

ON *UNCANCYLUS TICAGUS*

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(with 4 plates)

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Numerous ancyliids in an aquarium of our Department, to which our attention was called by Docent Dr. Claudio G. Froehlich, belong to *Uncancylus* Pilsbry, 1914. As the anatomy with exception of two radulae is not known of any representative of this genus (Hubendick 1955, p. 319-320), we studied the species. It does not agree completely with any of the previously described ones and is therefore considered as new and called *Uncancylus ticagus* sp. n. It can be shortly characterized as follows: Length of shell up to 6,5 mm; cephalic lobes distinct; tentacles long. Shell oval, translucent, nacreous; apex between second and last third and mid-line and right margin, minutely pitted, with flattened top. Posterior shell muscle to the left. Mantle with 3 fields of dark pigment cells. Pallial cavity and its aperture large. Infrapallial lobe with retractor and small dorsal and big ventral branchial appendage; anus between them. Concentration of ganglia varies individually. Bow of separate mandibular lamellae surrounding antero-dorsal plate. Radula with tricuspid laterals and asymmetrical principal cusps of central. Ejaculatory duct terminates with small penial papilla. Duct of bursa immediately inside female aperture. Together with the holotype, a 4,5 mm long snail in alcohol, further preparations are kept in the Department of Zoology, Faculty of Philosophy, Sciences and Letters of the University of São Paulo.

1. SYSTEMATIC DISCUSSION

The system of the Ancyliidae is still largely based on characters of the shell, but these are variable (Höff 1940, p. 224). *Hebetancylus moricandi* (d'Orb.) for example has a broad shell and *H. ploecarius* (Bgt.) a narrow one. The extremes are connected by intermediate forms, and broad-shelled and narrow-shelled snails occur at the same locality in Ceará (Haas 1939, p. 267). Therewith Walker's supposition that *moricandi* and *ploecarius* are individual variations is proven. A pitted apex appears in slightly eroded shells of species of *Uncancylus*, while perfect shells of the same species may have smooth apices (Pilsbry 1925, p. 58, note 10). As Connolly (1939) considered nature and area of the apical sculpture as of primary importance in specific determination of the Ferrissiinae, eroded specimens cannot be classified. In a collection of numerous animals from different places a purely conchological separation of the species (Biese 1949, p. 217-236) may be possible. But a systematization according to the localities whence the specimens proceed is impossible, because ancyliids are known to be transported adherent to the elytra of water beetles (Hesse 1924, p. 56; Allan 1950, p. 411-412; Fischer 1950, p. 65; Buttner 1953), and possibly together with mud on the feet of aquatic birds. Baker (1945, p. 40) explained the spreading of some planorbids from the West Indies into South America by "avian dispersal". Also Boettger (1932, p. 273; 1951, p. 78; 1954a, p. 35) supposed transportation of *Potamopyrgus jenkinsi* (E. A. Smith) by birds.

The insufficiency of the shell for the taxonomy of the Ancyliidae became evident when Haas (1955, p. 8) allocated material from Lake Titicaca to *Anisancylus* Pilsbry (1925, p. 8) due to the shells. The subsequent study of the radulae (Hubendick 1955a, f. 44, 52) however revealed their incompatibility with the radula of the genotype (Pilsbry 1925, f. 6).

Hebetancylus and *Uncancylus*, genera or subgenera of *Ancylastrum*, were characterized by their shells (Pilsbry 1914, p. 671, note 6). The apex of the first was described as obtuse rounded, that of the latter as acute. Also further indications (Pilsbry 1925, p. 57, 58; Thiele 1931, p. 483), the rather large, thin and longish-oval shell

of *Hebetancylus* and the small one in *Uncancylus*, are gradual and are difficult to interpret (Hoff 1940, p. 224). According to Scott (1954) *Hebetancylus* is a synonym of *Gundlachia*.

Without Baker's drawings of the radulae of two species of *Uncancylus* (Pilsbry 1921, f. 5; 1925, f. 7; Walker 1925, figure on p. 3) we hardly would have recognized our species as belonging to this genus. For specific separation conchological characters cannot be avoided yet, because the radula is only known of *U. leucaspis* (Anccy, 1901) from Mato Grosso and the State of Rio de Janeiro, Niteroi and Pernambuco (Walker 1925, p. 2; van Benthem Jutting 1943, p. 484), and of *U. calverti* Pilsbry (1921, p. 7) from Costa Rica. The first with an apex depressed towards the tip and slightly S-shaped rows of the radular teeth is evidently nearest to *ticagus*, but differs by its symmetrical principal cusps of the central tooth. In *U. calverti* the left cusp is longer (Baker in Pilsbry 1925, p. 58) as in *ticagus*, but the asymmetry is slighter. Besides the transverse radular rows are nearly straight in *calverti*, and the hooked apex of the shell is acute. The last character separates also the other species of *Uncancylus* (Pilsbry 1921, p. 7-9) from *ticagus*.

The systematic arrangement (Thiele 1931) followed here is obsolete, but makes a survey possible for those who know ancylids from general texts. In the modern system (Wenz & Zilch 1959) the Protancylinae are a subfamily of the Planorbidae (though not in Hubendick 1955b); *Uncancylus*, *Anisancylus*, *Hebetancylus* and others belong to the Ferrissiidae; the Ancylidae are restricted to *Ancylus*; the older, dextrally whorled Acroloxidae comprise *Pseudancylastrum* and *Acroloxus*.

2. SHELL (Figs. 1-6)

The shell is fragile, oval, moderately elevated: its height is less than half the breadth. The anterior border is more obtuse, the posterior narrower. The right border is rather straight, the left convex. The apex lies on the limit of the second and last thirds, approximately in the middle between mid-line and right margin. The top of the apex is flattened. The right and posterior slopes are somewhat concave, the left and anterior ones rather convex, but often irregular,

probably due to repairs of lesions. The shell is translucent, but not glossy; the colour is nacreous, with a light brown periostracum.

With low power only the fine concentric growth-rings are seen, with higher power the apex appears pitted (Fig. 3), and in some of the 50 dry shells examined in detail radial lines were seen produced by slight ribs on the inner surface.

Measurements of some shells in mm:

Length	Breadth	Height	Proportion of length to breadth
6,5	5,0	2,0	1,3
6,0	4,2	1,8	1,43
5,8	4,0	1,8	1,43
5,5	4,0	1,5	1,38
5,0	3,5	1,3	1,43
4,1	2,8	—	1,46
3,5	2,5	1,3	1,4
3,0	2,0	1,0	1,5
0,85	0,55	—	1,54

The shell agrees with that of an unnamed ancyloid from Lassance, north of Belo Horizonte, Minas Gerais (Walker 1925, p. 6, pl. 1, f. 10-11).

The three shell muscles are visible without removal of the shell (Fig. 19). The biggest is the left, and the smallest the posterior muscle. The left muscle lies a little farther in front than the right one, and the posterior lies to the left (Hubendick 1955, f. 40, 43), not in the middle as in *Ferrissia tarda* (Hoff 1940, f. 2).

Parts of the shell border damaged by manipulation were repaired in the course of two days (21° C.) provisionally.

3. EXTERNAL FEATURES

The creeping snails attain 7,5 mm in length, without the tentacles. When the animal moves, the gill often stands out over the shell, and the pointed tail projects with about 1 mm. Of the 4 mm long tentacles 3 mm appear in front of the shell. The body is rather transparent with yellowish flesh. The muscles of the buccal bulb and gizzard are reddish due to haemoglobin (Pelseneer 1935, p. 156; Carriker 1946, p. 36).

Some gland cells of the mantle border contain crystals which are white in reflected light, while others in this region show dark blue contents in transmitted light. This colour disappears in fixed material. In three fields the epithelial cells of the mantle are crowded with purplish black pigment granules (Fig. 19, last phase) which leave the nuclei free, as in the species of *Ancylus* and *Acroloxus* studied by Hubendick (1960, pp. 499, 512-514). The left anterior of these fields emits an anterior and a posterior branch which vanish peripherally, while the corresponding right and the posterior field are concentrated. These pigments do not pass into the shell. The liver of young animals is brown; with age it becomes dark red, violet or purple. The pedal sole has blue or black glands whose colour disappears in fixed material, as that in the mantle skirt. In sections they stain blue with hematoxylin and appear as long tubes which extend far into the tissue of the foot. Into the fold between head and foot the cells of the suprapedal gland (Simroth 1909, pp. 142-143) or anterior pedal mucous gland (Graham 1957, p. 141) open near one another without a common duct. Big melanophores with light nuclei are scattered on the back of the head; sections reveal their submuscular position in the wall of the cephalic cavity.

The head is well separated from the foot and can be withdrawn into the deep fold (x) between mantle and foot beyond the anterior shell muscles. This is the supranuchal cavity of *Lymnaea* (Régonaud 1961, p. 180). The fibres of the cutaneous cephalic muscles concentrate behind forming a strong retractor (h) which originates in the middle of the dorsal mantle surface to the right of the pericardium. In comparison with some other ancylids (Hoff 1940, f. 2; Hubendick 1947b, f. 4) the lobes of the head (Fig. 12) and the anterior depression between them are more distinct. The tentacles are very long, nearly as long as the foot; they are pointed and circular in transverse section. Behind the eyes the tentacles are continued backwards forming bulges (j) which bear sensory cells. They correspond to the auricles, foliate appendages or undulate folds of *Ancylus fluviatilis* *) (Moquin-Tan-

(*) Contrary to Boettger (1944) who applies the rules of nomenclature, we follow Hubendick (1947b, p. 142, note 1; 1960) who uses the traditional generic names of *Ancylus fluviatilis* and *Acroloxus lacustris*. Hubendick's argument of the "*Ancylus-sea*" is striking (see also Opinion 363, Comm. Zool. Nomencl. vol. 11, 1955, p. 183-202).

don 1852, p. 12; Lacaze-Duthiers 1899, p. 46), to the pouches of *Protancylus* (Simroth 1909, pp. 210, 215, pl. 8, f. 13, pl. 12, f. 1) and to the sensory lobes or furrows of other basommatophores (Lacaze-Duthiers 1872, p. 448-449, 473, 477). In *Ancylus fluviatilis* such a bulge is developed especially on the left, the genital side (Hubendick 1947b, p. 143). The head ends with broad latero-ventral lobes. The mouth (Fig. 12) lies on the ventral side of the head between small folds, the lips. On the inner border of the lips the lining cuticle of the buccal cavity is strengthened with a single row of about 40 separate broad obtuse mandibular lamellae (ic). These show almost black around the mouth in life, brown in mounts. The bow of lamellae leaves the middle of the hind border free. On the roof of the buccal cavity the cuticle is reinforced and forms a broad, colourless plate (ui) which does not protrude in living snails. A superior median jaw is also mentioned for *Ferrissia tarda* (Hoff 1940, p. 230).

4. PALLIAL CAVITY AND KIDNEY

The pallial cavity (c) and its opening (Fig. 7) are larger than in all other known members of the family. The limits are the anterior and posterior shell muscles (sm) of the left side. The cavity is slit-like and extends a little beyond the mid-line to the right (Fig. 10). The epithelium of roof and floor (diaphragm; Hubendick 1960, p. 501) bears scattered tufts of cilia. The roof has some inconspicuous folds under the pericardium, and in this region a small area of the epithelium (ru) consists of goblet cells of glandular character discharging into the mantle cavity. Remnants of a hypobranchial gland occur in all genera of the Ellobiidae (Morton 1955b, p. 153), while Hubendick (1947a, p. 107-108; 1947b, p. 144, 146) has described differentiations of the connective tissue in the roof of the mantle cavity in lower and higher aquatic pulmonates. Régonaud's recent research (1961) makes it doubtful, whether we may continue to call the respiratory cavity of the Lymnaeaceae a pallial cavity with vestiges of a hypobranchial gland.

Aerial respiration was not recorded for ancylids (Pilsbry & Bequaert 1927, p. 148). It occurs in *Uncancylus ticugus*. In boiled, but also in aquarium water, we saw snails hanging to the surface film take

an air bubble into their pallial cavity. We describe this process in chapter 10.

The kidney (Fig. 7, k, z) lies in the connective tissue of the roof of the pallial cavity. It is for the most of its extension bathed in the arterial blood of the mantle sinus (s) and corresponds fundamentally to the kidney of *Ancylus* and *Acroloxus* (Sharp 1884, p. 236f.). It consists of an excretory (z) and an ureteric (k) portion which Sharp termed saccular and tubular parts. The first appears as a sausage-shaped winding organ. Its high epithelium is generally stuffed with concretions. These are most frequently sulphur-yellow, sometimes white or pink, and rarely bluish green. The wall of the excretory portion is smooth in young snails, while its surface is enlarged by irregular folds in bigger animals. A short canal (eo) whose cilia can be seen beating under favourable conditions connects the excretory part with the left wall of the pericardium (er). The reno-pericardial duct lies on the ventral side of the kidney, approximately in the middle of the organ. From here the kidney curves backwards and to the left, then forwards and to the middle, again to the left, then to the middle, and finally turns backwards. Here the excretory epithelium disappears and is substituted by a flat, smooth epithelium with scattered cilia which line the entire tubular part, the ureter. This emptying duct accompanies the windings of the excretory portion on the left side. A little behind the latter the ureter is dilated into a urinary chamber where the concretions of excretory matter may be seen revolving or are expelled backwards through the renal pore (n). The current produced by the cilia of the pallial cavity carries the excreta outwards.

5. INFRAPALLIAL LOBE

The infrapallial (auriform or anal) lobe (pseudobranchia, gill) begins at the anterior end of the pallial aperture and extends along the whole length of the mantle cavity (c). The inferior border of the latter constitutes the base of the lobe. The rectum (r) runs inside the base along its entire postero-anterior direction, and is surrounded by an ample blood sinus (s); it opens near the anterior end of the lobe. The absence of an anterior lobe shows that the infrapallial lobe at least in *Uncancylus ticagus*, is not specially related with the double

lobe (anal lobe and gill) of the Planorbidae (Hubendick 1947b, p. 156-157). The gill itself is similar in our species with that of the planorbid *Plesiophysa ornata* (Hubendick 1950, f. 5). In young snails the base bears a single, ventrally directed appendage. In older snails the ventral appendage (p) is folded longitudinally, and still later a smaller dorsal, also folded appendage (no) of the base develops. The anus (ar) lies between ventral and dorsal appendage. Number and depth of the folds increase enormously with age. Both appendages have the same structure (Fig. 8), viz a ciliated epithelium (zi) with scattered gland cells and muscular trabeculae (xa) between the blood lacunae (s). Thus the pseudobranchia of *Uncancylus* resembles the gill of *Acteon* (Perrier & Fischer, 1911, p. 32, fig. H) and other Cephalaspidea. The gill can be contracted by a strong muscle along its anterior border which accompanies the sinus described in the following. The muscle originates from the left anterior shell muscle, divides during its course outwards (rm) and inserts on several branchial folds. The edge of the mantle is underlain by a wide circular blood sinus (s) (Simroth 1912, p. 477, f. 157) which is in front and on the left side broader than behind and on the right side. The muscle fibres of the sinus are similar to the trabeculae of the pseudobranchia; they traverse the sinus obliquely and are in connection with the three shell muscles. These fibres constitute the so-called mantle retractor (Hoff 1940, p. 226, f. 2, mt). When the snail is manipulated with tweezers, the mantle narrows to half its breadth at the spot where the tweezers touch it. The muscle fibres bring about circulation within the mantle sinus, hence act like the trabeculae in the pseudobranchia. Pulsation of the mantle sinus was occasionally seen at the place where the sinus passes to the kidney.

6. HEART AND CIRCULATION

The pericardium (er) lies to the right of the kidney; the auricle to the left of the ventricle (w). The aorta divides soon into two branches, an anterior and a posterior one. They enter the cephalic and visceral cavities which are incompletely separated by the diaphragm, Hoff's "membrane of André" (1940, p. 236). In the head cavity the organs are loosely suspended. The muscles of buccal mass and gizzard are reddish, according to Leydig due to haemoglobin (Pelseneer 1935, p. 156).

Arterial blood supplies the organs of the head, the foot and the viscera. The venous blood passes from the cephalic cavity to the body sinus whose lacunae communicate with the marginal sinus of the mantle in the posterior region, where they are in contact. As the pedal border is richly provided with blood lacunae, a certain oxygenation may take place here. The blood goes from the foot of the peripheral mantle sinus and the perirectal sinus through multiple communications. This intestinal sinus is connected with the mantle sinus at the hind end of the pseudobranchia and in front of the anus on the level of the osphradium (o). Hence the base of the pseudobranchia is supplied with blood from the mantle sinus. The branchial lacunae communicate with the mantle sinus. The blood flows through the lacunae (s) of the pseudobranchia in longitudinal direction, not transversely as in André's figures (Simroth 1912, p. 477, f. 157). Contrary to *Ferrissia tarda* (Hoff 1940, p. 234) the richly folded and long organ of *Uncancylus ticagus* is evidently efficient for oxygenation. The arterial blood flows around the osphradium, the kidney, where it is cleaned, and to the auricle. The rhythm of the circulation is a complex phenomenon which is difficult to analyze. Though the heart of our young snails generally pulsates more slowly than that of older animals, in contrast with indications for *Lymnaea* (Hoffmann 1924-28, p. 977, 979; Boettger 1944, p. 334), and in most cases heartbeats are more numerous at higher temperatures, there are exceptions in our protocols. Possibly local

Length (in mm)	Heartbeats per minute	Temperature (in centigrades)
0,6	46	18
0,6	89	18
0,65	65-72	17
0,65	73	20,5
0,65	65	21,5
3	30	17
4	74	18
4	170	31
5	96	20,5
5,5	78	17
5,5	42	18
5,5	64	18

muscle contractions exert influence upon the flow of the blood in the chiefly lacunar circulatory system of our snail.

Moquin-Tandon (1852, p. 128) observed 50-60 heartbeats in young *Ancylus fluviatilis* and Saint-Simon (1852, p. 121) the same in adult *Acroloxus lacustris*. Both authors did not indicate the temperature.

7. NERVOUS SYSTEM AND SENSORY ORGANS

The central nervous system (Fig. 11) is as highly concentrated as in the other ancylids (Hubendick 1947b, p. 149). The ganglia are however in some specimens more and in others less distinctly circumscribed and set off from one another, and the lengths of the commissures vary individually. The cerebral ganglia (1) are biggest; their commissure is less than half the diameter of one of them. The next in size, the pedal ganglia (3) are ventrally apposed to the posterior third of the cerebral ganglia and bear the statocysts (oc) with many statoliths on their dorsal surface. The pleural (4) and parietal (5, 6) ganglia are frequently separate as in several planorbids (Hubendick 1955b, figs. on p. 230). These ganglia or this complex of ganglia is somewhat bigger on the left than on the right side. The separation of pleural and parietal ganglia explains the indication of 3 visceral besides the pleural ganglia (Aeberhardt 1905, quoted from Hubendick 1947b, p. 149).

The abdominal (Hoff 1940, p. 237: left posterior visceral) ganglion (7) is big and lies to the left of the mid-line. The length of the cerebro-buccal connectives varies; the buccal commissure is as long as or longer than the diameter of one buccal ganglion (2). In snails with separate pleural and parietal ganglia sometimes a further small visceral ganglion (8) was seen between right parietal and abdominal ganglion. As in these cases the left parietal (supra-intestinal) ganglion is contiguous with the abdominal ganglion, the whole visceral loop consists of ganglia.

A nerve from the left parietal ganglion innervates the osphradium which lies in front of the entrance of the mantle cavity under the left anterior shell muscle. It is a deep, narrow pit (Fig. 9) coated with a fine tunic of connective tissue and lined with an epithelium whose long cilia beat lively. The ciliated cells enter the osphradial concavity,

but do not continue around the whole lumen. The cells of the bottom (sc) bear short rods, not long cilia, and their nuclei are big and spherical, not narrow and longish as in the external cells. Lacaze-Duthiers (1872, p. 483) discovered the osphradium of limnic Basommatophora, though not in ancyliids, and distinguished the external and internal cells of the pit in *Planorbis* (p. 486). Both types are distinctly separated, and at the limit between outer and inner cells clusters of subepithelial cells (wo) form a corona around the osphradium. These cells are glandular and discharge their secretion into the pit. In *Planorbis* Lacaze-Duthiers (p. 491) observed mucous secretion expelled when the aperture of the osphradium was stimulated, and Bernard (1890, p. 242) noted mucus cells. The bottom cells are evidently sensory. The big, cup-like osphradial ganglion (oa) around the fundus of the pit was in ancyliids first described by Sharp (1884, p. 231).

The origin of the four anterior cerebral nerves is not as separate as in *Acroloxus lacustris* (André 1893, quoted from Simroth 1910, fig. 74 E). The inner nerve trunk divides into inner and outer cephalic nerves nearly as in *Ferrissia tarda* (Hoff 1940, f. 17), but the outer trunk is different. Optic and tentacular nerve are united for a long distance in *Uncancylus ticagus*; this corresponds to the "most lateral main nerve" of *Ancylus tapirulus* (Hubendick 1960, p. 504). Near the surface of the bulge (j) behind the base of the tentacle the tentacle nerve forms a club-shaped ganglion (9) connected with the sensory cells of the bulge. These cells stand in subepithelial groups, and sections of the bulges with the secondary ganglion and subepithelial clusters of sensory cells resemble those of the Hancock's organ of the Cephalaspidea. The "cup-shaped ganglion" of *Protancylus* (P. & F. Sarasin 1898, quoted from Simroth 1909, p. 210, pl. 12, f. 1) may be the complex of subepithelial sensory cells. The tentacle nerve runs forward into the tentacle (t) ventally to the ganglion of the bulge.

8. ALIMENTARY CANAL (Fig. 14)

The jaws were described at the end of chapter 3. The radula (Fig. 13) consists of 125-145 slightly opisthocoelous rows with about 20.1.20 teeth. The rhachidian tooth (R) has two principal cusps, each flanked by an accessory cusp. The left principal cusp is distinctly longer than the right one. The lateral teeth are fundamentally

tricuspid. The first has besides the ental cone, mesocone and ectocone, one entoconal and two to four ectoconal accessory cusps. The following laterals are similar; sometimes two accessory entoconal cusps were observed. Farther outwards the size of the ectocone decreases, an interstitial cusp may appear also between mesocone and entocone, and the latter may split into two as do the principal cusps in *U. leucaspis* (Walker 1925, p. 4). From the 16th or 17th tooth outwards the teeth are very weak. The radula of a 0,66 mm long snail has already 85 rows, the oldest of which contains three, the newest six tiny teeth on each side of the rhachidian tooth. The latter has two principal cusps and a single accessory one beside the left and larger of these. The cushions of supporting tissue (radular cartilages) are separate.

The rather short salivary glands (sa) are tubular, not lobate, dorsal to the cerebral commissure and coalesced over the oesophagus (oe) behind, as Hubendick (1955a, p. 317) had supposed in his material. The narrow oesophagus has very long cilia (Hoff 1940, p. 231: "flagellated cells") and a few longitudinal folds. It opens suddenly into a wide crop (cr) where the folds become irregular, and the long cilia stop. Only a dorsal and a ventral median band of higher cells are ciliated. Near the passage to the gizzard (mu) there is a narrow belt of cilia which are much shorter. The gizzard has a high epithelium without cilia thrown into about a dozen folds. The cuticle is very thin, not "relatively thick" as in *Lymnaea stagnalis* (Carriker 1947, p. 33). The muscle mantle of the gizzard contains haemoglobin as in *Lymnaea* (ibid., p. 36). It is composed of four circular layers separated by three longitudinal ones, while *Ancylus fluviatilis* has five and four layers respectively (Heidermanns 1924, p. 350). The muscle coat is of equal thickness all round as in *Ancylus fluviatilis* and *Acroloxus lacustris* (ibid.), contrary to lymnaeids and planorbids with two muscular pads. According to Heidermanns (p. 365-366) only gizzards with muscle pads can grind. He supposes that the gizzard of ancylids only functions as press forcing the food into the digestive gland and the intestine (p. 352).

The contents of the gizzard of *Uncancylus ticagus* are mingled with numerous sand grains which are moved to and fro, but rarely evacuated. This indicates that they are biologically significant, possibly slitting the membranes of plant cells. The following region, the py-

lorus of Hoff (1940) and Carriker (1947), "Hintermagen" of Heidermanns (1924), may be called stomach (ac), because it communicates with the digestive gland (1). The latter has a single duct, already seen by Moquin-Tandon (1852, p. 52). The wall of the stomach has a thin muscle coat and a ciliated epithelium with several folds. These are difficult to analyze due to the small size of the animals. We found a curved major pyloric fold (Carriker 1946, p. 35) which probably acts as a valve protecting the opening of the hepatic duct against the entering of stones or other big particles. This fold occurs also in *Gadinia peruviana* (Schumann 1911, p. 32). The atrial and hepatic corrugations (Carriker 1947, f. 13, p. 28-29) which enter the small caecum (cu) represent a posterior sorting area. The caecum opens after the entrance of the hepatic duct, but lies in front of it due to the winding of the alimentary tract. The caecum has a high folded epithelium of glandular character beset with cilia; it is a sorting organ and contributes to the mucus of the faecal string as in *Lymnaea* (Morton 1953, p. 244). The epithelium of the stomach near the opening of the caecum is similar to the description of an elementary style-sac (Morton 1955a, p. 127). The height of the cells (18μ) is less than in *Otina* (30μ), and they have only one nucleolus.

In a rather transparent living snail that had fed on lettuce the gut contained fine homogenous green particles which made it possible to observe the movements of the food. The contents of the gizzard, food as well as sand, were pumped alternately into the crop and the stomach and sucked back into the gizzard many times. The green masses, not the sand, are also driven into the lobes of the digestive gland and regurgitated repeatedly. Also the caecum is filled with food masses. The described process does not support Heidermanns' above cited idea of the ancylican gizzard as a simple force pump which presses the food through the flexure of the stomach. It is true that Heidermanns dealt with other species. His observations (1924, p. 353-354) refer only to intestinal peristalsis.

The peristaltic intestine (i) carries the digested masses to the rectum (r), gradually concentrating the faecal string. The intestine first runs in a loop around the gizzard, anteriorly from right to left, then backwards, and again to the right around the hind lobe of the

liver to the ventral side, turning along its own course to the left and forwards. The intestine has a glandular ciliated epithelium and an inconspicuous intestinal groove till it enters the blood sinus in the infrapallial lobe (p). The ring of high cells described in *Ancyclus fluviatilis* (Sharp 1884, p. 221) is absent. In its terminal course forwards the ciliated epithelium of the alimentary tract is lower and no longer glandular, hence this outermost portion of the intestine can be called a rectum. According to the contraction of the infrapallial lobe the anal opening (ar) is directed to the dorsal or to the ventral side.

9. REPRODUCTIVE ORGANS (Fig. 15)

The acini of the orange hermaphrodite gland (ov) are surrounded by the liver and lie over the descending portion of the intestine. The female germ cells are the more ental (proximal), the male cells the more ectal (distal) elements. The hermaphrodite duct (so) has an inner and an outer portion separated by the irregularly coiled seminal vesicle (vs). The latter and the ental portion of the duct were filled with sperms in July 1961, while the ectal course was empty. This ends at the "crible ou carrefour génital" (Lacaze-Duthiers 1899, p. 36, 64 ff.), where the male and female ducts separate. Own sperm is absorbed by the epithelium of the vesicula seminalis as in *Acteon* (Fretter & Graham 1954, p. 574).

The male or efferent duct begins prostatic (q) as a convolute glandular tube whose epithelium contains big spherules of secretion. The cells of the prostatic section are very big, their nuclei are 20μ in diameter. The following muscular portion of the efferent duct (d) passes through the left anterior shell muscle and unites with the flagellum (u), a long tube with big gland cells in its ental widened part, decreasing towards the narrower, so-called flagellum duct. Ectally to the junction (un) of efferent and flagellum duct the male canal can be called ejaculatory duct (Hubendick 1955, p. 318). Its circular muscle layer is thicker than that around the precedent efferent duct. A retractor (re) originating in front of the head inserts on its base. The flagellum duct enters the male canal on the same level as in *Uncancylus ticagus* in *Ferrissia parallela*, according to Hoff (1940,

p. 241), and in Haas' so-called *Anisancylus*-species (Hubendick 1955a, f. 46, 47, 53), but farther ectally in other ancylids (Lacaze-Duthiers 1899, pl. 7, f. 30; Hoff 1940, pl. 2, f. 11; Hubendick 1947b, f. 23 on p. 153; 1960, p. 507, f. 11 on p. 509).

The outlet of the ejaculatory duct is permanent on a small papilla thickened by insunk glands. It hangs into the male atrium (e) that is entirely evaginated during copulation. In this state the atrium forms an up to 1,3 mm long tube of 0,1 mm diameter (Fig. 18). The retracted papilla measures about 0,12 mm in both directions and is surrounded by an annular fold. The male pore lies behind the basal bulge of the left tentacle.

In the literature the male copulatory organ is generally studied in fully retracted condition; then the atrium is composed of two compartments, an inner and an outer one. The former is called "deuxième prépuce" (Lacaze-Duthiers 1899, p. 87), penis sheath (Hoff 1940, p. 240; Hubendick 1947b, p. 150), or vergic sac (Baker 1945, p. 7; Hubendick 1955a, f. 46, 47, 53, vs), the latter "premier prépuce" (Lacaze-Duthiers 1899, p. 86) or praeputium (other authors). Penis sheath and praeputium are separated indistinctly by an oblique ring-shaped fold, the diaphragm (Baker, l. c.) or velum (Hoff 1940, p. 241; Hubendick 1947b, p. 154; 1955a, p. 317). In his figure 11 (pl. 2) Hoff called the velum 'sarcobellum', but Baker's description of the "sarcobelum" refers to a special organ of stimulation which occurs in *Planorbarius*.

The hermaphrodite duct conveys the eggs to the carrefour (ca) whose entrance is provided with a strong sphincter. This muscle blocks the way into the chamber for the own sperms. The carrefour is entally connected with the transparent yellow albumen gland (an), ectally with the capsule (nidamental or mucus) gland (cm). The cilia which also occur in the hermaphrodite duct, in the carrefour, and in its connection with the albumen gland are especially strong in the canal between the chamber and the capsule gland. Topographically Hoff's papilla of *Ferrissia tarda* (1940, p. 239) corresponds to the carrefour of our species; the carrefour belongs to the oviduct.

We suppose, as Simroth (1912, p. 498 did, that the carrefour of *Uncancylus ticagus* is a fertilization chamber, but as we have not yet seen sperm in the inner part of the female duct, we cannot affirm

it. According to the literature concerning neighbouring families mentioned by Alaphilippe & Régondaud (1959, p. 491) fertilization takes place still farther inwards, in the ectal part of the hermaphrodite duct.

The fertilized eggs supplied with the secretion of the albumen gland, which in the present species resembles the white of a hen's egg, enter the broad yellow capsule gland. This gland is connected with the female pore by the muscular nidamental duct which begins with an inward fold (va) of its wall. The nidamental duct (ni) which has no glands is in other Lymnaeacea subdivided into an inner portion (uterus) between capsule gland and entrance of the bursa canal, and an outer part (vagina) from this entrance to the female aperture. In the present species this subdivision is merely topographic. The outer opening (v) of the female organs lies beneath the osphradium or under the anterior end of the pseudobranchia. The duct of the bursa copulatrix (b) (spermatheca) opens immediately inside the female aperture.

A couple of snails (Figs. 17, 18) was preserved during its copulation. In the animal that has functioned as female the wall of the female opening is protruded and forms a cylindrical papilla (Lacaze-Duthiers 1899, pl. 3, f. 3, Va). In sections a plug of sperm and secretion sticks out of this papilla and fills the canal and the ampulla of the bursa copulatrix. The fold at the entrance of the capsule gland closed the latter, evidently to avoid the immediate ascent of the spermatozoa. Also in specimens preserved one and three hours after mating only the bursa contained sperm.

10. OBSERVATIONS ON LIVING SNAILS

The animals lived for months and in great numbers mating and laying eggs in two aerated aquaria, 80 cm in length, 40 cm in breadth, height of water 25 cm. The aquaria stood near a window, but were not exposed to direct sunlight; they contained a layer of coarse sand and small (2-6 cm) stones, algae and *Elodea*, some *Xiphophorus helleri*, green hydrae, many *Macrostomum* and *Chaetogaster*. Tufts of *Stentor* are attached to the shell of the ancyliids with their gelatinous investment, and irregular patches of green algae fasten themselves in the growth-rings. *Macrostomum gigas* Okugawa, 1930, a

macrophagous rhabdocoel, preyed upon our young ancylics. In one of the aquaria *Chaetogaster parvus* Pointner, 1914, was found on the surface of the snails, while in the other *Chaetogaster limnaei* C. Baer, 1827, gathered in their pallial and supranuchal cavity, sometimes up to 25 worms. They fed upon the faecal pellets of the snails and also upon Ciliata. They do not seem to be harmful to their host, as a richly infected isolated snail produced three capsules with 12-14 eggs each in the course of three days.

During the months of observation, May to September 1961, the temperature in the aquarium varied from 17° to 22° C.

The food of the snails consists of micro-organisms growing on stones, plants, and the glass panes of the aquaria, and decaying leaves and other organic detritus. Sometimes green spherical algae and eggs of *Macrostomum* in the faecal pellets had passed the alimentary canal entire. The youngest 0,66 mm long animals found in the aquarium had already a sand grain in the stomach. When adult snails with sand grains in the gizzard are kept in a dish and fed with clean lettuce the grains are retained, not evacuated.

The faecal pellets are greenish cylinders of 1-1,7 mm length and about 0,16 mm diameter in big specimens. There are also a few dark brown masses composed of conglutinated excreta from the digestive gland (Fretter 1939, p. 636-637). At a water temperature of 20° C. snails living with abundant food defecated thrice per minute. Measurements of pellets and frequency of evacuations are a little superior to those indicated of *Ancylus fluviatilis* (Heidermanns 1924, p. 353).

In the aquaria the snails sat on the light and on the dark walls, on the bottom, on rooted and on detached *Elodea*. They can reach the latter falling down from the surface where they glide with perfection as do other ancylics (Hoffmann 1924-1928, p. 1079). Moquin-Tandon (1852, p. 136) and Sharp (1884, p. 217-218) never saw the snails creep on the surface film. In this position and also while moving on a solid substratum, e. g. a slide, our species uses its cilia which cover the whole sole. This is facilitated by secretion from the anterior pedal gland, a ribbon of rather fluid mucus. We did not see the snails descending from the surface hanging on this thread, as was observed in *Ancylus fluviatilis* (Pelseneer 1935, p.

362), but proved its existence by drawing the snails backwards through the water with it (Kaiser 1959, p. 379). The mucous trail can also be shown by letting the snail creep on a greased slide, then the water adheres to the track. As Kaiser (p. 375-376) observed in bigger basommatophores also *Uncancylus ticagus* adheres to the surface by means of suction performed by dorso-ventral and oblique muscle fibres of the foot. The oscillation of these muscles ("die muskuläre Unruhe") produces concavities on the surface film which change their place continuously, while the mutual position of the pigment cells in the sole remains constant. In the present species whose pallial cavity generally does not contain air, the suction alone must overcome gravity; if it is relaxed, the snail loses its contact with the surface film and sinks. As long as the animal adheres to the surface a second of these positively thigmotactic snails can fix itself with its sole to the shell of the first, and even a third to that of the second, and all three are maintained suspended by the muscular action of one. The force of the cilia is responsible for locomotion. On a solid substratum the snails run on their mucous trail by means of the cilia. Compared with *Protancylus* (Simroth 1908, p. 11, note), and *Ancylus* (Moquin-Tandon 1852, p. 135; Wesenberg-Lund 1937, p. 740) *Uncancylus ticagus* is a vagrant snail. It moves about frequently and creeps 3 mm per minute at 17° C., 25 mm at 26° C. Hunter (1953, p. 625) indicates 1-2 mm per minute for feeding *Ancylus fluviatilis*, hence much more than Moquin-Tandon and Wesenberg-Lund.

Snails fallen upside down on a solid substratum, e. g. glass, recover their normal position rapidly (Fig. 19). However when the same snail is laid on its back several times, reversion becomes slow. The snail tries to regain contact with the substratum moving the anterior border of its maximally extended foot to all sides. It does not succeed to reach the substratum in front or over the right side, but when it touches the substratum on the left side, where the shell is not as steep as on the right one, it turns over immediately. When the snail moves on loose sand, the mucus forms a thick carpet to which the superficial sand grains stick. If it has fallen upside down, the carpet helps it to recover. If a snail falls on to loose sand, where it has no tract, it cannot turn round till it has grasped so many sand grains

with its foot and agglomerated them to a ball that this is heavy enough to counterbalance the snail while turning over.

A slight, by no means pronounced preference for the dark side in the aquarium led us to test the reactions of *Uncancylus ticagus* to light. In a first series of experiments snails which had lived under the normal rhythm of day and night were brought into a dish with one half dark and the other exposed to diffuse daylight. In a second series snails kept in the dark for 24 hours were submitted to the same conditions as the first. The results of both experiments were the same: the snails behaved indifferently, without preference to dark or light. However to direct sunlight they react negatively, avoiding it. They respond to this stimulus in form of a phobotaxis. Ancylicids fleeing from sunbeams were several times mentioned in the literature, e. g. by Moquin-Tandon (1852, p. 134) and Pelseneer (1935, p. 231).

A snail wanting to take air into its pallial cavity curves its foot so that a concave angle at the left side results. Here the concavity of adhesion is deepened so far that only a narrow rim of the sole remains in contact with the surface film. Also the left mantle border touches the film. Then the gill is apposed to the side of the foot, and the pallial cavity drawn widely open, so that air enters. The gill closes over the air bubble. Later on the shell muscles contract and press the air out of the cavity again.

As all basommatophorans (Boettger 1944, p. 396) also *Uncancylus ticagus* mates unilaterally, not reciprocally. Mutual copulation is excluded by the position of the genital apertures (Fig. 18). Lacaze-Duthiers' description and figure (1899, p. 93, pl. 3, f. 5) of a penis penetrating into the female orifice was repeated by Simroth (1912, p. 500, pl. 25, f. 12) and Hoffmann (1924-28, p. 1118). According to Moquin-Tandon (1852, p. 346) however *Ancylus fluviatilis* copulates in the same way as *Uncancylus ticagus*, not introducing the penis into the female aperture, but clasping the female papilla tightly ("presse fortement le mamelon vaginal"). We saw also chains of three copulating snails, the undermost functioning as female, that in the middle as male and female, and the uppermost as male. A mating couple is firmly united (Fig. 17) so that it can be turned upside-down for observation. In the transparent penis (e) the ejaculatory duct (d) and the entrance of the flagellum duct (un)

near the end of the former could be seen, as well as the whole extension of the flagellum (u) which remains enclosed in the evaginated male atrium of the active partner. Even when preserved, a couple stayed united, and separated only after decalcification. Evidently the snails are sticking together due to secretion of the flagellum. In the preserved animal the erected penis reached the right border of its foot; it measures 1,3 mm in length and 0,1 mm in diameter.

In the middle of July, at water temperatures of 18° C. in our dishes in the early morning and 25° at noon six snails produced 8 egg capsules in 24 hours. In the course of 48 h. we obtained 16, in 72 h. 26 capsules. These contain up to 14 eggs which can all hatch. After some days the number of capsules and that of eggs contained in them decreased. The size of the capsules corresponds to the number of eggs. With one and two eggs they measured 1 x 0,9 mm, with three eggs 1 x 1 mm, with five eggs 1,3 x 1,3 mm, and with six eggs 1,5 x 1,3 mm. The biggest capsules (Fig. 16) with 12-14 eggs were 2 mm in length and breadth. As the margin is about 0,1 mm broad, the diameter of the central space is about 1,8 mm. When recently laid capsules are detached, they become globular. The unsegmented egg is 80 μ in diameter. The developing embryo grows considerably and measures 0,12-0,14 mm on the third day, on the fourth 0,25-0,3 mm, and on the seventh 0,5 mm. The embryo rotates in its membranes on the fourth day. The snails hatch in 8-10 days with the shell 0,65 mm long and 0,4 mm broad. The time of hatching is quite variable in the ancyliids (Basch 1959, p. 274). Hatching snails have only 40 μ long tentacles and still yolk in the digestive gland; they feed already and have a green alimentary canal. With a length of 0,8 mm the mandibular teeth are present. The tentacles grow slowly, 1 mm long snails have them 60 μ long, in 2 mm long animals they are 0,4 mm. The pigment cells appear at a length of 2 mm, but their development is not always correlated with size.

Ferrissia shimekii studied by Basch (1959) and *Uncancylus ticagus* become mature before their somatic growth ends. This seems to be the case in all basommatophores, but contrasts with most of the Stylommatophora (Hoffmann 1924-1928, p. 1116). The capsules of the mentioned *Ferrissia* always contain only a single egg

(Basch 1959, p. 269). *Uncancylus ticagus* is bigger than *F. shimekii*, and in our dishes produced egg capsules already at a length of 3 mm. Once such a small snail isolated after copulation laid a capsule containing 3 eggs about 12 hours later, and on the 7 following days 7 further capsules with 3 eggs each. During this time the animal did not increase its size.

11. GENERAL CONSIDERATIONS

The surface of the ancylicids, as small snails, is relatively large. Hence cutaneous aquatic respiration facilitated by a patelliform, not coiled, body and locally reinforced by a gill is sufficient for them. The shell surface exposed to the movement of the water is only one and a half or two times larger than that of adhesion, against 12-20 times in planorbids of stagnant water (Hoffmann 1924-1928, p. 1323). So equipped ancylicids can enter brooks and torrents, where oxygen contents are highest. Food is scarce in this oligotrophic environment and gathers in sheltered niches at the bottom. As a bottom-dweller *Ancylus fluviatilis* may perhaps be called "earthworm of brooks" (Heidermanns 1924, p. 351), though it moves about much less than an earthworm. Moreover many members of the family Ancylicidae (sensu latiore) live in quiet, eutrophic waters, e. g. *Acroloxus lacustris* (Wesenberg-Lund 1937, p. 741; Boettger 1944, p. 439), *Ferrissia parallela* (Taylor 1960, p. 61), our *Uncancylus ticagus* and others. *Acroloxus lacustris*, it is true, from stagnant waters has a low shell, and so it opposes less resistance to mechanical aquatic action than the high-shelled rheophile *Ancylus aquaticus* (Berg 1952, f. 1 and p. 264).

During active life, e. g. on stones exposed to spray (Boettger 1944, p. 323), and during winter, with reduced activity (Pelseneer 1935, p. 314) ancylicids can breathe air. This respiratory amplitude is common in the Basommatophora. *Chilina* takes air or water into its mantle cavity, and higher limnic forms can live without air with aquatic cutaneous (*Lymnaea*, *Galba*) or branchial respiration (planorbids). The systematic position of the ancylicids cannot be derived from their on the whole aquatic respiration. Pondering their relation with the Patelliformia (Hubendick 1947a, p. 162-163), the

Amphibolidae, and Chilinidae (id., 1947b, p. 1956-1957), or with the Planorbidae, Hubendick favours the last position. He considers the patelliform shell and diminution of the mantle cavity as secondary specializations.

Within the family *Uncancylus ticagus* has several primitive characters: the well developed head lobes (Hubendick 1947b, p. 156), the relatively large mantle cavity, the sometimes separated pleural and parietal ganglia, and the occasional occurrence of a commissural ganglion between right parietal and abdominal ganglion. The penis of *Uncancylus ticagus* is intermediate between the more complex one of *Ancylus* and *Ferrissia* and the simpler one of Hubendick's species (1955a). These have all a flagellum. Hubendick (1947a, p. 131) stressed the lability of the distal reproductive organs and points to histological differences (1947b, p. 159-160) between a flagellum and the tubiform organ of *Amphibola*. It is however the only topographically comparable organ in these snails that may belong to the ancestry of ancylids. The ental part of the reproductive system in ancylids as well as planorbids is similar to that of the lymnaeids which hints to *Chilina*.

Besides the general organization of the generative organs the central nervous system and the alimentary canal offer criteria which unite the higher limnic Basommatophora or Lymnaeacea. Morton (1955b, p. 163) called them Branchiopulmonata, but as Physidae and Lymnaeidae have no gills, the choice of the name is strange. As far as Heidermanns' studies of some species (1924) inform, Physidae have the least, Planorbidae and Lymnaeidae the most developed gizzard; the Ancylidae stand between Physidae and Planorbidae. The weak gizzard of the physids coincides with the radula more elaborate than in the other lymnaeaceans. A posterior caecum (caecum pyloricum) is a feature of the earliest gastropod stock (Morton 1953, p. 244). It occurs in all families of the Lymnaeacea; in *Uncancylus ticagus* there is also a vestigial style-sac.

Beyond the known relationships between Cephalaspidea and Basommatophora in nervous system, radula, gizzard, and hermaphroditism there are no special affinities of ancylids to opisthobranchs. Burch,

Basch, and Bush (1960, p. 202, note) think that the chromosome numbers might suggest such.

Hubendick (1947a, b) and Morton (1955a, b) agree in a main bipartition of the Basommatophora, distinguishing the more primitive Archaeopulmonata (Morton 1955a, p. 148) and the higher limnic Basommatophora (Branchiopulmonata or Lymnaeacea). The families of the latter were already mentioned; the former comprise Ellobiidae, Chinidae, Latiidae, Amphibolidae, Siphonariidae, and Gadiniidae.

An operculum in the adult or in the embryo, free swimming veligers (*Melampus*, *Amphibola*, *Siphonaria*, *Gadinia*), embryonic vestiges of a velum, the nervous system, sometimes with vestigial streptoneury, parallels in the reproductive organs, and a general compatibility of the stomach of *Amphibola* with the ellobiid type (Morton 1955b, p. 163) justify the name Archaeopulmonata, and make it probable that the two parallel lines, viz. Ellobiidae and the other families, have their origin in common (Hubendick 1947a, p. 160).

Pelseneer (1894, p. 117: diagram) derived the Lymnaeacea from *Chilina*, and Plate (1895, p. 203), Thiele (1935, p. 1110), Boettger (1944, p. 269; 1954b, p. 269), and Hubendick (1947b, p. 156: Amphibolidae and Chinidae) are of the same opinion. If the higher limnic Basommatophora were early land pulmonates reverted to freshwater (Morton 1955b, p. 162), their infrapallial lobe and osphradium would be convergences. Boettger (1944, p. 331; 1954b, p. 268) follows Herfs (1922, p. 20-30) and considers the mostly subepithelial position of the glands in the limnic basommatophores as testimony of ancestral terrestrial life, as a formerly necessary protection against dry air on the seashore. Certainly such glands arranged on different levels in the connective tissue can secrete more mucus than intra-epithelial goblet cells, and cutaneous secretion helps to shield the body of gastropods besides shell and operculum. But also limnic snails are exposed to drying. Many of their biotopes lose the water in summer or winter. A snail that passes from sea to freshwater must be equipped as well as or even better than one going to the land. It has to counterbalance not only dry periods but also a hypotonic medium and cannot withdraw into the shell like a terrestrial snail during heavy rains.

12. RESUMO

A espécie encontrada em aquários no Departamento de Zoologia da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo tem concha de até 6,5 mm de comprimento, com ápice achatado, finamente pontilhado. O comprimento da cúspide principal esquerda, no dente central da rádula, ultrapassa o da direita. A cavidade do manto é larga, e o animal serve-se dela para respiração de ar. Órgãos respiratórios aquáticos são a brânquia bilobada e o bordo do manto. A concentração dos gânglios varia individualmente. Grãos de areia evidentemente auxiliam na trituração do alimento, principalmente vegetal. A papila penial é pequena; o duto da bolsa copulatória que recebe os espermatozóides na cópula, abre-se perto do orifício feminino. Na locomoção na superfície d'água, músculos dorso-ventrais e oblíquos seguram, por sucção, o gastrópode, os cílios locomovem-no ao longo de uma fita de muco. Animais caídos de dorso voltam à posição normal virando sôbre o lado esquerdo da concha, menos íngreme que o direito. Os animais são indiferentes à luz difusa do dia e ao escuro, mas evitam, fobotáticamente, os raios solares. Os casulos de ovos contêm até 14 embriões; os animais podem tornar-se maduros antes de terminar o crescimento somático. Não há evidência de que os Lymnaeacea sejam caracóis outrora terrestres voltados para a água doce.

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14. EXPLANATION OF LETTERS

1 — cerebral ganglion	im — pigment
2 — buccal ganglion	j — post-tentacular sensory organ
3 — pedal ganglion	k — ureteric part of kidney
4 — pleural ganglion	l — digestive gland
5 — right parietal ganglion	m — male aperture
6 — left parietal ganglion	mo — mouth
7 — abdominal ganglion	mu — gizzard
8 — accessory visceral ganglion	n — renal pore
9 — ganglion of the post-tentacular sensory organ	ni — nidamental duct
a — mantle skirt	no — dorsal lobe of gill
ac — stomach	o — osphradium
an — albumen gland	oa — osphradial ganglion
ar — anus	oc — statocyst
b — bursa copulatrix	oe — oesophagus
c — pallial cavity	ov — ovotestis
ca — carrefour	p — pseudobranchia
cm — capsule gland	q — prostate
cr — crop	r — rectum
cu — caecum	rē — retractor of penis
d — efferent duct	rm — retractor of gill
e — penis	ru — "hypobranchial" gland
eo — reno-pericardial duct	s — blood sinus
er — pericardial cavity	sa — salivary gland
f — foot	sc — sensory cells
g — glands of mantle skirt	sm — shell muscle
h — retractor of head	so — hermaphrodite duct
i — intestine	t — tentacle
ic — mandibular lamellae	u — flagellum

uc — buccal bulb	w — ventricle
ui — mandibular plate	wo — osphradial glands
un — junction of flagellum and efferent duct	x — supra-nuchal cavity
v — female aperture	xa — trabeculae of gill
va — valve closing capsule gland	y — eye
vs — seminal vesicle (ampulla)	z — excretory part of kidney
	zi — ciliated cells of epithelium

PLATES

15. PLATES

PLATE 1

- Fig. 1 — Broad shell, 6 x 4,5 mm.
- Fig. 2 — Narrow shell, 4,2 x 2,8 mm.
- Fig. 3 — Young shell, 0,85 x 0,55 mm.
- Fig. 4 — Profile of 6,5 mm long shell.
- Fig. 5 — Same of 5,0 mm long shell.
- Fig. 6 — Same of 4,5 mm long shell.
- Fig. 7 — Left side of living snail showing entrance (c-c) of pallial cavity.
- Fig. 8 — Part of transverse section of pseudobranchia.
- Fig. 9 — Section of osphradium.

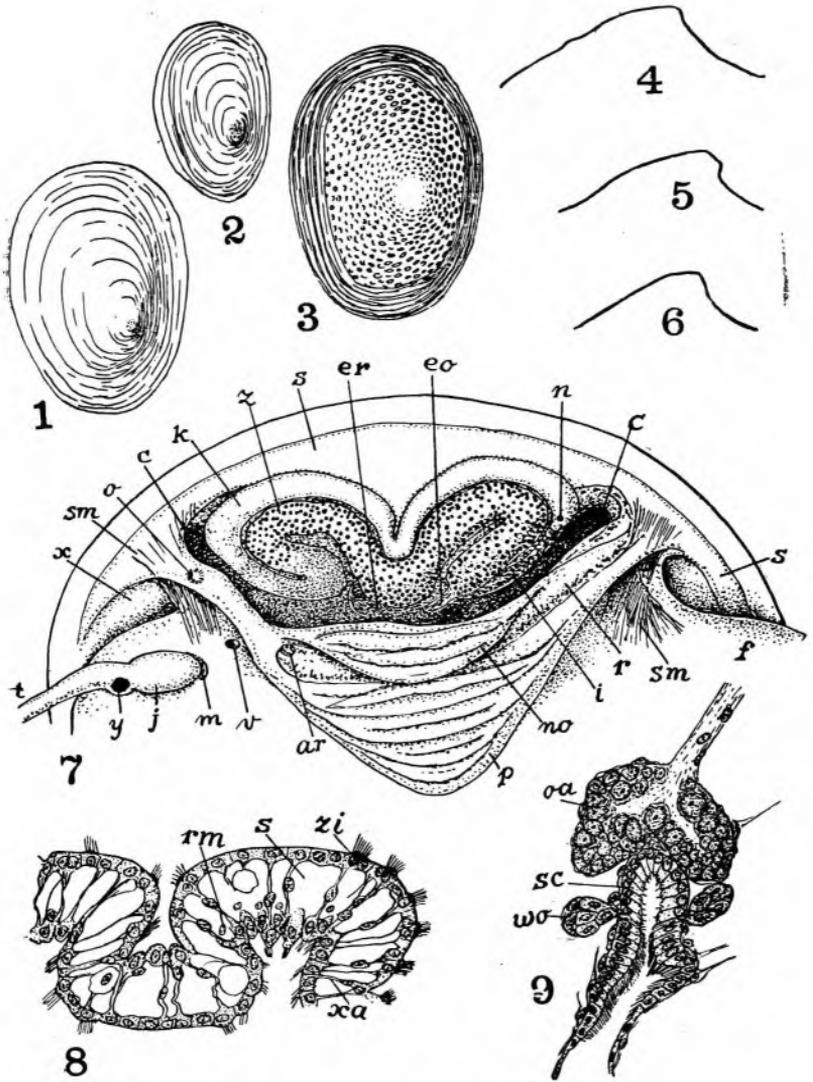


PLATE 2

- Fig. 10 — Combined transverse section of snail on level of pseudo-branchia and pallial cavity.
- Fig. 11 — Diagram of central nervous system.
- Fig. 12 — Mouth.
- Fig. 13 — Radular teeth of adult snail. R — rhachidian tooth.

PLATE 3

- Fig. 14 — Alimentary canal.
- Fig. 15 — Diagram of reproductive organs in ventral view.
- Fig. 16 — Recently laid egg capsule.
- Fig. 17 — Mating snails.
- Fig. 18 — Details of same.

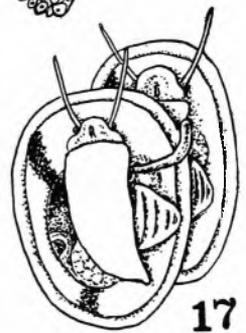
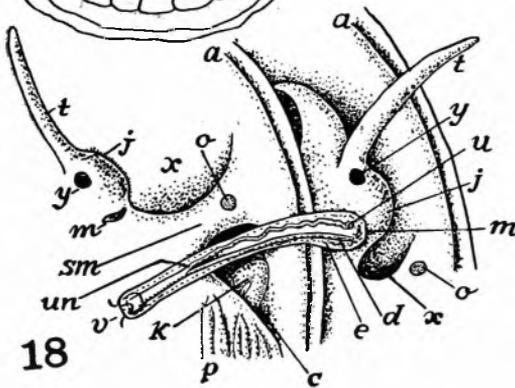
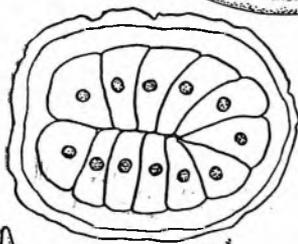
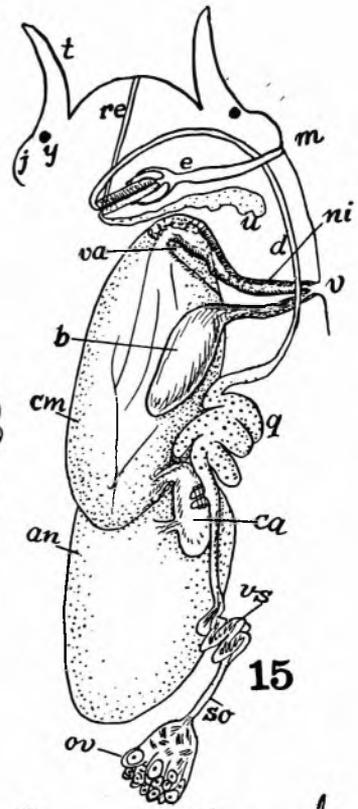
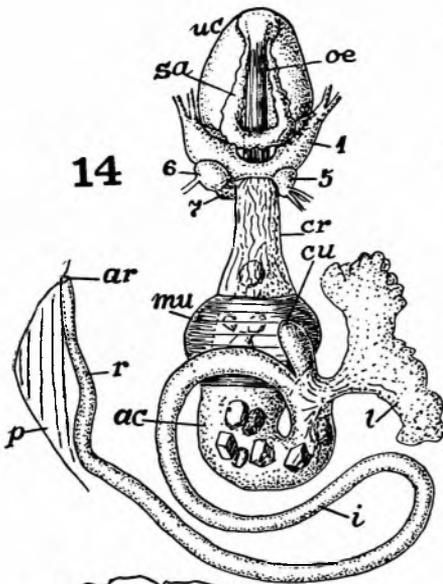


PLATE 4

Fig. 19 — Snail fallen upside-down recovering normal position; successive phases.

