THE STYLE SACS OF SOME MORE GASTROPODS.

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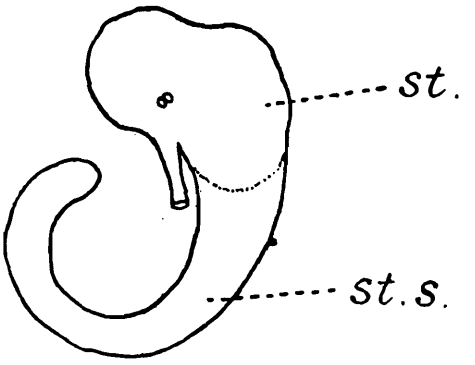
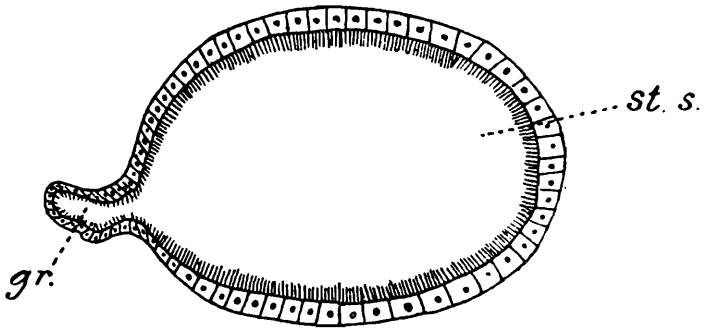
In the group *Platypoda* of the *Prosobranchs* a crystalline style and style sac have been definitely recorded in the families (1) Cyclostomatidae, (2) Aderobiidae, (3) Hydrobiidae, (4) Melaniidae, (5) Typhobiidae, (6) Turritellidae, (7) Strombidae, (8) Calyptraeidae, (9) Vermetidae, and (10) Capulidae. The present paper records the occurrence of the style sac and crystalline style in two more families, Cerithiidae and Assimineidae, and also discusses the nature of the style sac in the genera *Bithynia* and *Turritella*.

In the family Cerithiidae, the style sac and the crystalline style are present in *Potamides* (*Tympanotonos*) *cingulatus* (Gmelin), *Potamoides* (*Telescopium*) *telescopium* (Linn.) and *Potamides* (*Cerithidea*) *obtusum* (Lam.).



Text-fig. 1.—Stomach of *Potamides* (*Tympanotonos*) *cingulatus* (Gmelin). *st.* stomach proper or gastric chamber; *st. s.* style sac.

The stomach of *Potamides* (*Tympanotonos*) *cingulatus* (Gmelin) like other style-bearing stomachs consists of an anterior portion which is the style sac and of a posterior portion which is the gastric part or stomach proper. The two parts, however, are not marked off so clearly as in some other genera. The general outline of the stomach with its



Text-fig. 2.—Transverse section of the style sac of *Potamides* (*Tympanotonos*) *cingulatus* (Gmelin), *gr.* groove on the pyloric side; *st. s.* style sac.

broad posterior portion and a narrow curved anterior portion is not unlike that of a vertebrate embryo in the early stages of development.

The style sac is about 12 mm. long and nearly twice as long as the stomach proper, thus differing from the stomach of *Paludomus*, where the style sac and the stomach proper are of about the same length. Its cavity is tubular and the inner surface presents a shining appearance. On the pyloric side of the cavity the style sac presents a longitudinal groove which has nearly the same features as in *Melanoides* and *Paludomus*. Anteriorly this groove forms the slit of communication between the style sac and the short pylorus for a length of about 0·6 mm.

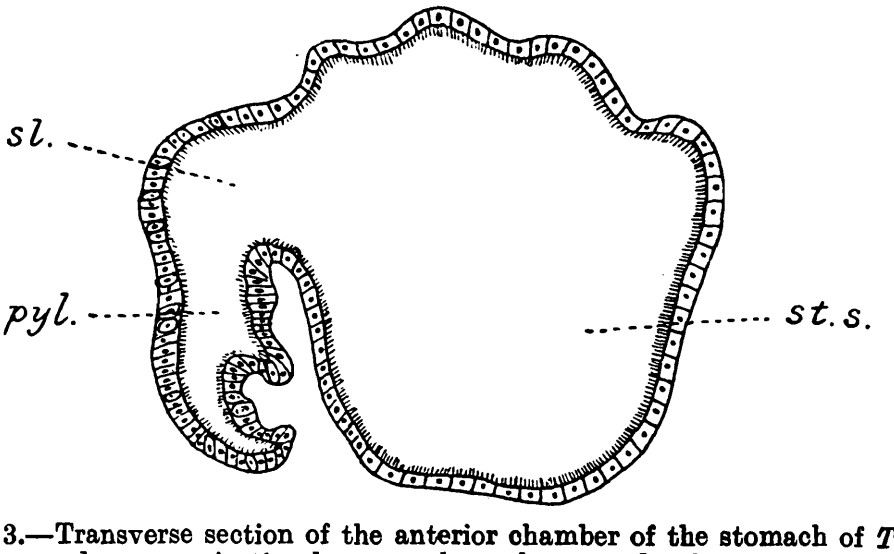
The style sacs of *Potamides* (*Cerithidea*) *obtusum* (Lam.). and *Potamoides* (*Telescopium*) *telescopium* (Linn.) are very similar to that of *Potamides* (*Tympanotonos*) *cingulatus* (Gmelin). In *Potamoides* the style is about 50 mm. long, curved and gradually tapering towards the anterior end. The crystalline style is narrowly cylindrical and about 52 mm. long. As the style tapers anteriorly, the anterior end of the style is narrow while the posterior end is dilated and club-shaped unlike the styles of the Melaniidae and Hydrobiidae.

The posterior chamber in all the three forms possesses a well developed gastric shield and gastric folds which are much more conspicuously developed than in *Paludomus*.

The style sac of Cerithiidae is thus of the type found in Melaniidae.

Heude (1) who worked on the genus *Assiminea* makes no mention of the occurrence of the style sac and the figure of the viscera of *Assiminea* given by him does not indicate its presence. The style sac of *Assiminea* is of the type found in Hydrobids like *Mysorella* and *Amnicola* (*Alocinma*). The anterior chamber of the stomach consisting of the style sac and pylorus is about 1·4 mm. long and the pyloric communication of the style sac extends for a length of about 0·8 mm.

In *Bithynia* nothing has been recorded excepting the occurrence of the style sac. I examined a few specimens kindly placed at my disposal by Dr. Baini Prashad and found the stomach of *Bithynia* also resembling that of *Mysorella*. The anterior part consists of the style sac and the pylorus lying side by side and with a longitudinal slit of communi-



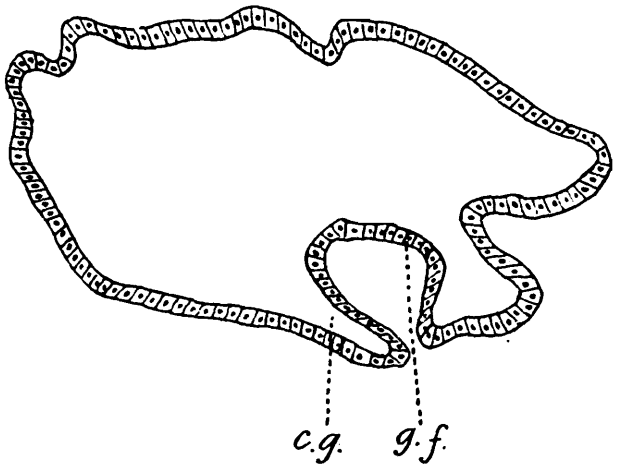
TEXT-FIG. 3.—Transverse section of the anterior chamber of the stomach of *Turritella*. *pyl.* pylorus; *sl.* communication between the style sac and pylorus; *st. s.* style sac.

cation as in *Mysorella*. The posterior gastric chamber possesses a well developed gastric shield whose outline is similar to that of *Potamides*.

The stomach of *Turritella* was first examined by Randles (4), who, however, did not make any reference to the connection between the style sac and the pylorus. He described the style sac as " situated within the lower portion of the stomach on the convex border and bounded by the narrow anterior chamber, which eventually leads into the intestine." This statement in the light of my description of the style sacs of forms like *Mysorella*, clearly indicates that the style sac and the pylorus constitute an anterior chamber of the stomach but fails to explain whether the style sac communicates with the pylorus or not. Robson (5) in his account of the relation between the style sac and the intestine of the Gastropods and Lamellibranchs stated that in *Turritella* the style sac and the intestine are quite separate. Mackintosh (2) included *Turritella* along with *Melania* in stage 3 of the style sacs where the style sac is quite independent of the intestine.

But an examination of the style sac of *Turritella* made by me by sections as well as dissections shows that the style sac in this form also communicates with the pylorus in more or less the same way as the *Mysorella*. The difference lies only in the relative size of the pylorus and the extent of the communication of the style sac with it.

In transverse section the pyloric cavity is seen to be somewhat shorter in the dorso-ventral axis than the style sac and the communication of the style sac and the pylorus is wider than in *Mysorella* and extends for about two-thirds of the length of the style sac.



TEXT-FIG. 4.—Transverse section of the posterior or gastric chamber of the stomach of *Turritella*. *c. g.* crescentic groove; *g. f.* gastric fold ("fleshy ridge").

Randles' conclusions regarding the structure of the posterior or gastric chamber of the stomach of *Turritella* call for some discussion. As described by Randles (4), the posterior chamber of the stomach of *Turritella* shows a single fleshy fold and a crescentic groove. This groove which receives the openings of the oesophagus and the digestive gland corresponds in position and structure to the groove between the outer and inner gastric folds in the stomach of *Paludomus* and between similar structures in the stomach of *Potamides*. In *Mysorella* and *Amnicola* (*Alocimma*) also a fleshy fold and groove are present.

This groove on the floor of the stomach of *Turritella* is considered by Randles (4) as a vestigial caecum indicating the retention of a very primitive feature. In support of this conclusion Randles points out

that (1) in *Trochus* a groove runs up into a spiral caecum bounded by tumid lips and receiving the openings of the oesophagus and the digestive gland, (2) and in primitive forms like *Limnotrochus* and *Nassopsis* a style sac and a spiral caecum are co-existent.

An examination of the stomachs of various style-bearing forms does not lend support to the view that the crescentic groove on the floor of the posterior chamber of the stomach is a vestigial caecum. Sections of the posterior or the gastric chambers of the stomachs of *Turritella*, *Paludomus*, *Melanoides*, *Mysorella*, and *Potamides* show that the fleshy ridges or gastric folds and grooves are similar or homologous in all the forms, being the result of typhlosole-like foldings of the ventral wall of the stomach. What has been termed as a spiral caecum in *Nassopsis*, so far as can be judged from a figure, may also, on further investigation, proove to be due to the folding of the ventral wall as in *Paludomus*.

The case of *Trochus*, with a spiral caecum is cited by Randles (4) as a primitive form for comparison. In addition to the gross examination of the stomach of *Trochus* I made a detailed examination of the stomach of *Pterocyclus*, in which also a spiral caecum is present with a groove leading up from the openings of the oesophagus and the digestive gland and bounded by a fleshy ridge. In a tranverse section the fleshy ridge is seen to be due to a typhlosole-like fold of the stomach epithelium.

What is the relation between the spiral caecum and the structures noted in the gastric chambers of the style bearing forms ? Grooves and ridges are present in the stomachs of several forms and evidently serve for directing the course of the gastric contents or for increasing the digestive surface. In primitive forms like *Pterocyclus* or *Trochus* these take the form of a spiral caecum. But in the style-bearing forms the groove and the ridges have evolved in another direction and come to subserve the function of accommodating the trough-like gastric shield, besides directing the gastric contents before being subjected to the action of the crystalline style. On this view the crescentic groove on the floor of the stomach, though homologous with that in the spiral caecum in its being the result of the folding of the gastric epithelium, cannot be considered as a vestigial structure and as a retention of a primitive feature. A good reason for this inference is seen in the correlation between the complexity of the gastric folds and the degree of separation between the style sac and the pylorus. In forms like *Paludomus*, *Melanoides* and *Potamides* which show a much specialised condition of the style sac in the degree of its separation from the pylorus, the gastric folds are very well developed and the groove is very pronounced. In the nature of its style sac *Nassopsis* also shows a specialised condition and not a primitive condition. In this connection it may be stated that the structure of the stomach of *Nassopsis* as given by Moore (3) shows that the style sac has a short pyloric connection as in *Paludomus* and *Melanoides*, and is not totally independent of the intestine, a feature not noticed hitherto. In forms like *Turritella* and *Mysorella*, the style sacs of which show a less specialised condition in having a long pyloric communication; the gastric folds and the groove are less pronounced.

Randles' view that the crescentic groove in the posterior chamber si a *vestigial* structure cannot therefore hold ground. The anatomical

evidence shows that the groove and the adjoining ridges or folds are functional structures, and the correlation between the gastric folds and the specialisation or separation of the style sacs can be explained only by considering the folds and the groove as having evolved along a line different from that of the spiral caecum, to meet the exigencies of accommodating the gastric shield and of directing the gastric contents towards the style.

In conclusion, I have to express my best thanks to Dr. Baini Prashad for helping me with some of the references, the verification of the species and for sending a few specimens of *Bithynia*, and to Dr. H. S. Rao for sending me a copy of Heude's figure of the viscera of *Assiminea* and for references on it.

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