ANATOMY OF *MYSORELLA COSTIGERA* KUSTER.

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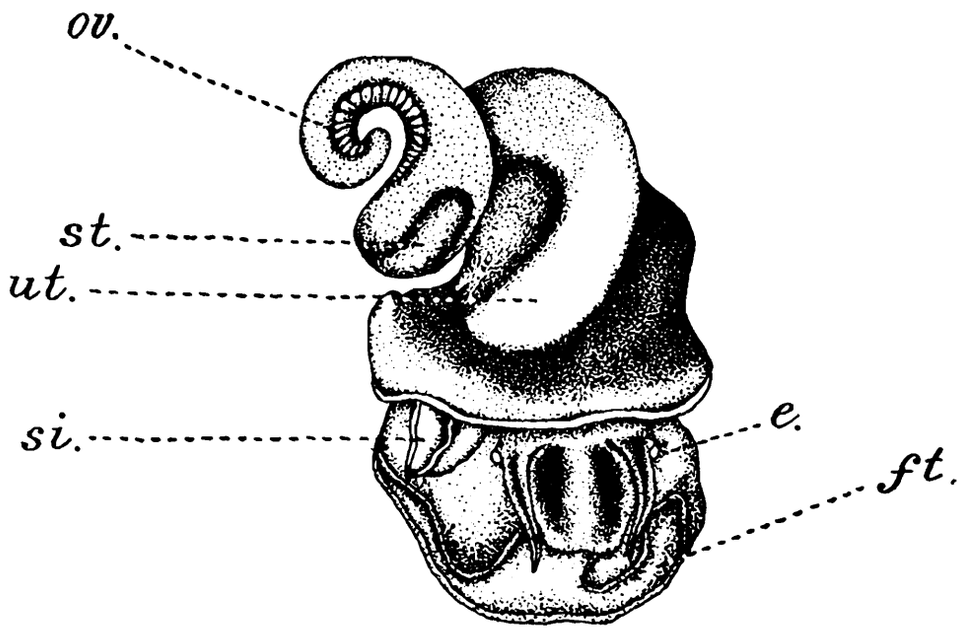
This paper is an elaboration of a note which I read before the annual session of the Indian Science Congress at Madras in January, 1929. My best thanks are due to Dr. Baini Prashad for guidance and encouragement, and for helping me with a translation of portions of Bregenzer's paper on *Bythinella* (3). I am also greatly indebted to the Syndicate of the Madras University for the award of a research grant to meet the expenses of my investigations.

Mysorella costigera is a small Hydrobiid mollusc, easily recognised by the spiral ridges on its shell. It inhabits shallow pools and tanks in which clay predominates in the soil at the bottom. The animal spends its time crawling on the bottom and does not float at the surface of the water, as is the case with *Amnicola* (*Alocinma*) or *Bithynia*. A fair number of specimens of *M. costigera* can be found in pools in which it lives by searching in the clayey silt at the bottom at about 3 or 4 ft. from the margin of the pool. They are often seen near the margin of the pool and as a rule crowd towards the side of the tank which is exposed to sunshine. Evidently warmth makes the animals active, for I have often observed that inactive specimens contained in a basin of water can be rendered active by exposing the basin to moderate sunshine. The food of the animal seems to consist almost entirely of diatoms along with minute clay particles. Specimens were kept alive for about six months in my laboratory, and they were fed on clayey silt from tanks. When the tanks and pools dry up, the species retreats deeper into the mud or into the moist situations underneath stones. Specimens taken from such situations can be revived within ten to fifteen minutes by placing them in water. A single shower of rain results in small collections of water in the pools and is quite enough to bring the animals out from their retreats and render them active. The breeding season lasts from September to December and is dependent on the water-supply in the pools. The eggs are laid in a single row, in tough gelatinous capsules, on hard substrata like stones or shells of other molluscs. The number of eggs in a capsule may vary from two to fourteen or more. The egg-capsules resemble in all respects the capsules of *Amnicola* (*Alocinma*).

The Animal.

The body of the animal after removal from the shell (fig. 1) is seen to be spirally twisted and consists of three to three and a half whorls. It is roughly divisible into the head, foot and visceral mass. In the living condition the head and foot alone can be extended out of the shell. Near the free edge of the mantle the colour is yellow; the head and foot are light grey in colour with yellow coloured spots interspersed here and there. In the female, on the right side of the body whorl, except

for a short distance near the free edge of the mantle, the thick uterus is seen bulging through it. The ctenidium cannot be distinguished



TEXT-FIG. 1.—*Mysorella costigera*. The animal removed from the shell; the foot is seen in the contracted condition. *e*. eye; *ft*. foot; *ov*. ovary; *si*. pseudo-epipodium; *st*. stomach; *ut*. uterus.

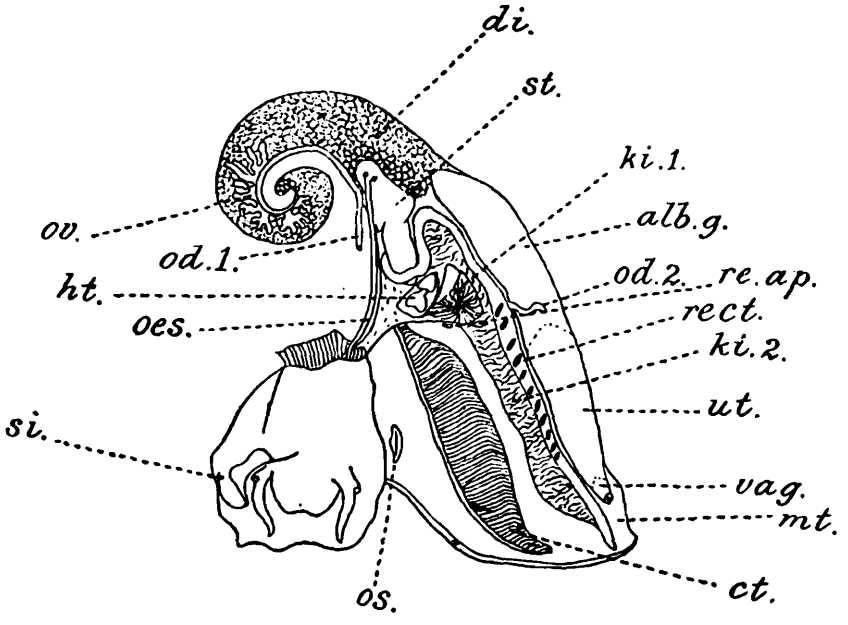
through the thickness of the mantle, but if the animal has been actively feeding, the rectum, owing to its being packed with cigar-shaped faecal pellets, is visible on the right side of the animal, to the left of the uterus in the female and in a corresponding position in the male. The region of the digestive gland is greenish-brown in colour and the genital gland at the apex of the visceral mass is yellow in the adult female, and orange in the adult male. In the male the apical whorls often show a black pigmentation to a varying extent.

The head projects forwards as the partly contractile snout and bears at its anterior end the vertical slit-like mouth. Starting from the base of the head and slightly dorsally placed are the two tentacles, one on either side. The tentacles are of the same colour as the snout, but show a central core of a blackish-brown colour. In the contracted condition, they extend but little beyond the snout, but when extended they are much longer than the snout. On the outer side of each tentacle, near its base, is the sessile eye.

Projecting over the foot immediately from behind the right tentacle is the pseudo-epipodial flap which, as in *Vivipara* (10), forms a spout-like siphon into the mantle cavity. Starting from behind the right tentacle it passes forwards and downwards, and projects over the foot on the right side. It then runs backwards and upwards and terminates near the right ventral attachment of the mantle with the foot. In the living animal, by the approximation of the anterior descending and posterior ascending margins, this siphonal opening regulates the flow of water into the mantle cavity, and can be observed to vary in size from time to time. The flap is covered by rather elongate ciliated cells and the main thickness of the flap is composed of connective tissue, blood spaces and longitudinal and transverse muscles.

The foot of the animal is roughly triangular in outline with rounded angles. It is extensile and its shape varies with the movements of the

animal. Near its anterior margin it shows a small transverse groove (fig. 4*a*, *gr.*). As the animal creeps a trail of mucus, the secretion of the well-developed pedal gland in the foot, is left behind. The operculum is attached to the foot postero-dorsally and the shell, when the animal crawls, rests on the operculum. There is nothing special in the general arrangement of the muscles of the foot. The lower part of the foot is composed of a close network of muscles. The upper portion consists posteriorly of the muscle-fibres of the columellar muscle and in the anterior part of the upper portion the network of muscles, which is less dense than in the ventral portion, contains the pedal ganglia and statocysts. The ventral surface or sole is covered by a ciliated epithelium consisting of columnar cells with oval nuclei.



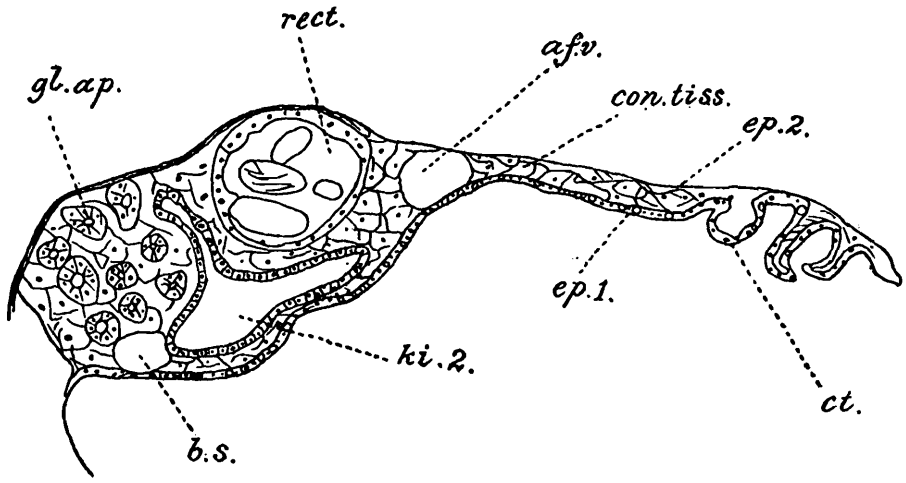
TEXT-FIG. 2.—Diagram of a partial dissection of a female animal; the anterior extension of the kidney is cut open. *alb. g.* albumen gland; *ct.* ctenidum; *di.* digestive gland; *ht.* heart; *ki. 1.* kidney; *ki.* 2. anterior extension of the renal organ; *mt.* mantle; *od.* 1, *od. 2.* cut ends of the oviduct; *oes.* oesophagus; *os.* osphradium; *ov.* ovary; *re. ap.* opening of the kidney into the mantle cavity; *rect.* rectum; *si.* pseudo-epipodium; *st.* stomach; *ut.* uterus; *vag.* vagina.

As stated above, the foot possesses a well-developed pedal gland. This is best developed in the region of the transverse groove and lies slightly anterior to it. In this region it appears as a deeply staining mass. It lies immediately below the ventral epithelium, and consists of several gland masses arranged irregularly. The cells of the pedal gland, when filled with their thick granular secretion, stain deeply and it is not possible to distinguish the structures in this condition. In the resting condition, however, the cells appear as irregularly rounded structures with a clear round nucleus and a homogeneously staining granular cytoplasm.

The columellar muscle is of the usual type. It consists of whitish muscles, most of which are attached to the columella, but some are also attached to the inside of the penultimate whorls of the shell. The fibres of the columellar muscle run down to become continuous with the hinder portion of the foot, and are finally attached to the boss of the operculum.

The Mantle and Mantle cavity.

The colour of the mantle has been described already. Its attachment and general disposition are similar to what is the case in other Prosobranchs. Ventrally it is attached to the foot, leaving a narrow free fringe in front of the attachment. The mantle edge is somewhat thickened, the thickened area consisting of connective tissue, blood spaces, glands and muscles.



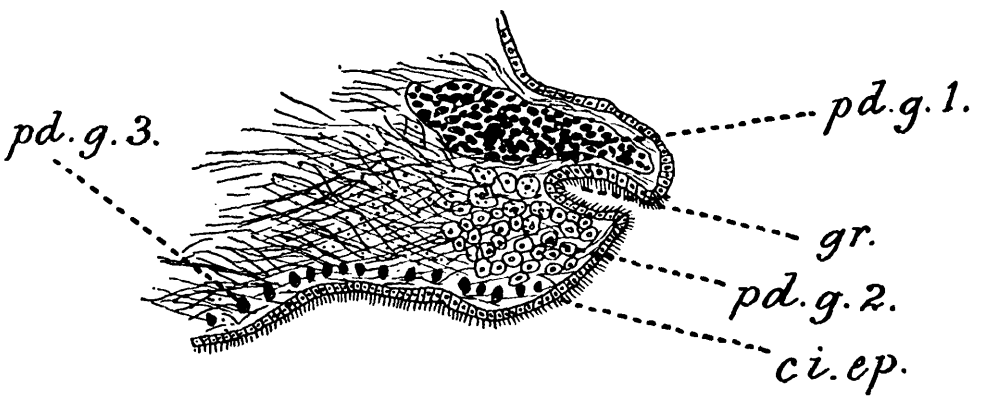
TEXT-FIG. 3.—Section through the roof of the mantle cavity of a male animal. *af. v.* afferent ctenidial vien ; *b.s.* blood sinus returning blood from the right side of the mantle ; *con.tiss.* connective tissue in the thickness of the mantle ; *ct.* ctenidium ; *ep.* 1 *ep.* 2. inner and outer epithelia of the mantle ; *gl. ap*, glandular attachment of the vas deferens ; *ki.* 2. anterior extension of the kidney lying in the roof of the mantle cavity ; *rect.* rectum.

The mantle cavity encloses the osphradium, the ctenidium, the rectum, the anterior extension of the renal organ, the uterus in the female, and the lower part of the glandular attachment of the vas deferens and the penis in the male. The rectum, the anterior prolongation of the renal organ and the lower part of the uterus in the female, and the glandular attachment of the vas deferens in the male lie along the roof of the mantle cavity and are not free in the mantle cavity. The organs are embedded in a connective tissue mass which forms the thickness of the mantle (fig. 3). The mantle is bounded dorsally by an outer layer of epithelium and ventrally by an inner layer. The cells of the epithelium separating the above mentioned organs from the mantle cavity, as also those to the right of the ctenidium, are slightly elongate. Large numbers of gland-cells are also found in between the epithelial cells, but it may be noted that no definite hypobranchial gland can be distinguished. The gland-cells in this region are not appreciably different from similar cells on the left side of the mantle.

The osphradium is situated on the left side of the mantle cavity close to the junction of the mantle with the body. The efferent ctenidial vessel and the ctenidium lie to the right of the osphradium. The osphradium is a simple ridge-like structure, somewhat lanceolate in shape. It is about 1 mm. long and 0·33 mm. wide. A shallow groove is usually visible in the middle of its upper surface, but this is probably due to shrinkage during preservation.

The anal opening, which lies in the mantle cavity, is situated at a little distance posterior to the free edge of the mantle. The female

genital opening lies close to but somewhat posterior to the anus. The renal opening is placed at the apex of the mantle cavity (fig. 2, *re. ap.*).

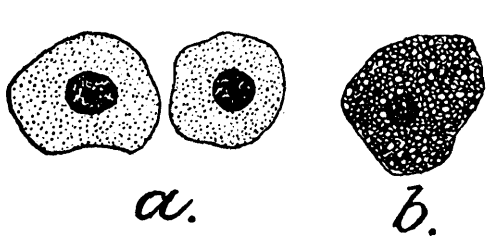


TEXT-FIG. 4*a*.—Vertical section of the anterior part of the foot. *ci. ep.* cillated epthelium of the sole of the foot; *gr.* groove near the anterior margin; *pd. g*.1. dark staining glandular mass; *pd. g*.2. empty gland-cells (without secretion); *pd. g*.3. scattered gland-cells.

The ctenidium lies to the right of the osphradium and extends from the mantle edge to near the pericardium. It is monopectinate and consists of about 90 lamellae. The lamellae in the middle region of the ctenidium are of the greatest width, those near the ends being very short and narrow. Each lamella is roughly triangular in shape (fig. 5), and is attached to the mantle by its base. The straight afferent side of the ctenidial leaflets is short, while the efferent side is very long and slightly curved. The histology of the lamellae resembles, in general features, that of other Prosobranchs. The epithelium of each lamella consists of (1) ciliated and (2) non-ciliated cells with gland-cells scattered in between them. The ciliated cells are confined to the upper portion of the lamella in a line parallel to the efferent side. The ciliated cells, like those of *Pila*, are columnar, but are shorter and have more prominent oval nuclei; the cilia on the other hand are longer than those in *Pila*. The space between the lamellae is occupied by connective tissue and a few muscle-fibres as in *Bythinella*. At the base of each lamella there is a definite lacunar space which receives its blood from the afferent ctenidial vein and the blood-space at the apex is connected with the efferent ctenidial vein.

The Alimentary Canal.

The mouth is a vertical slit placed at the anterior end of the snout; it is not provided with definite lips and the area around it is smooth. The mouth leads into the short oral cavity. The oral cavity is lined by cylindrical epithelium of the general surface of the snout. The cells of the oral epithelium have elongate nuclei and are lined on their free edges by a thin cuticle. Posteriorly, the cuticle becomes thick in the dorsal area and the oral cavity shows a ventro-lateral diverticulum on either side (fig. 7).



TEXT-FIG. 4*b*.—Cells of the pedal gland. In *b* the cell is filled with secretion. In *a* the cells are empty.

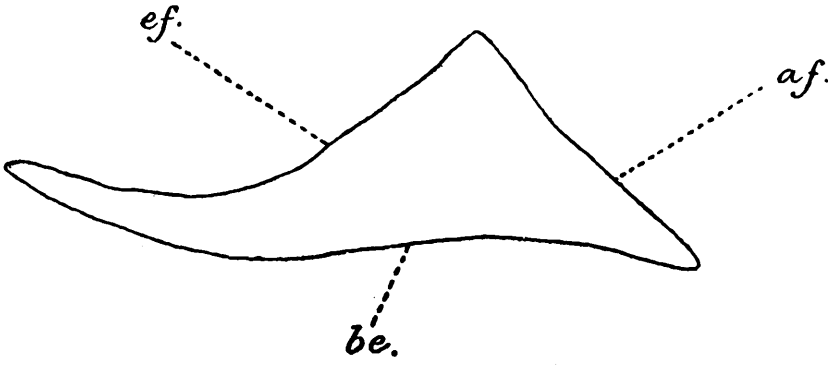
At a distance of about 1 mm. from the mouth the jaws are situated, one on either side. When viewed in section, each jaw appears to consist of a number of columnar chitinous pieces, each piece being the secretion of an underlying cell. The cuticular pieces are longer than the corresponding underlying cells. The jaws stain deep red with eosin.

Surrounding the epithelium of the mouth and the jaws is a connective tissue consisting of polygonal cells with rounded nuclei and containing some brown pigment. These cells constitute what Bregenzer (3) termed labial cartilages in *Bythinella*. The greater part of this connective tissue lies on either side of the oral region.

The oral region is provided with a thick layer of circular muscles and some of the connective tissue cells lie between these muscle fibres. The contraction of these muscles brings about the approximation of the jaws. The separation of the jaws and the retraction of the oral tube is effected by a number of very slender muscles, running from the sides of the oral tube to the roof of the buccal region of the head.

The buccal bulb is very muscular and is pyriform in shape. The dorso-median and the dorso-lateral muscles are very slender threads arising from the anterior parts of the buccal mass. On the ventral surface a transverse band of superficial muscles and some longitudinal muscles can also be made out. The sphincter muscle running round the anterior part of the buccal bulb is more conspicuous dorsally.

The retractor muscles of the buccal mass are stout and club-shaped ; muscles of a slightly red colour, which arise from the buccal mass near the posterior edge of the buccal cartilage of each side and pass between the cerebropedal and cerebropleural commissures, become attached ventrally to the body-wall. A pair of anterior retractors are also present; they are similar in position to those of *Vivipara* (10) and arise from the ventral surface of the buccal mass and run backwards dorsally to the pedal commissure.

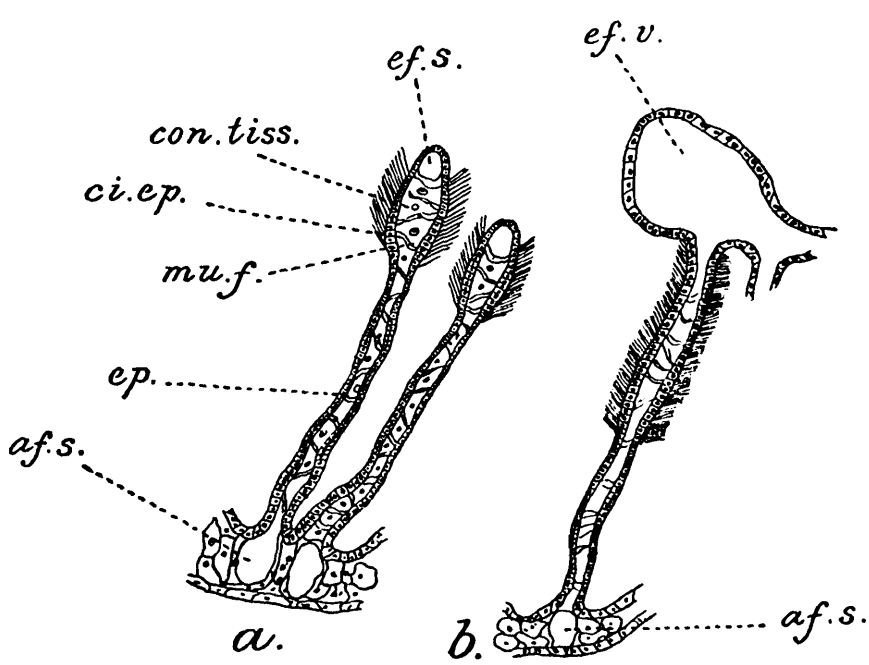


TEXT-FIG. 5.—A single lamella of the ctenidium.
af. afferent side ; *be.* base ; *ef.* efferent side.

The oral cavity leads into the pharyngeal cavity, which resembles, in general, that of *Bythinella* and *Paludestrina*. In a transverse section, it is seen to consist of three parts, (1) a median unpaired dorsally directed cavity, (2) the dorso-lateral expansions, and (3) the ventro-lateral expansions. The median cavity to some extent resembles that of *Bythinella* in shape and is more elongated than in *Paludestrina*. Its lateral walls are ciliated, but no cilia were found on the roof. In the

region of the openings of the salivary glands there is a short dorso-lateral diverticulum on either side of the median cavity into which the salivary glands open. These diverticula also are ciliated but in between the ciliated cells there are a few flask-shaped gland-cells of the same type as are found in other parts of the alimentary canal. The cells of the ventral epithelium of the buccal cavity are shorter than those of the dorsal epithelium, and have a well-developed cuticle. In the middle line the ventral epithelium of the pharyngeal cavity passes into that of the radular sac.

The buccal cavity contains a single pair of buccal cartilages, which, when viewed from above, appear as obliquely placed and rather L-shaped structures. The buccal cartilages almost meet in front but diverge posteriorly. The anterior portions are narrower and are situated at a higher level than the posterior portions. Ventrally they are connected by a pair of broad muscles, one of which is more anterior and dorsal than the other. The other important muscles of the cartilages are (1) the dorso-lateral muscles, which connect the cartilages and the elastic membrane, (2) the circular, and (3) the longitudinal muscles. The longitudinal muscles arise posteriorly and ventrally and pass forwards partly on the inner side of each cartilage. External to these longitudinal muscles are what Bregenzer (3) and Robson (6) termed the circular muscles in *Bythinella* and *Paludestrina*. The circular muscles arise ventrally and run up on the inside of each cartilage to the elastic membrane.



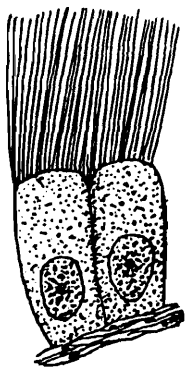
TEXT-FIG. 6*a*.—A section through two gill lamellae. *af. s.* afferent vessel at the base of the lamella; *ci. ep.* ciliated epithelium; *con. tiss.* connective tissue; *ef. s.* efferent vessel of the lamella; *ep.* non-ciliated epithelium; *mu. f.* muscle fibres.

6*b*.—Section to show the course of blood through the gill lamella. *af. s.* afferent vessel; *ef. v.* efferent vein taking away blood from the ctenidium.

The minute structure of the buccal cartilages agrees with that of other forms in which they have been described. Each buccal cartilage consists of polygonal cells with slightly oval nuclei. The cytoplasm surrounding the nuclei is sparse and fibrillar and extends from the centre

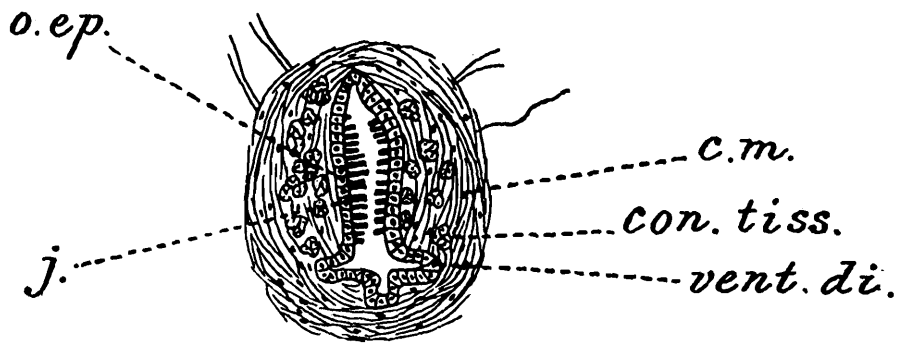
as very thin strands towards the cell wall; it is feebly stained by cytoplasmic stains but the rest of the cell substance remains colourless.

The radula has the typical taenioglossid formula 2, 1, 1, 1, 2. There are about fifty transverse rows of teeth in the radula. The central tooth is prominent. It is roughly trapezoidal in outline. The base or the posterior edge is broader, while the anterior edge is slightly reflexed and bears a central triangular denticle with three smaller denticles on either side. Often a fourth denticle is also to be distinguished on either side. The central tooth bears in addition a downwardly directed lateral process on either side. In many cases I also noticed an additional process behind each lateral process and in some specimens two additional lateral porcesses were present. This is of interest, as considerable taxonomic importance was attached by Annandale (1) to the presence of a single downwardly directed process on the central tooth of the radula in the genus *Mysorella*. The lateral tooth is larger than the central. It is roughly triangular in shape and its base is prolonged on one side, but not to the same extent as in *Bythinella*. The cutting edge has four denticles on either side of a central denticle. The denticles can only be seen when the tooth is viewed from the ventral or the cutting surface. The outer marginal is narrow and roughly sickle-shaped in side-view. Its base is broad, while the upper portion is narrow and has six to eight triangular denticles. The inner marginal is broader than the outer. Its base is narrower than the upper cutting edge, which is broad and has 15-20 very minute teeth.



TEXT-FIG. 6c.—Ciliated cells of the ctenidium.

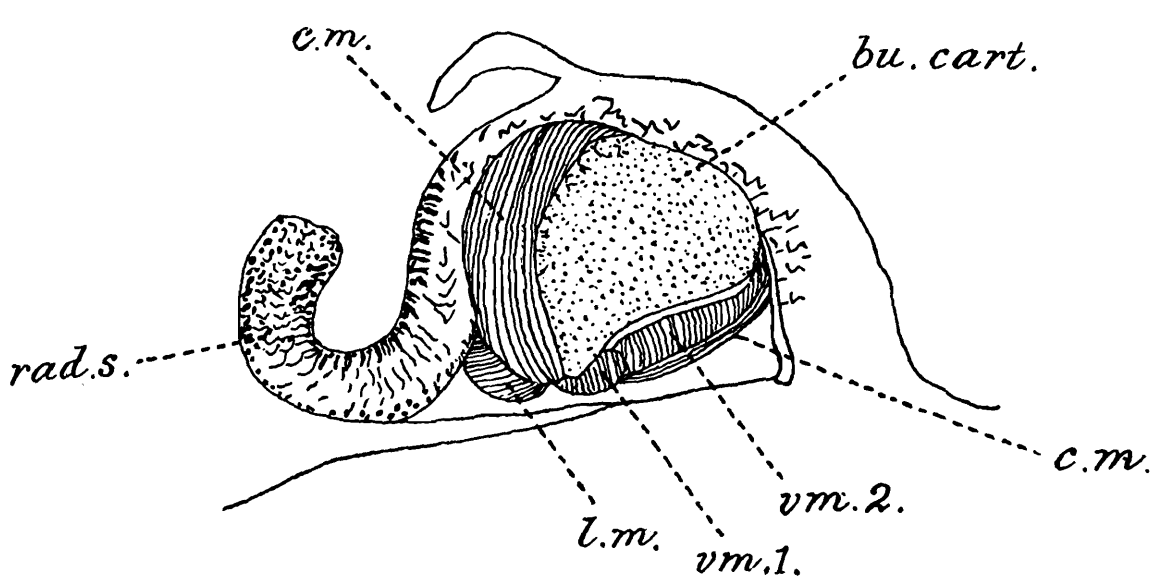
The salivary glands are simple tubular structures. Their posterior portions are a little flattened and wider than the anterior portions and lie over the cerebral ganglia and extend a little beyond them. The narrow anterior part of each gland constitutes the duct, while the posterior part is the gland proper. There is, however, no difference in the histological structure of the anterior and posterior parts. They consist of glandular non-ciliated epithelium, comprised of cylindrical gland-cells with large oval nuclei placed basally in the cells and of narrow supporting cells lying between them. The supporting cells stain red with eosin. The gland-cells consist of a homogeneously staining granular cytoplasm.



TEXT-FIG. 7.—Transverse section through the oral region. *c.m.* circular muscles; *con. tiss.* connective tissue; *j.* jaw; *o. ep.* oral epithelium; *vent. di.* ventro-lateral diverticula.

The oesophagus starts from the dorsal surface of the posterior part of the buccal mass and descends to pass under the cerebral commissure. It then runs somewhat obliquely and opens on the ventral surface of the stomach, close to its left posterior margin. The part of the oesophagus lying alongside the stomach runs almost parallel to it. It has a thick investment of circular and longitudinal muscles, but the muscular coats are thinner in the posterior than in the anterior part of the oesophagus. The epithelial wall of the oesophagus consists of ciliated cells with a few gland-cells interposed between them.

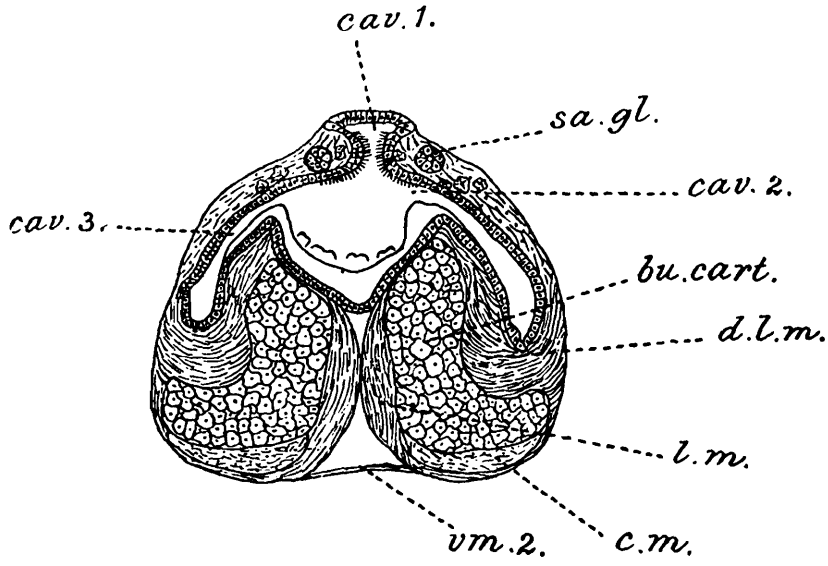
The posterior or gastric portion of the stomach is rather irregularly shaped. The posterior end is rounded and the right corner of the anterior side (fig. 11) is protruding. The openings of the digestive gland are two in number and lie close to the oesophageal opening. On opening the posterior chamber, the ventral wall shows some elevations or thickenings (fig. 12) which are really folds of the wall. Near the posterior end of the stomach and close to the openings of the oesophagus and the digestive gland is a small roughly pyriform fold with a central groove, dividing its surface into two portions. Near the left margin of the ventral wall there is a fold similar in shape and disposition to the one designated by me as the marginal fold in *Paludomus* (8). The anterior end of this fold, as in *Paludomus*, is V-shaped. The V-shaped bend abuts on the oesophageal opening. The function of this fold seems to be to prevent the contents of the oesophagus from passing directly into the pylorus and to direct these to be subjected to the action of the free end of the style, which lies on the right side of the pyriform fold.



TEXT-FIG. 8.—Longitudinal section through the buccal bulb. *bu. cart.* buccal cartilage; *c. m.* circular muscles; *l. m.* longitudinal muscles; *rad. s.* radular sac; *vm.*1, *vm.*2. muscles connecting the cartilages ventrally.

The ciliation and development of the cuticle on the stomach wall are worth mentioning. The epithelium of the posteriormost portion of the gastric chamber is ciliated all over. In the region of the pyriform fold the right side has a strongly developed cuticle and this extends along the right side of the ventral wall. Anterior to this fold also, the stomach epithelium dorsally and ventrally is covered with a cuticular covering, while the dorsal epithelium is somewhat folded. The cuticular

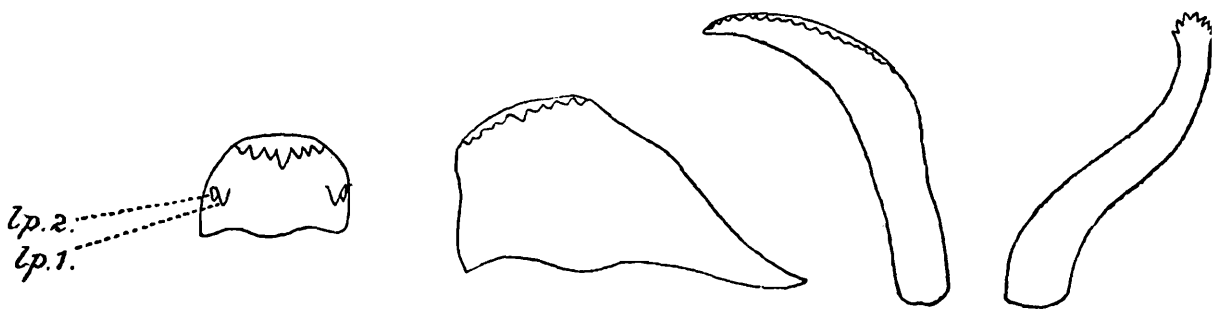
investment of part of the pyriform fold and the epithelium to the right of it appears as a tooth-like investment and constitutes the gastric shield. Robson (6) and Bregenzer (3) do not refer to the details of these folds but so far as can be judged from the figures of the latter author and the description by the former, the stomach of *Mysorella* resembles that of *Bythinella* and *Paludestrina*. The ciliated cells of the stomach are cylindrical and glands of the usual type are found between them. In the cells underlying the cuticle a brownish pigment is present as in the case of *Paludomus* and *Melanoides*. The stomach has a thin investment of muscles surrounded by a connective tissue layer.



TEXT-FIG. 9.—Transverse section through the buccal bulb. *bu. cart.* buccal cartilage ; *cav.*1. dorso-median cavity ; *cav.*2. dorso-lateral expansion of the pharyngeal cavity; *cav.*3. ventro-lateral expansion of the pharyngeal cavity ; *c. m.* circular muscles ; *d. l. m.* dorso-lateral muscles ; *l. m.* longitudinal muscles ; *sa. gl.* salivary gland ; *vm.*2. posterior ventral muscle connecting the two cartilages.

The intestine on leaving the pylorus takes a loop over the ventral aspect of the style-sac, and after running up towards the posterior chamber, turns round and passes to the roof of the mantle cavity as the rectum. The portion over the style-sac is stouter than the remaining portion of the intestine. The posterior part of the ascending portion of the intestinal loop is situated slightly dorsal to the style-sac. A well marked typhlosole is developed in the dorsal wall of the intestine, both in the transverse and the ascending portions ; it appears crescentic in transverse sections. In transverse sections the rectum shows a number of villi-like elevations of its epithelial wall, projecting into the rectal cavity. As a result of these projections, the distal part of the intestine, like the oesophagus, has a number of longitudinal grooves. These projections are more numerous and thinner than similar folds in the oesophagus. In places where the rectum is distended with faecal matter, these folds are obliterated. The transition from the proximal part of the intestine to the rectum is gradual. In the beginning of the descending part of the intestinal loop, only two longitudinal grooves and projections are seen and their number increases gradually in the lower or anterior part. The intestine also has a thin muscular coat and its epithelium consists

of cylindrical ciliated cells with interposed gland-cells; these gland-cells are more numerous in the distal part of the intestine.

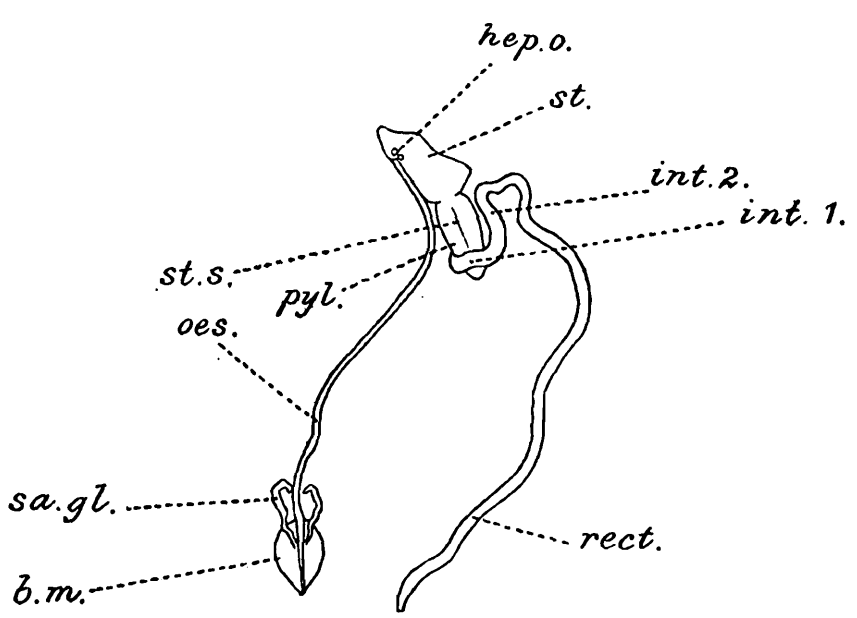


TEXT-FIG. 10.—The teeth of the radula.
lp.1. lateral process ; *lp*.2 accessory lateral process.

The faecal pellets in the rectum, as noted already, are cigar-shaped. They usually consist of minute clayey particles, and are a source of trouble in sectioning the intestine of animals that have been actively feeding.

The Digestive Gland.

The digestive gland is similar to that of other Prosobranchs. It is situated in the apical whorls of the visceral mass and is spirally coiled. The anterior part of the digestive gland lies on the ventral surface of the stomach and extends as far as the origin of the intestine from the pylorus, while its posterior portion embraces the posterior end of the stomach. The gland is of a greenish-brown colour, and consists of a large number of tubules bound together by connective tissue. There are two main ducts of the digestive gland, which open into the stomach. The posterior duct runs on the columellar side of the gland, and is a some-



TEXT-FIG. 11.—Outline diagram of the alimentary canal.
b. m. buccal mass ; *hep. o.* openings of the digestive gland ; *int.*1, *int.* 2, *rect.* intestine ; *oes.* oesophagus ; *pyl.* pylorus ; *sa. gl.* salivary gland ; *st.* posterior or gastric part of the stomach ; *st. s.* style sac.

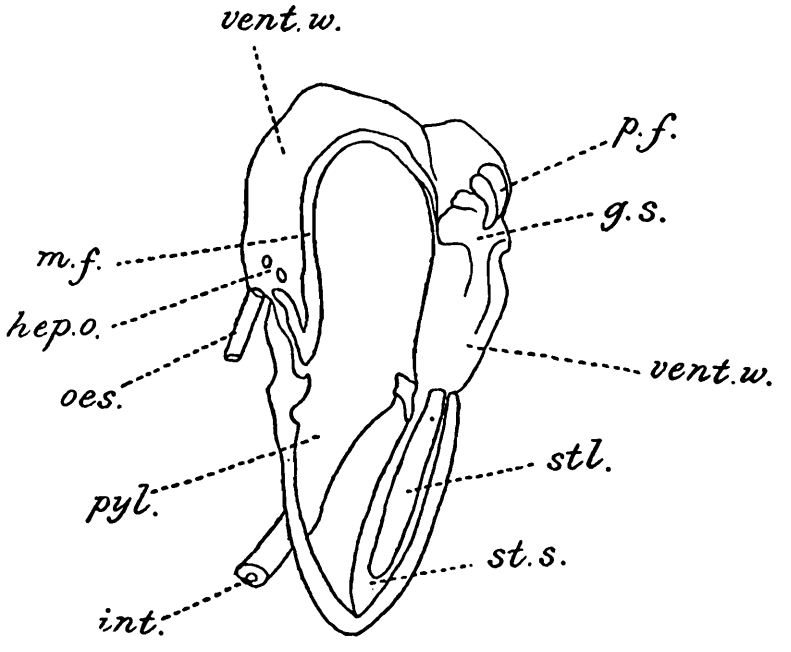
what stout duct. It opens on the ventral surface of the stomach immediately posterior to and in apposition with the oesophageal opening.

The anterior duct runs on the ventral side of the stomach and opens into it anteriorly and to the left of the oesophageal opening. Both the openings of the digestive gland are circular.

The tubules of the digestive gland are roughly circular in transverse sections and are lined by two kinds of cells, the gland-cells and the ferment-cells. The gland-cells are cylindrical, and have slightly oval nuclei placed in the lower part of the cells. There is a distinct nucleolus and the cytoplasm is granular. The ferment-cells are large and conspicuous. They are ovoid in section and possess a large nucleus with a distinct nucleolus. Their protoplasm is granular, the granules being large and staining deeply. A big vacuole is often present in the ferment-cells and it contains usually one but sometimes more than one (I have seen four) secretory bodies. These bodies are of a solid nature, round to ovoid in shape, and chocolate brown in colour. In the ferment-cells containing these secretions, the lower parts of the cells stain feebly. The connective tissue between the tubules contains a fair number of blood vessels. The blood supply of the digestive gland, as is discussed further, is from a distinct branch of the posterior aorta.

The Excretory System.

A portion of the kidney is visible through the epithelium on the dorsal surface of the animal as a triangular, greenish-yellow organ, situated at the upper extremity of the body whorl. This portion of the kidney, which is bounded by the pericardium, the rectum and the mantle cavity, does not constitute the whole renal organ, for, in sections, it is found that the kidney has an anterior extension lying to the left of and slightly ventral to the rectum, and enclosed together with it and part of the re-

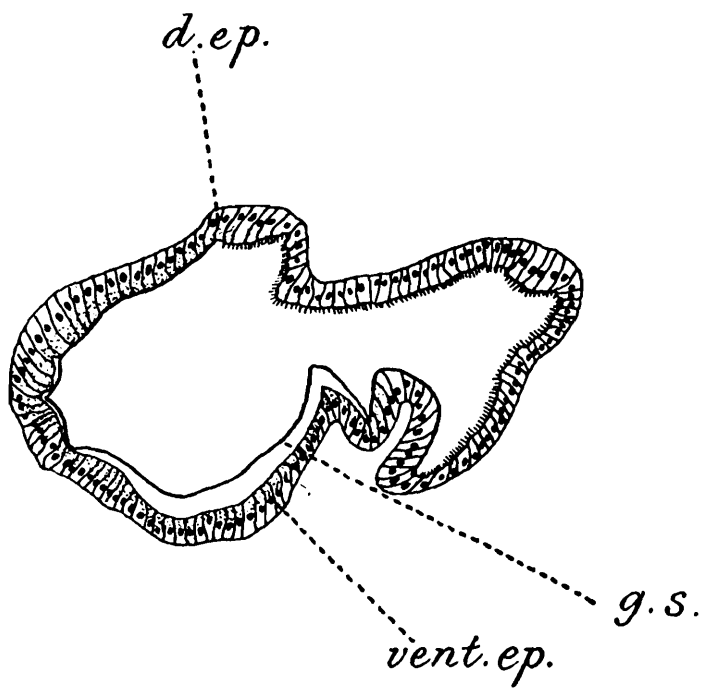


Text-fig. 12.—Diagram of a dissection of the stomach. The ventral wall of the stomach is cut open a little to the right of the oesphageal opening. *g. s.* gastric shield; *hep. o.* openings of the digestive gland; *int.* intestine; *m. f.* marginal fold; *oes.* oesophagus; *pyl.* pylorus; *p. f.* pyriform fold; *stl.* style; *st. s.* style sac.

productive system by the inner surface of the mantle. The posterior extension of the kidney runs for some distance between the ascending

and descending parts of the intestinal loop, and lies posteriorly by the side of the stomach.

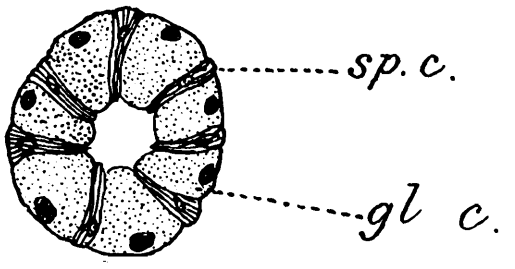
The greater part of the kidney, when seen in a surface view, shows a number of striations corresponding to the lamellae present inside. In the anterior extension of the kidney these lamellae under a low magnification appear as transverse folds. The portion lying in the pericardial region of the animal is much thicker than the other parts, and, viewed from the ventral surface, is seen to have a spongy appearance. It presents on the ventral surface a number of lines or striations radiating from a blood vessel situated in the centre. The spongy appearance is due to this part constituting a " blood gland ". Posterior to this portion and about the level of the anterior termination of the style-sac is a conspicuous triangular lamellar portion which passes forwards obliquely to the pericardium, and opens there at its tip. The posterior extension of the kidney, which can be made out only in sections, has a spacious cavity more or less triangular in outline. Bregenzer does not speak of any such prolongations of the kidney in *Bythinella* (3). In *Paludestrina* (7) the kidney is said to send ramifications among some of the viscera, but its exact relations have not been described.



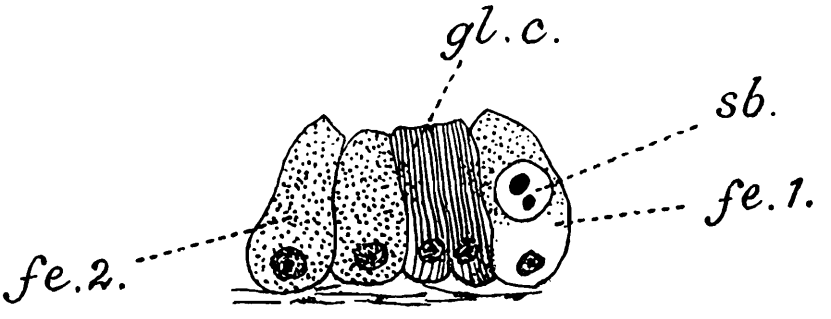
TEXT-FIG. 13.—Transverse section through the stomach.
d. ep. dorsal epithelium ; *g. s.* gastric shield ; *vent. ep.* ventral epithelium.

The kidney opens into the apex of the mantle cavity a little to the right of the root of the ctenidium. The renal aperture is slit-like and is provided with rather thick lips. It is ciliated and is provided, as in *Paludestrina* and *Bythinella*, with dilator and sphincter muscles. The kidney also communicates with the pericardium. Bregenzer (3) does not refer to the existence of a reno-pericardial aperture in *Bythinella* and none could be found by Robson in *Paludestrina* (7). In *Mysorella*, however, a definite aperture is present on the same side of the pericardium as the renal vein but more ventrally to it. The portion of the kidney leading to this aperture is narrow and canal-like.

The portion of the kidney lying in the pericardial region, as stated already, possesses a "blood gland" on its dorsal side. The blood gland consists of branched blood vessels, connective tissue, and blood sinuses. The blood gland is separated from the general renal cavity by an epithelium consisting of somewhat short oval cells from the inner surfaces of which arise stiff and straight protoplasmic threads. A fair number of these threads pass to one or other of the branches of the blood vessels in the blood gland. The nuclei of the epithelial cells of the blood gland are oval and each cell usually has one process. The connective tissue of the blood gland consists mostly of irregular cells surrounded by blood sinuses. A few large cells with round nuclei are also seen. The blood channels in some of the lamellae of the kidney communicate with the blood gland. A blood gland has been mentioned both in *Paludestrina* and *Bythinella.*



TEXT-FIG. 14.—Transverse section of the salivary duct. *gl. c.* gland-cell; *sp. c.* supporting cell.



TEXT-FIG. 15.—Cells of the digestive gland.
*fe.*1. ferment-cell containing solid secretory bodies; *fe.*2. ferment-cell with granular section; *gl. c.* gland-cell; *sb.* secretion bodies lying in a vacuole.

The kidney receives the blood from the general venous system, while the renal vein from the kidney opens directly into the auricle. The lamellae traversing the cavity of the renal organ are folds of renal epithelium with blood channels between them. The renal epithelium consists of cubical cells with round and clear nuclei. Many of the cells show vacuoles of varying size and cell contents in various stages of disintegration. The renal epithelium passes gradually into the ciliated epithelium of the aperture which opens into the mantle cavity. In the transitional portion, the cells are cylindrical and narrower than the cells of the general renal epithelium. Their distal ends are slightly broader than their basal ends, and the nuclei are oval. The ciliated cells are longer than these cells. The reno-pericardial passage is lined by short narrow non-ciliated cells and here also the transition from the renal epithelium is gradual.

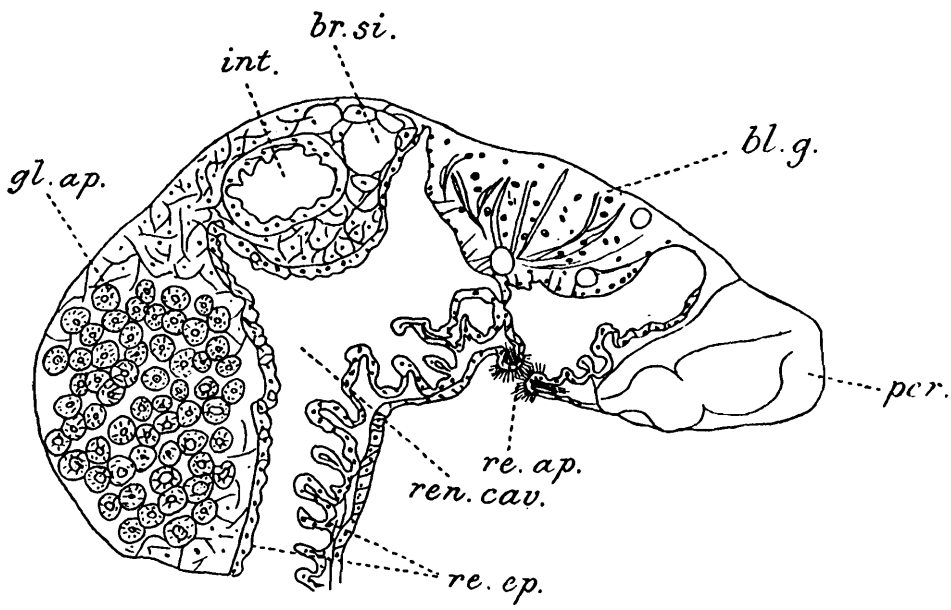
The Circulatory System.

The heart lies in the roughly triangular pericardial cavity and is bounded by the style-sac, the kidney and the mantle cavity. The wall

of the pericardium is composed of a thin epithelium, surrounded by muscle-fibres. The reno-pericardial opening has been described already.

The heart consists of a single auricle and a ventricle. The auricle varies in shape from conical to ovoid-pyramidal, according to the extent of its distension. In the systolic condition, the auricle is seen attached to the ventricle by a slender stalk-like portion, which becomes obliterated in the diastolic condition.

The auricle receives two blood vessels, the efferent renal vein and the efferent ctenidial vein, which open into its base on the right and left sides respectively. The auricle is lined by a thin endothelium and there are a few muscles passing from the base to the apex, but it is not muscular like the ventricle.

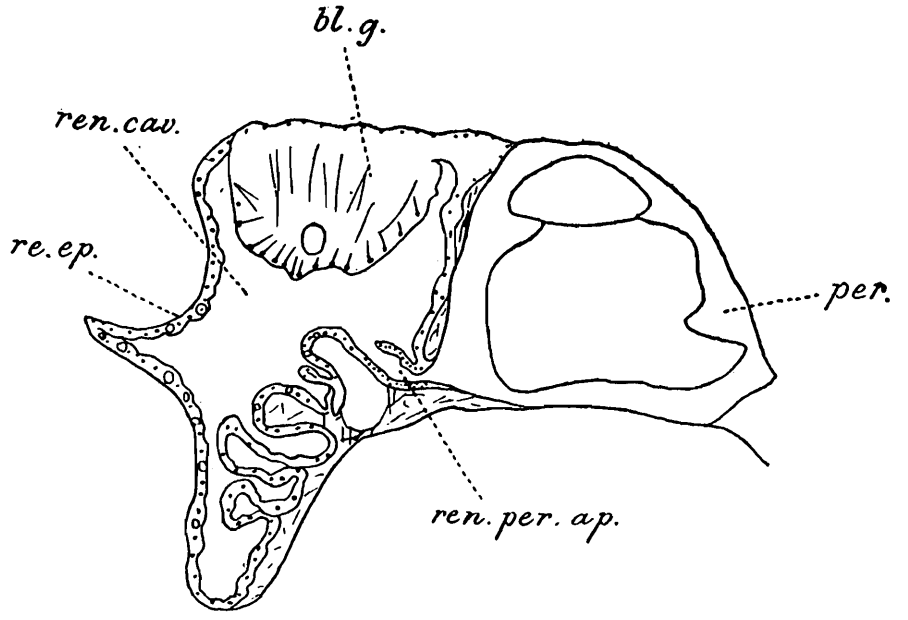


TEXT-FIG. 16.—Section of the animal through the kidney region to show the renal opening into the mantle cavity. *bl. g.* blood gland; *br. si.* branchio-renal sinus; *gl. ap.* glandular attachment of the vas deferens; *int.* intenstine; *per.* pericardium; *re. ap.* renal aperture; *ren. cav.* cavity of the renal organ; *re. ep.* renal epithelium.

The ventricle is pyriform in shape, and the opening of the auricle into the ventricle is guarded by two muscular semi-lunar valves, which arise from the auricle. These allow of the passage of blood from the auricle to the ventricle, but not in the opposite direction. Bregenzer (3) does not make any mention of auriculo-ventricular valves. Robson (7) only found traces of auriculo-ventricular valves in *Paludestrina.* The wall of the ventricle, which is lined by endothelium, is thick and muscular. The muscles of the ventricle are better developed on one side and project into the ventricular cavity forming a sort of incomplete longitudinal partition extending from the base to the apex. Besides these, there are muscles traversing the cavity in different directions.

A short truncus arteriosus arises from the ventricle, and its origin is guarded by two muscular valves. Similar valves have not been noticed either by Bregenzer in *Bythinella* or by Robson (7) in *Paludestrina.* The short truncus arteriosus divides into the posterior or visceral aorta and the anterior or cephalic aorta. The course of the former is better defined and consequently it can be made out with less difficulty.

It passes by the side of the stomach between it and the kidney. It gives off a short branch to the style-sac and, further up, it recedes from the stomach and comes to lie close to the genital duct. It then gives off a branch to the digestive gland, but its further course is not clear.



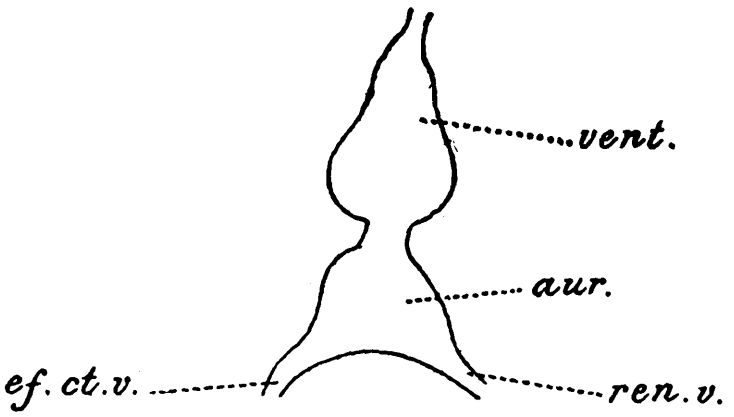
TEXT-FIG. 17.—Section through the kidney and the pericardium to show the reno-pericardial passage. *bl. g.* blood gland; *per.* pericardium; *ren. cav.* cavity of the renal organ; *re. ep.* renal epithelium; *ren. per. ap.* reno-pericardial passage.

The cephalic artery passes by the side of the oesophagus. Further forwards, it becomes dorsal to the oesophagus and gives off a branch to the foot. I have not been able to trace its further distribution.

The arterial blood opens into a system of lacunae in the different parts of the body. The blood from the lacunae passes into sinuses, which return the blood to the heart. The principal sinuses which I have made out in *Mysorella* are (1) an anterior or cephalopedal sinus, (2) a posterior sinus, and (3) a sinus corresponding to the branchio-renal sinus of *Pila*. Besides these, a small definite sinus lies by the side of the lower part of the glandular appendage of the vas deferens in the male and the uterus in the female (fig. 3). It joins the anterior cephalic sinus posteriorly.

The cephalic sinus collects the venous blood from the anterior parts of the body in the head and the anterior part of the alimentary canal, etc. A small sinus is also found in the penis near the penial nerve. The tentacles also possess sinuses, which open into the cephalic sinus. The coils of the penial gland and the cephalic portion of the vas deferens lie in a well-developed sinus beneath the floor of the mantle cavity. This sinus communicates posteriorly with the cephalic sinus, but anteriorly the two are separated by connective tissue. A pedal sinus collects the blood from the foot and is separated from the cephalic sinus anteriorly, but posteriorly the two communicate and form the cephalo-pedal sinus. The small sinus lying by the side of the glandular appendage of the vas deferens in the male, and the uterus in the females joins the anterior sinus posteriorly. It collects blood from the right side of the mantle.

The venous blood from the visceral mass is collected in a posterior sinus. The genital gland also lies in a sinus. The sinuses from the liver, stomach, etc., all unite to form the posterior sinus. The anterior and posterior sinuses unite to form the abdominal sinus in the region of the pericardium.



TEXT-FIG. 18*a*.—The heart.
aur. auricle ; *ef. ct. v.* efferent ctenidial vein ; *ren. v.* efferent renal vein ; *vent.* ventricle.

The kidney receives the blood from the abdominal sinus, and from the kidney the blood, after the removal of the excretory products, passes to the auricle by the efferent renal vein opening into the base of the auricle on the right side. The renal vein passes between the kidney and the apex of the mantle.

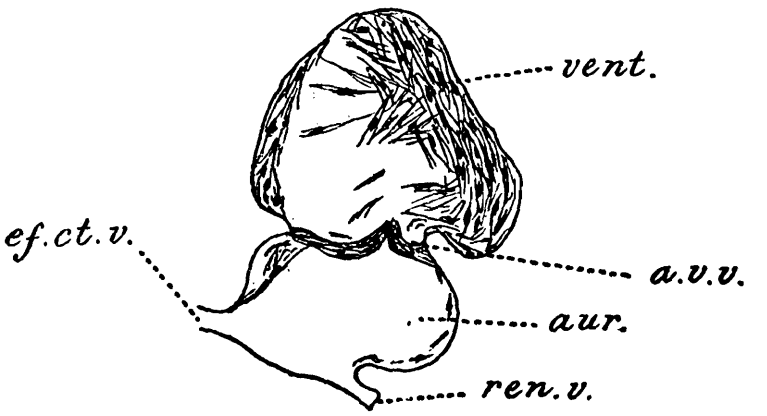
The branchio-renal sinus begins dorsal to the intestine in the region of the blood gland (fig. 16) and it receives in its course blood from a part of the kidney also. It accompanies the rectum and forms the efferent ctenidial vessel. From the efferent ctenidial vessel the blood passes along the roof of the mantle cavity into a definite lacuna at the base of each gill-lamella. After oxygenation the blood from the ctenidium passes into the efferent ctenidial vein, which opens into the base of the auricle on the left side.

The Nervous System.

The nervous system of *Mysorella* (fig. 19), like that of *Bythinella*, *Bithynia* and *Paludestrina* is characterised by the approximation of the superior and lateral centres. The cerebral ganglia are pear-shaped and are situated dorsal to the oesophagus immediately behind the posterior end of the buccal mass and ventral to the salivary glands. The two cerebral ganglia are connected with one another by a short thick commissure. The apex of each cerebral ganglion is anterior and somewhat ventro-laterally directed. It gives off four nerves, the innermost of which is the buccal nerve. The other nerves supply the oral region and the dorsum of the snout. The buccal nerve is long, and after passing forward from the cerebral, turns round under the buccal muscles and ends in the buccal ganglion.

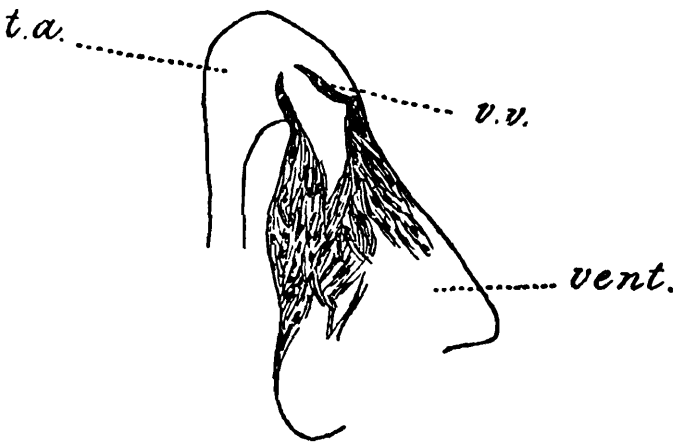
The buccal ganglia are oval and are connected by fairly long commissures. They are situated ventral to the oesophagus, one on either side, immediately after its origin from the buccal mass. Each buccal

ganglion gives off a nerve to the buccal mass. *Mysorella* resembles *Bythinella* and differs from *Paludestrina* in having the buccal ganglia separated from the cerebrals by long connectives.



TEXT-FIG. 18*b*.—A section of the heart showing the auriculo-ventricular valves. *aur.* auricle ; *a. v. v.* auriculo-ventricular valves ; *ef. ct. v.* efferent ctenidial vein ; *ren. v.* efferent renal vein ; *vent.* venrticle.

Besides the four nerves at the anterior end, each cerebral ganglion gives off nerves to the tentacles and the eyes. The tentacular nerve arises dorsally from the external face of the cerebral ganglion and runs to the tentacle somewhat parallel to the ocular nerve. In the tentacle the first branch arises from the tentacular nerve about the level of the eye. Higher up it gives off more branches. No tentacular ganglion, such as has been described for *Bythinella* and *Paludestrina*, is found in *Mysorella*. The ocular nerve is distinct from the tentacular ; it also arises dorsally from the cerebral ganglion posterior to the tentacular nerve.

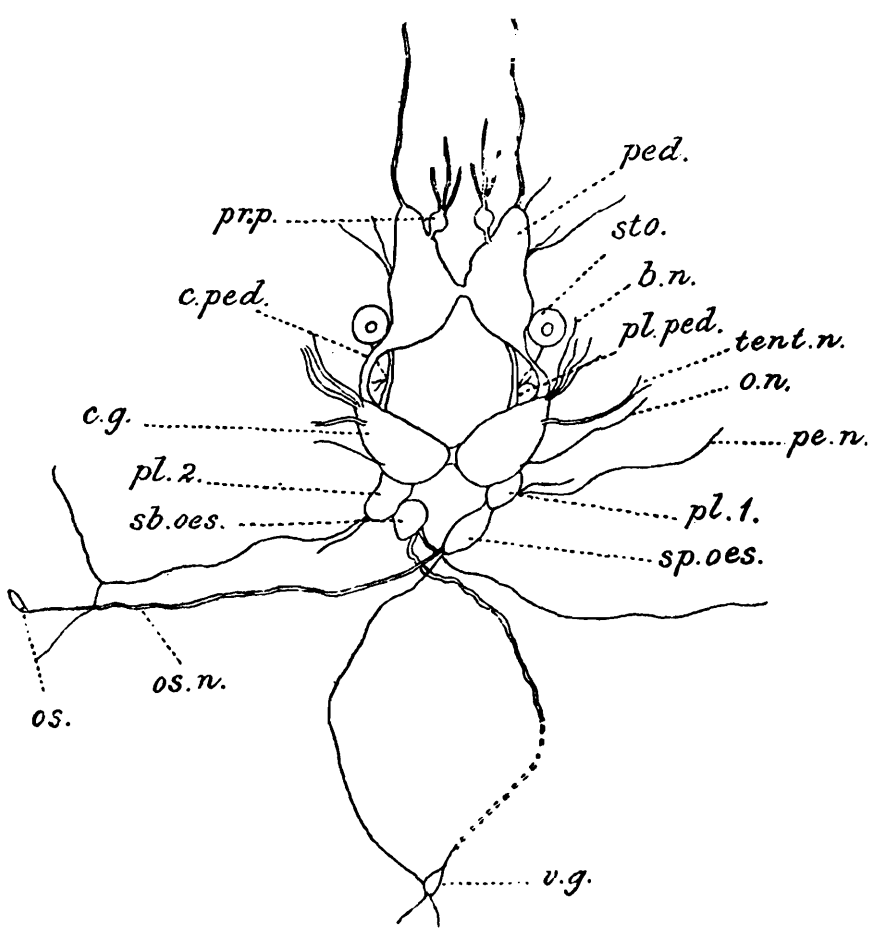


TEXT-FIG. 18*c*.—Section of the ventricle showing valves at the commencement of the truncus arteriosus.
t. a. truncus arteriosus ; *vent.* ventricle ; *v. v.* valves at the commencement of the truncus arteriosus.

The pleural ganglia lie in close contact with the cerebrals and there are no distinct cerebro-pleural connectives. The right pleural ganglion is oval in shape and its anterior part lies under the right cerebral ganglion. From its outer face a slender nerve runs to the mantle. In the male, besides this nerve, a long, thick nerve passes into the penis between the penial gland and the vas deferens. In the penis this nerve runs by the side of the vas deferens. The left pleural ganglion is larger

than the right, while the reverse is the case in *Paludestrina.* It is cylindrical in shape and, on account of a slight constriction, appears to consist of two parts. It gives rise to two nerves, the posterior of which is very slender and supplies the mantle. The anterior one is stouter and passes towards the mantle edge after anastomosing with the osphradial nerve from the supra-oesophageal nerve.

The supra-oesophageal and the right pleural ganglia lie close together, while in *Paludestrina* they are separated by a fairly long connective. The supra-oesophageal ganglion is elongate, somewhat oblong to elliptic in outline. From its distal end two nerves arise, one of which passes to the visceral ganglion, while the other, which passes to the mantle, is the osphradial nerve. The osphradial nerve, which is a long, fairly thick nerve, anastomoses with the pallial nerve by one or two branches. After this anastomosis, it gives off a slender branch, which passes to the mantle in the direction of the ctenidium, while the main nerve passes to the osphradium where it swells into an elongate ganglion. Bregenzer (3) represents the osphradial nerve as quite short in *Bythinella,*



TEXT-FIG. 19.—The nervous system (slightly diagrammatic).
b. n. buccal nerve; *c. g.* cerebral ganglion; *c. ped.* cerebro-pedal connective; *o. n.* ocular nerve; *os.* osphradium; *os. n.* osphradial nerve; *ped.* pedal ganglion; *pe. n.* penial nerve; *pl.*1, *pl.*2. right and left pleural ganglia; *pl. n.* pallial nerve; *pl. ped.* pleuro-pedal connective; *pr. p.* propodial ganglion; *sb. oes.* sub-oesophageal ganglion; *sp. oes.* supra-oesophageal ganglia; *sto.* statocyst; *v. g.* visceral ganglion.

but in *Mysorella* the osphradial ganglion is more removed from the supra-oesophageal and the nerve is fairly long.

The sub-intestinal ganglion is a round ganglion and gives rise to two nerves, one of which is stout and forms the sub-intestinal nerve. The sub-intestinal nerve in the first part of its course is wavy, while in the next part of its course it runs in the ventral body wall of the animal. The other nerve from the sub-intestinal ganglion passes to the right side of the mantle and supplies the region of the lower part of the genital duct and rectum.

The pleuro-pedal and cerebro-pedal connectives are of moderate length and are distinct from each other. The cerebro-pedal connective is thicker than the pleuro-pedal. From each pleuro-pedal a nerve arises and divides into two branches. On the right side, one of these nerves seems to pass to the siphon.

The pedal ganglia are triangular with their bases directed outwards, and their vertices joined by a short thick commissure. As in *Paludestrina* and *Bythinella*, three chief nerves arise from each pedal ganglion, an anterior, a lateral and a ventral. The anterior nerve arises from the anterior face of the pedal ganglion and immediately after its origin swells into the propodial ganglion. From the propodial ganglion two branches arise, while the main nerve passes to the anterior part of the foot. The postero-lateral supplies the muscles of the posterior-lateral region of the foot. No definite ganglia could be made out on the ventral nerve and there was no trace of a metapodial commissure.

The visceral ganglion is elongate and lies immediately posterior to the columellar region a little anterior to the pericardium. It gives off two nerves which supply the visceral mass.

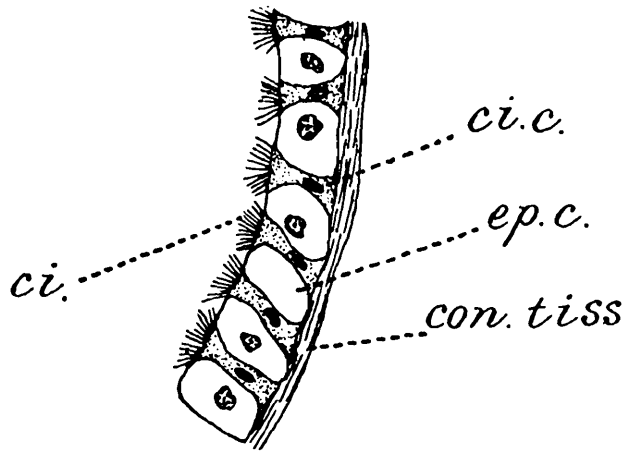
Sense organs.

The statocysts lie on the outside of the upper part of the pedal ganglia. The nerve of the statocyst is very slender and crosses the pleuro-pedal where the latter gives off the pallial branch described above. Its further course was not clearly traceable in any of the specimens. Probably it arises from the cerebral ganglion close to its attachment with the pleural ganglion. Each statocyst is spherical and is surrounded by connective tissue. The wall of the statocyst (fig. 20) consists of two kinds of cells : (1) narrow, somewhat hour-glass-shaped cells, which stain deeply and carry at their free ends cilia spread in a fan-like manner, and (2) lying between the sensory cells are cubical cells which do not stain. The interior of these cells often shows a rounded nucleus surrounded by a structureless cytoplasm. In the statocysts of *Paludestrina* and *Valvata* cilia have not been noticed and no reference is made to them in the case of *Bythinella*. A single statolith of a moderate size is present in the statocyst.

The position and appearance of the osphradium have already been described. The osphradium overlies an elongate ganglion and its epithelium consists, as in *Bythinella* and *Paludestrina*, of sensory and ciliated cells. The ciliated cells are mainly found along the sides of the osphradium. The non-ciliated cells are cylindrical and have an oval nucleus.

The eyes, whose position has already been described, do not call for special remark. As in other gastropods, they are closed vesicles.

The outer cornea is slightly thinner than the adjacent epithelium of the base of the tentacle.



TEXT-FIG. 20.—Portion of the wall of the statocyst.
ci. cilia ; *ci. c.* ciliated cells ; *con. tiss.* connective tissue ; *ep. c.* non-ciliated cells.

The tentacles are lined by columnar epithelium with a thin cuticle with oval nuclei. Beneath the epithelium is the basement membrane and the main mass of the tentacles consists of longitudinal muscles, branches of the tentacular nerve, connective tissue and blood vessels. The connective tissue consists of polygonal cells and those lying in the centre of the tentacle contain a dense blackish-brown pigment, which appears in the entire tentacle as a dark pigmented central part.

The Reproductive System.

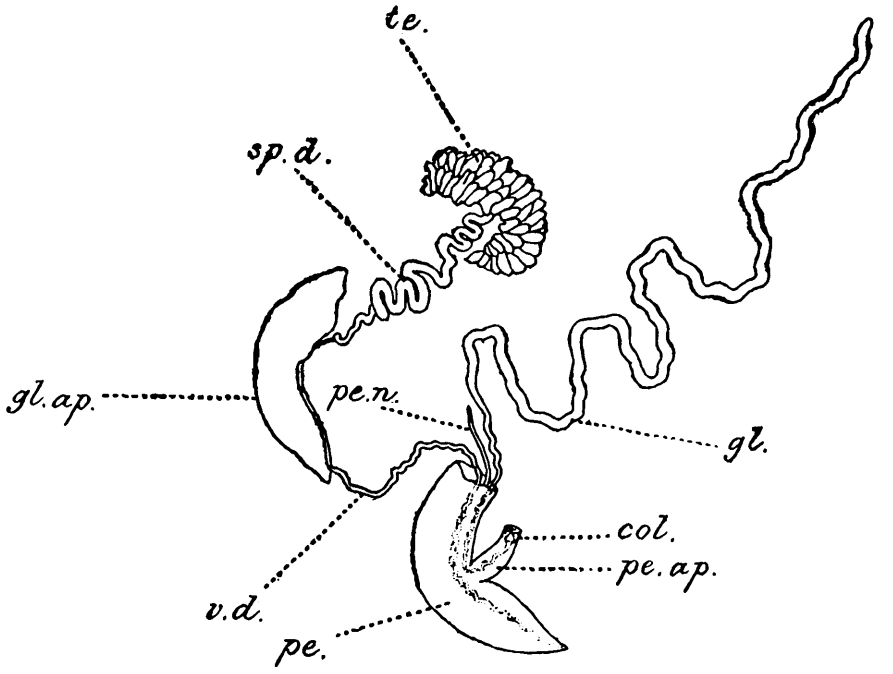
Mysorella is dioecious. The specimens of the two sexes, except in the greater width of the body whorl of the shell in the female, do not show any marked difference externally. After the removal of the shell, the males can easily be recognised not only by the conspicuous penis projecting forwards at the anterior end of the animal, but also by the presence of a black pigmentation in the apical whorls from the region of the stomach to the apex of the animal.

Male Reproductive System.

The testis is situated on the columellar side of the apical whorls 1 and 1½, and extends to a length of about 2 mm. It consists of numerous branched tubular follicles and in the mature condition is of an orange colour.

The sperm duct (fig. 21, *sp. d.*) arises from the middle of the testis and after taking about ten close loops, of which the middle ones are the stoutest, it shows about the level of the kidney a glandular attachment which is about 3 mm. long. The sperm duct runs on one side of this glandular attachment, and emerging at the lower end passes to the right side of the neck of the animal. The total length of the duct is 1·25 mm. and for a part of its course it lies in the epithelium covering the right side of the neck of the animal. The vas deferens then enters the

penis on the dorsal side of the neck or junction of the foot and head, and running excentrically in the penis, opens at its anterior end.



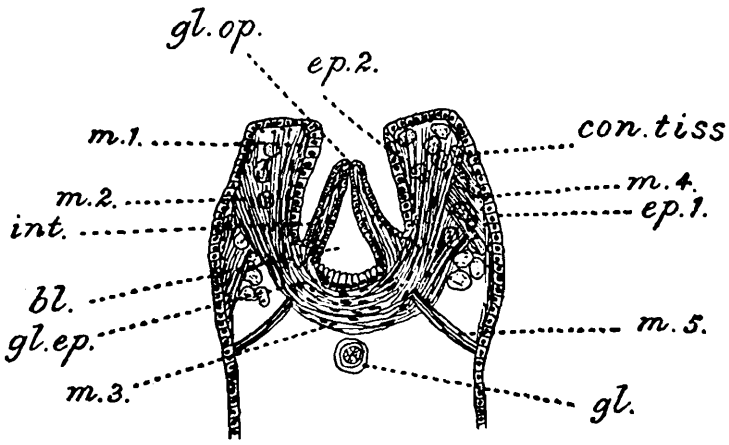
TEXT-FIG. 21.—Male reproductive system. The penial gland (gl.) is uncoiled and partly stretched.
col. collar-like thickening of the penial appendage ; *gl.* penial gland ; *gl. ap.* glandular attachment of the vas deferens ; *pe.* penis ; *pe. ap.* penial appendage ; *pe. n.* penial nerve ; *sp. d.* sperm duct ; *te.* testis ; *v. d.* lower part of the male genital duct.

The penis is a whitish, sickle-shaped, dorso-ventrally flattened organs about 3 mm. long and projecting from the mantle cavity over and beyond the head of the animal. It is developed from the floor of the mantle cavity immediately posterior to the pseudo-epipodium. Its free end bearing the external male opening is usually directed to the left. The left side of the penis about its middle possesses a laterally directed finger-shaped appendage (fig. 21, *pe. ap.*), about ·75 mm. long, and termed by Bregenzer (3) the " gland rute." Its distal portion has the appearance of a collar-like thickening (fig. 21, *col.*) and bears at its apex the opening of a long tubular glandular structure of a total length of over 20 mm., of which the major portion lies as a much convoluted tubular structure beneath the dorsal epithelium of the neck of the animal. This gland complex has about twelve loops and its posterior portion extends nearly to the columellar region of the animal. Anteriorly it becomes narrow and enters the penis, where, after a wavy course, it turns aside into the lateral penial appendage and opens at its apex.

The portion of the penis near the left margin, which is traversed by the gland and the vas deferens, is less opaque and consequently the course of these structures can to some extent be distinguished through the wall of the penis.

The terminal portion of the penial appendage is of interest. Bregenzer (3) described this appendage in *Bythinella* as a cylindrical structure of nearly constant thickness. In his figure, however, he represents the terminal portion of the appendage as having the appearance of a collar-like thickening. He has not described the internal anatomy

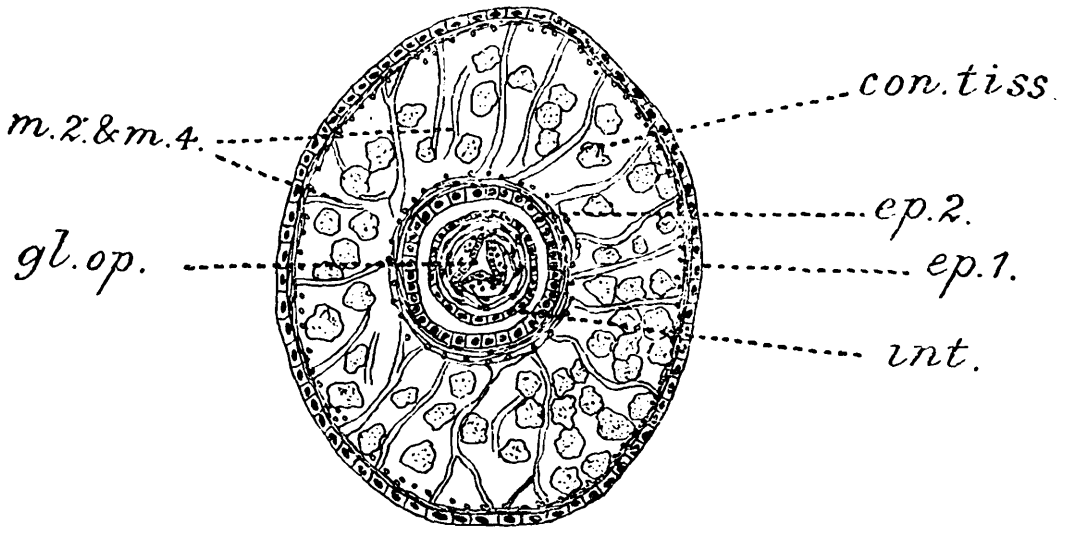
of this portion of the appendage. The collar-like external appearance is due to a partial invagination of the terminal portion of the appendage. In a longitudinal section of this portion in the retracted condition, one finds a double wall enclosing a hollow conical protrudable portion (fig. 22,



TEXT-FIG. 22.—Longitudinal section through the distal portion of the penial appendage. *con. tiss.* connective tissue cells ; *ep.* 1. outer epithelium ; *ep.* 2. inner epithelium ; *gl.* gland cut transversely ; *gl. ep.* glandular epithelium ; *gl. op.* external opening of the protrudable portion ; *int* central protrudable portion ; *m.*1. longitudinal muscles ; *m.*2. oblique muscles passing up from the base ; *m.*3 circular muscles at the base : *m.* 4. oblique muscles passing between the outer and inner epithelium in the invaginated condition ; *m.* 5. muscles passing downwards to the body wall.

int.) bearing at its apex a short canal (fig. 22, *gl.op.*) leading to the exterior. The gland opens into the base of this structure. The lower portion of the cavity is lined by a glandular epithelium, continuous with that of the gland complex, while the remaining portion of the cavity leading to the exterior is lined by an ordinary epithelium consisting of short, cubical cells. The wall of the central protrudable portion of the appendage consists of outer and inner layers of short cubical epithilial cells, underlying which are layers of circular muscles and longitudinal muscles. The circular muscles are very well developed, especially round the base of the protrudable portion (fig. 22, *m.* 3). From its base muscles run upwards obliquely and also longitudinally (fig. 22, *m.* 1, *m.* 2) to the walls of the penial appendage. There are also a few muscle-fibres (fig. 22, *m.* 5) running downwards to the wall of the appendage from the base of the protrudable portion. Besides these, there are muscle strands (fig. 22, *m.* 4) which run obliquely between the outer and inner layers of the double wall and surround the central part in its invaginated condition. The space between these two walls in the invaginated condition is seen to be filled with polygonal connective tissue cells (fig. 22, *con. tiss.*), which may serve as supporting tissue in the protraction and retraction of the central portion. The outer epithelium of the terminal portion of the penial appendage is similar to that covering the rest of the appendage, and consists of short cubical cells. Underlying this are thin layers of circular and longitudinal muscles. The inner wall is covered with similar cells, but the cell nuclei are more prominent. In the retracted condition, which alone I have observed, the whole structure resembles an acrecbolic introvert as figured by Pelseneer (4) for a proboscidiferous gastropod (p. 87, fig. 72, *f.*). The secretion of the

gland collects in the base of the cavity of the protrudable portion, which is really the swollen termination of the gland itself. By the contraction of the oblique and longitudinal muscles running upwards from the base of the bladder to the wall of the penial appendage, a partial



TEXT-FIG. 23.—Transverse section through the distal portion of the penial appendage ; lettering as in fig. 22.

evagination resulting in the protrusion of the central portion can be brought about. At the same time, the well-developed circular muscles, as also the longitudinal muscles by their contraction, can effect the exudation of the glandular secretion through the narrow canal at the apex. The muscles running downwards from the base of the central protrudable portion, and the oblique muscles seen running between the outer and inner epithelium in the invaginated condition, by their contraction would bring about the partial invagination. Bregenzer (3) says that he observed the secretion of the gland oozing out of the opening of the gland-rute in the act of copulation. I have not had an opportunity of observing this phenomenon in *Mysorella* but probably the conditions are similar in this form. The arrangement described above would enable the terminal portion of the penial appendage to be thrust forward and to expel the secretion of the gland during the act of copulation.

I often found the gland filled with its secretion in the proximal portion but near its termination in the appendage the gland often had a clear, empty cavity in the centre, thus indicating the recent expulsion of the contents of the gland.

The penial nerve arises from the right pleural ganglion and enters the penis between the gland and vas deferens. In the penis it accompanies the vas deferens. Judging from its origin and inervation, the penis of *Mysorella* is neither cephalic nor pedal.

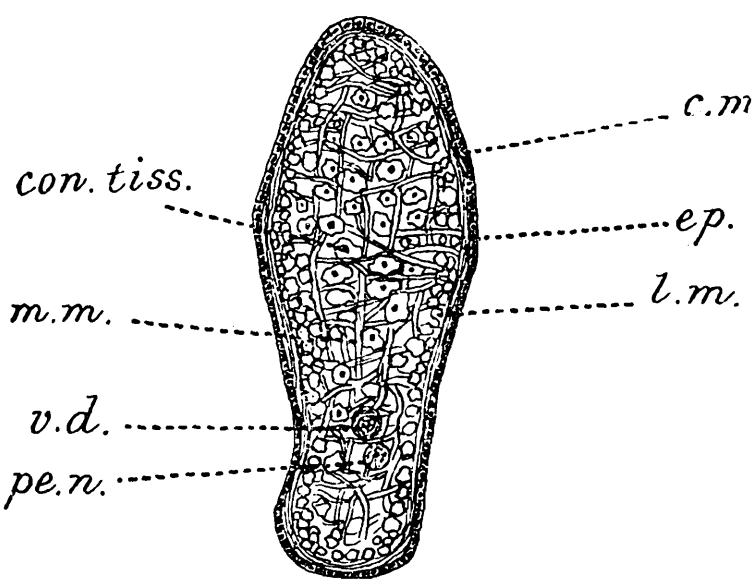
Histology.—The testis consists of a large number of tubes bound together by connective tissue. It is covered by an epithelium which is continuous with the general body epithelium and under which is the connective tissue containing blood vessels. Each tubule has a thin layer with nuclei and sperm mother cells. The spermatozoa are of the eupyrene type only. They are pointed in front. I could not make out a

distinct middle piece. The anterior portion of the sperm excluding the tail is about ·0025 mm., while the tail is about 18μ. long.

The commencement of the sperm duct is lined by somewhat squarish cells with large rounded nuclei. Further on the epithelium consists of flattened cells. The part of the sperm duct lying against the liver is stout in mature individuals and contains numerous sperms.

The portion lying on the glandular appendage is narrow and its epithelium consists of short cubical ciliated cells with slightly oval nuclei. It is surrounded by circular muscles. In the next portion of the vas deferens also the same structure prevails. But in the portion of the vas deferens traversing the penis, the investing circular muscles form a very thick sheath.

The glandular appendage is a much convoluted tubular structure. Its cells are cylindrical and the nuclei are more or less oval and have clear nucleoli. The cells show a dense collection of secretory products. The gland seems to communicate with the vas deferens in various places. The supporting cells are narrow and have elongate nuclei.



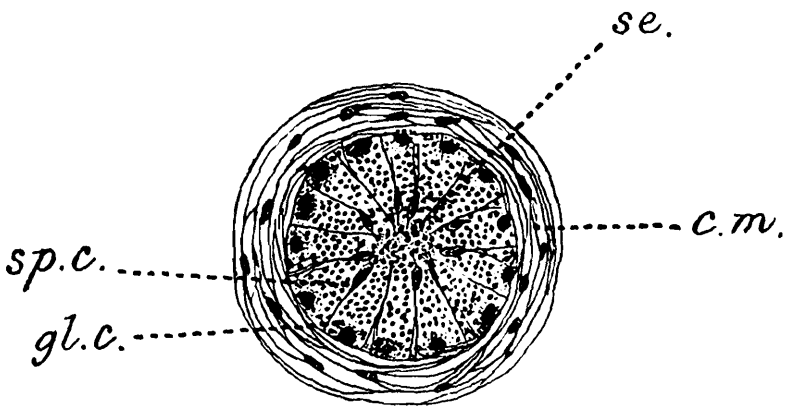
TEXT-FIG. 24.—Transverse section through the penis.
c. m. circular muscles ; *con. tiss.* connective tissue cells ; *ep.* epithelium ; *l. m.* longitudinal muscles ; *m. m.* mesh work muscles ; *pe. n.* penial nerve ; *v. d.* vas deferens.

The epithelium of the penis (figs. 23, 24) consists of cubical cells with oval nuclei. Beneath the epithelium are layers of circular and longitudinal muscles. The rest of the penis is filled with a loose parenchymatous tissue in which there are longitudinal and transverse muscle fibres having in their meshes feebly staining connective tissue cells with rounded nuclei. The tissue around the vas deferens, owing to the presence of a penial sinus, is more loose in texture, and consequently the course of the sperm duct is discernible through the wall of the penis.

The structure of the penial appendage (gland-rute) has been dealt with already.

The gland (fig. 25) has a thick sheath of circular muscles and is composed of cylindrical gland cells with narrow, oval, basally situated nuclei. The general appearance of these cells is similar to those of the glandular appendage of the vas deferens. The cytoplasm round the nuclei stains

more deeply than the rest. The cells are filled with products of secretory activity, and the centre of the gland, especially in its proximal



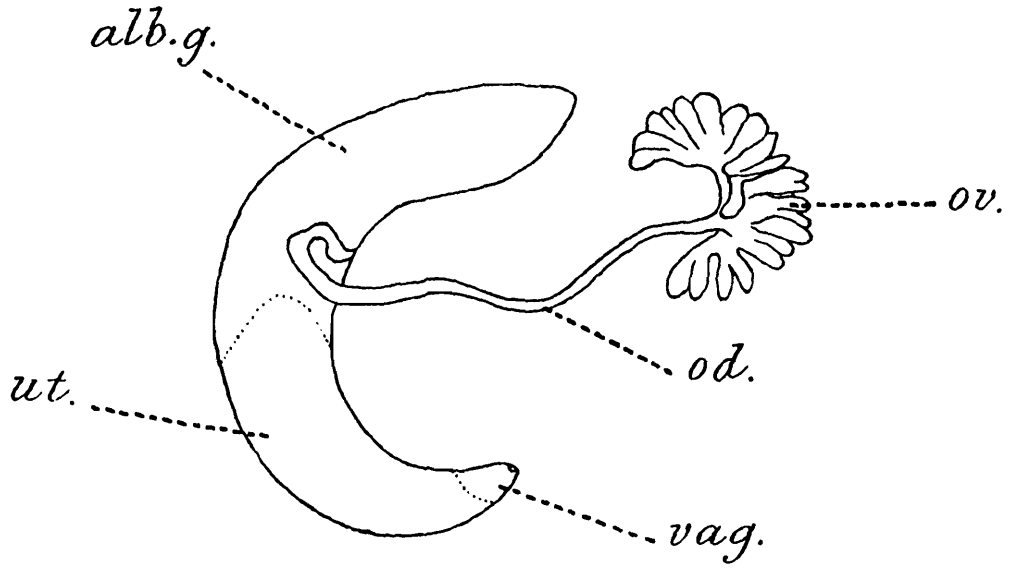
TEXT-FIG. 25.—Transverse section of the penial gland.
c. m. circular muscles; *gl. c.* gland cells; *se.* secretion; *sp. c.* supporting cells.

portion, shows a collection of the secretion (fig. 25, *se.*) of the cells. The supporting cells are conspicuous. They are narrow, elongate, with correspondingly shaped nuclei which are placed at the distal ends of the cells near the centre of the gland. The blunt ends of these narrowly oval nuclei are directed towards the centre of the gland.

Female Reproductive System.

The female reproductive system of *Mysorella,* in contrast to the male reproductive system, is simple.

The ovary (fig. 26, *ov.*) is situated in a position corresponding to that of the testis in the male and extends to about a length of 2 mm. In the mature condition, it is yellow in colour. It consists of branched tubular follicles usually about a dozen in number. From each follicle



TEXT-FIG. 26.—Female reproductive system.
alb. g. albumen gland; *od.* oviduct; *ov.* ovary; *ut.* uterus; *vag.* vagina.

a small duct arises, and the small ducts so formed unite to form the oviduct. The oviduct (fig. 26, *od.*) is 4 mm. long, and unlike the sperm

duct is not convoluted. It passes by the side of the stomach in the region of the kidney to the albumen gland (fig. 26, *alb. g.*). Near the albumen gland the oviduct becomes stouter and on the albumen gland it is doubled on itself.

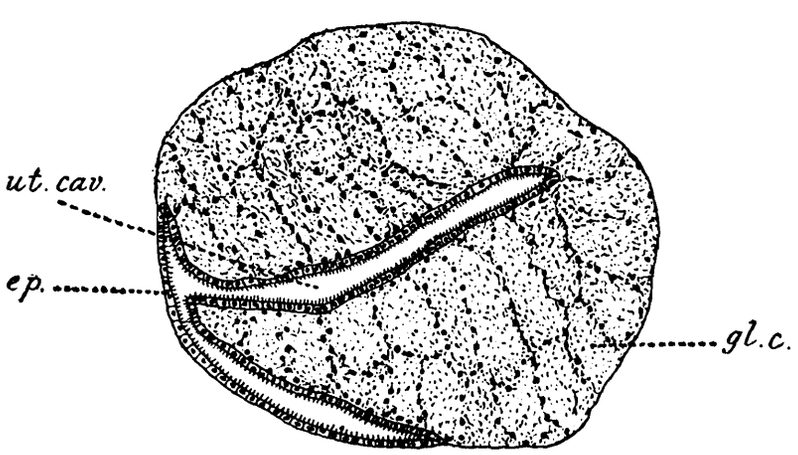
Lying to the right of the intestine in the animal is a stout elongated structure having somewhat a sickle-shaped outline, and extending from about the posterior end of the stomach nearly to the free edge of the mantle. The posterior portion of the structure is the albumen gland, and its lower part surrounds the oviduct as the latter passes into the uterus. The portion anterior to the albumen gland, about 3 mm. long, forms the uterus (fig. 26, *ut.*) and the vagina. The albumen gland has a slightly translucent appearance in the living animal, while the uterus is opaque. The distal portion of the female reproductive system for about ·75 mm. of its length is of the same colour as the albumen gland and constitutes the vagina.

The distal part of the oviduct after passing the albumen gland leads into the uterus. The cavity of the uterus is elongated, narrow, and roughly V-shaped in transverse section (fig. 26). The female genital opening is situated in the mantle cavity posterior to the anal opening.

Histology.—The epithelial covering of the ovary is continuous with that of the general body epithelium. Under the epithelium is the connective tissue containing a few blood vessels. The general epithelium consists of short cubical cells, with rounded, basally placed nuclei. Each tubule has a thick basement membrane surrounding the germinal epithelium, which is composed of cubical cells with round nuclei basally placed. Ova in various stages of growth can be seen in mature individuals, either attached to the germinal epithelium or in the cavity of the tubule.

The oviduct has a thick investment of circular muscles and is lined by ciliated cells with round basally placed nuclei.

The albumen gland in the adult stains very deeply with haematoxylin and owing to its brittle nature its structure cannot be made out properly. It consists of polygonal portions containing rounded bodies resembling



TEXT-FIG. 27.—Transverse section of the uterus.
ep. epithelium of the uterus ; *gl. c.* gland cells ; *ut. cav.* uterine cavity.

flat globules. In the young or immature individuals it is thin, and is composed of tubular masses of glandular structures consisting of

cylindrical cells with large rounded nuclei and distinct nucleoli. The cytoplasm of the cells contains deep staining granules and globules.

The cavity of the uterus, as stated above, is roughly V-shaped in transverse sections. The epithelium (fig. 27) lining it consists of ciliated cells with rounded, centrally placed nuclei. One arm of the V-shaped cavity and the inner side of the other arm are invested with glandular cells lying beneath the epithelium. The thickness of the uterine wall is due to the gland-cells which are cylindrical and have rounded, basally placed nuclei and a granular cytoplasm. In mature individuals these do not usually show any definite cell limits, and the nuclei are arranged in a striking manner, as a result of which the uterine wall in the transverse section appears as if it were divided into four to six-sided areas.

The structure of the vaginal wall differs from that of the uterine wall in that its cells, which are really the same as those of the uterine wall, are filled with a dark staining secretion.

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