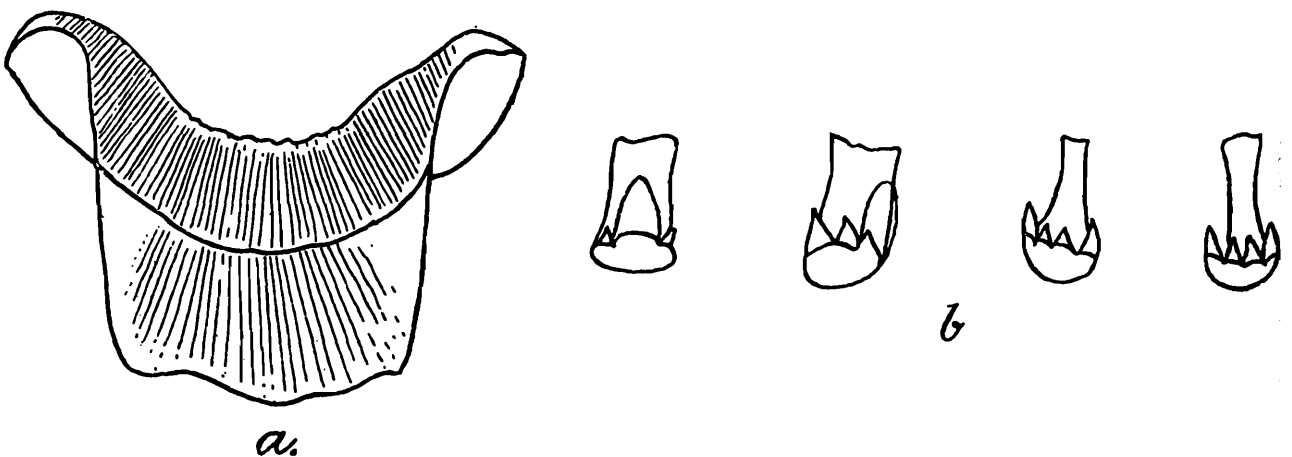


FIG. 27.—*Succinea semiserica*, Gould.
(a) Jaw. (b) Radular teeth.

the receptaculum seminis are contiguous and open in a common slit situated on the right side of the body, below the right tentacle.

The jaw is stout and has a deeply concave cutting edge. The margin of this edge is not smooth, but under a low power of the microscope shows small irregularities. The quadrate plate is broad and truncate behind.

The radula is broad and moderately long. The teeth are normal and do not show any structural peculiarity. The dental formula, however, is 85.15.1.15.85, while in all the other species examined the marginals do not exceed 40. The large number of teeth in a single row may possibly be due to the food requiring a broad radula in order that a sufficient quantity of material may be rasped from the comparatively hard surface of growing leaves.

Succinea indica, Pfeiffer.

This species has hitherto been recorded from Kashmir, the Kumaon Hills and the Southern Shan States. It has now been

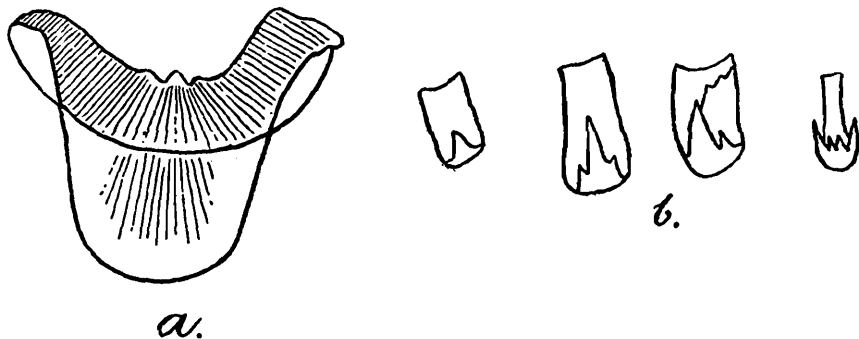


FIG. 28.—*Succinea indica*, Pfeiffer.
(a) Jaw. (b) Radular teeth.

found abundantly by Dr. Annandale in the North-West Frontier Province near Peshawar, and in the Punjab at Gurdaspur. In its general habits it resembles *S. elegantior*. Near Peshawar it was found on decaying reeds in the water of a swamp with very little sub-aquatic vegetation.

Dr. Annandale's field-book gives the following particulars about the living animal:—

“Animal as a rule dark in colour, almost black, with white longitudinal lines on the dorsal surface of the exposed parts of the body. Ventral surface of the foot grey, speckled with black. Mantle with pale spots. Tentacles reduced to small rounded tubercles. Exposed surface irregularly tuberculate. Foot narrow, tongue-shaped, broadly rounded in front and narrowly rounded behind. Young individuals paler than old ones.”

The generative organs are slightly different from those of *S. elegantior*. The penis sac is elongately pear-shaped and acuminate distally. The prostate is narrowly elliptical.

The jaw is small and has rounded extremities. The cutting edge is concave and is provided with a central blunt projection and a subobsolete accessory projection on either side. The quadrate plate is narrow and rounded posteriorly.

The radula is fairly long and broad and has the formula 28. 12.1.12.28. The bases of the marginals are rather short and concave.

LITERATURE.

1. Annandale, N.,—Jaw and radula of *Succinea indica*. *Rec. Ind. Mus.* XIV, pl. xi, figs. 5, 6 (1918).
2. Binney, W. G.,—On the jaw and lingual membrane of North American terrestrial Pulmonata. *Proc. Acad. Nat. Sci. Philadelphia* XXVII, pp. 230–232 (1875).
3. Cooke, A. H.,—*Mollusca*, in *Cambridge Natural History*, London (1895).
4. Fischer, P.,—Observations anatomiques sur divers Mollusques des Antilles attribués au genre *Succinea*. *Journ. Conchyliol.* XXII, pp. 137–155, pl. v (1874).
5. Ihering, H. von,—Ueber den Geschlechts-apparat von *Succinea*. *Jahrb. Deut. Malakozool. Ges.* IV, pp. 136–142 (1877).
6. Jacobi, A.,—Japanische Pulmonaten. *Journ. College. Sci. Tokyo* XII, pp. 82–85, pl. vi, figs. 116–119 (1899).
7. Rieper, H. von,—Studien an *Succinea*. *Ann. Soc. Malacol. Belgique* XLVII, pp. 125–191, pl. iii, iv (1912).

THE PELECYPODA.

By B. PRASHAD.

The collection of Lamellibranchs from Manipur described in the following pages is of special interest, in that most of the species are represented by large series of both dry shells and specimens preserved in spirit. This has enabled me to describe the soft parts of most of the species investigated. I have also included here the description of a new species of the genus *Trapezoideus*, Simpson, collected by Mr. Sunder Lal Hora at Dimapur in Assam.

In the collection this class is represented by the two families Unionidae and Cyrenidae. Of the former, specimens of the genera *Indonaia*, *Lamellidens* and *Trapezoideus* are represented, and of the latter there are specimens of *Corbicula*, *Sphaerium* and *Pisidium*. The most common genera in the valley are *Indonaia* amongst the Unionidae and *Corbicula* and *Sphaerium* amongst the Cyrenidae.

Family UNIONIDAE.

Genus *Indonaia*, Prashad.

1918. *Indonaia*, Prashad, *Rec. Ind. Mus.* XV, pp. 146–148, fig. 2.

In the Manipur Valley the genus *Indonaia* is represented by five species. Of these *I. theobaldi* is apparently confined to the