THE STYLE-SAC OF SOME FRESHWATER GASTROPODS.

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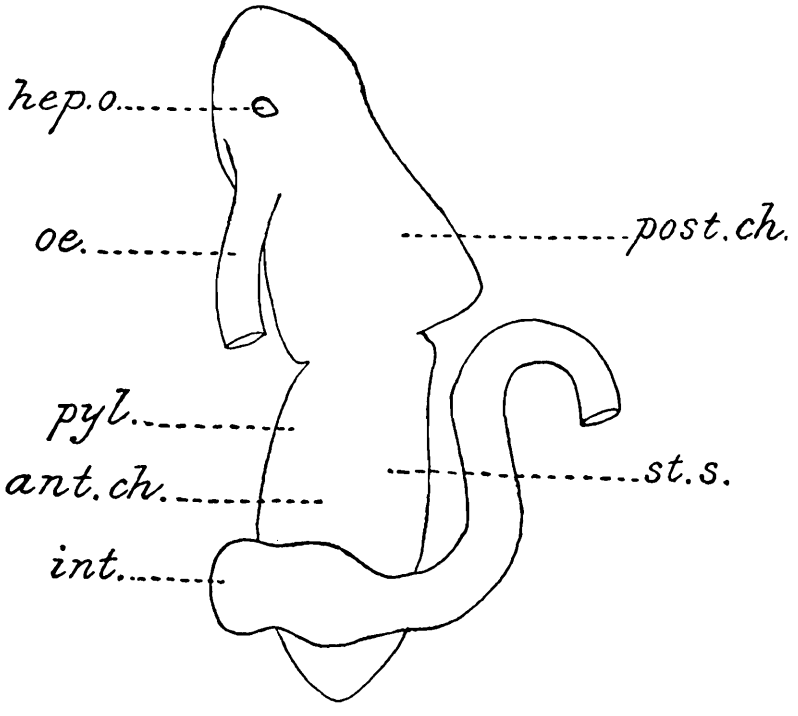
In a recent paper (6) I showed that the stomach of *Paludomus* is interesting owing to the possession of a much restricted communication between the style-sac and the pyloric part of the stomach. The present note deals with the style-sacs of *Melanoides*, *Mysorella* and *Amnicola* (*Alocinma*). A comprehensive account of the style-sacs of Gastropods was published by Robson (5) and Mackintosh (2), but none of the genera which form the subject of this note are mentioned by them. Even in the closely allied genera *Bithynia* and *Melania*, which are known to possess a style-sac, the relation of the style-sac to the intestine has not been properly investigated. *Melania* is said to possess a style-sac completely separated from the intestine, but from my observations on the stomach of *Melanoides* and *Paludomus* I am of opinion that the stomach of *Melania* needs reinvestigation. In *Bithynia* nothing is known except that a style-sac is present.



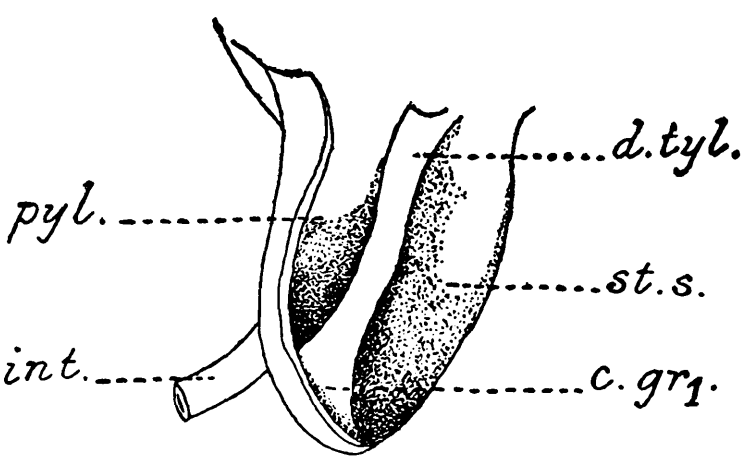
Text-fig. 1.—Stomach of *Mysorella* as seen from the ventral side.

ant. ch., anterior chamber ; *hep. o.*, opening of the hepatopancreatic duct ; *int.*, intestine ; *oe.*, oesophagus ; *post. ch.*, posterior chamber ; *pyl.*, pylorus ; *st. s.*, style-sac.

The style-sac of *Melanoides* bears a close resemblance to that of *Paludomus* in its disposition, structure, and relationship to the intestine. Externally the style-sac appears to be independent of the intestine, but a closer examination of the junction of the style-sac with the stomach proper shows a distinct, though short, communication between

the style-sac and the short pylorus by means of a transverse slit measuring about 0·65 mm. long and about 0·05 mm. wide. It would, therefore, be incorrect to state that the style-sac and the pyloric element of the stomach are quite distinct in a form like *Melanoides*. The slit-like connection between the pylorus and the style-sac extends for a distance of 0·14 mm. in a medium sized individual in which the style-sac has a cavity about 1·85 mm. long.

As in the case of *Paludomus* the slit-like communication between the pylorus and the style-sac is continued as a longitudinal ciliated groove on the left or the pyloric side of the style-sac, while at its anterior end the style-sac has a circular termination, in which the crystalline style appears to be held. The longitudinal ciliated groove is wider than in *Paludomus* and its diameter is not uniform throughout its course. The cells lining the ciliated groove are shorter than those of the style-sac epithelium. On the sides of the groove the cells have well developed cilia, while those at the bottom of the groove show sparse ciliation and are sometimes without any cilia. Where the style-sac epithelium becomes continuous with that of the right side of the ciliated groove the cells are narrow, long and crowded together. The style-sac epithelium shows the usual structure. The cilia form an uniform coating on the cells of sac and are about one-third the length of the cells. The nuclei are large and rounded and are situated about the middle. The cytoplasm near the free ends of the cells possesses a greenish-brown pigment. In general features the style also resembles that of *Paludomus*.

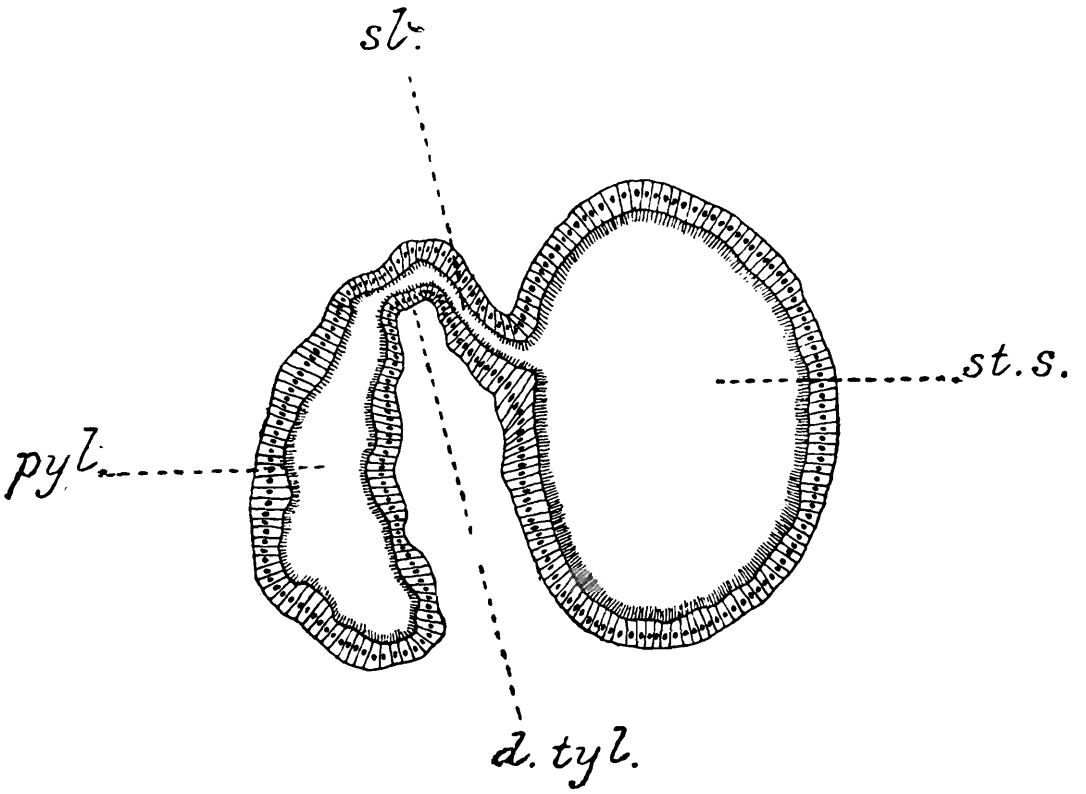


Text-fig. 2.—Anterior chamber of the stomach of *Mysorella* with the ventral wall removed.

c. gr$_1$, portion of the anterior chamber which appears as the ciliated groove in section; *d. tyl.*, typhlosole of the dorsal wall between the pylorus and style-sac; *int.*, intestine; *pyl.*, pylorus; *st. s.*, style-sac.

The style-sac of *Mysorella* differs from that of *Melanoides*, and resembles more that of *Hypsobia* and *Paludestrina* as described by Robson (3, 4). The stomach of *Mysorella*, like that of forms with a style, is divisible into an anterior and a posterior portion, the latter constituting the gastric portion. On opening the anterior portion of the stomach of *Mysorella*, two cavities are noticed, a right tubular cavity which is the style-sac, and a shorter, narrower, obliquely-disposed cavity on the left, which is the pylorus. The pylorus at a distance of about two-thirds the length of the anterior portion of the stomach passes into the

intestine. Throughout its length, about 1·21 mm., the pylorus communicates with the style-sac by a longitudinal slit, which is about 0·34 mm. by 0·03 mm. In transverse sections of the anterior chamber, anterior to the origin of the intestine from the pylorus, the style-sac has a groove on the pyloric side. Robson (4) has recorded a groove in *Paludestrina*, but he does not make any definite mention about the portion of the style-sac which exhibits this groove on the pyloric side. Judging from what I have observed in *Mysorella*, the groove in *Paludestrina* also must be anterior to the termination of the pyloric chamber. Serial sections and a careful dissection of the anterior chamber show that after the pylorus gives rise to the intestine the slit-like communication between the style-sac and the pylorus is continued to the free end of the anterior chamber and appears as the groove of the style-sac. The groove, thus, has essentially the same structure, and arises in the same way as in *Palu-*



Text-fig. 3.—Transverse section from the middle of the anterior chamber of the stomach of *Mysorella* showing the relations of the style-sac to the pylorus.

d. tyl., typhlosole of the dorsal wall between the pylorus and style-sac; *pyl.*, pylorus; *sl.*, slit of communication between style-sac and pylorus; *st. s.*, style-sac.

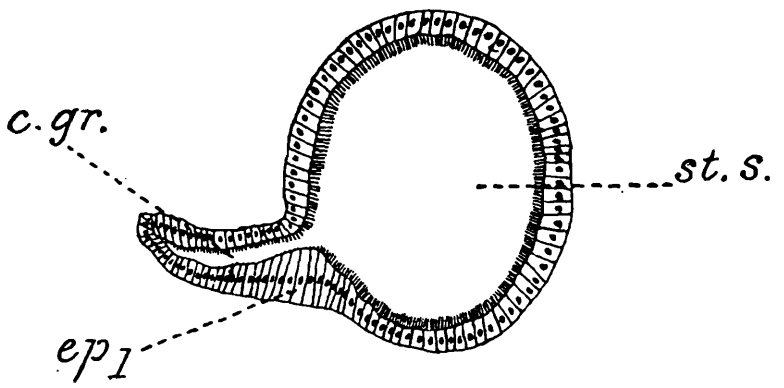
domus and *Melanoides*, and the difference lies in the much longer pyloric connection and a consequently short groove. The following measurements will give an idea of the different portions of the pylorus, style-sac, etc. of *Mysorella*:—

Length of style-sac	1·47 mm.
Total length of the pyloric chamber . .	1·21 mm.
Origin of the intestine	Extending from 0·89 mm. to 1·21 mm. of the pylorus.
Portion of the style-sac anterior to the termination of the pylorus and showing the ciliated groove	0·26 mm.

The cavity of the style-sac is roughly tubular, though somewhat flattened laterally. In transverse section it is 0·46 mm. by 0·41 mm. The pyloric cavity is narrower and is much compressed. In transverse section it is 0·45 mm. by 0·17 mm. The ciliation and the epithelium of the style-sac present the usual features, and do not call for any further remarks. No pigment was detected in the cytoplasm of the cells. The pyloric epithelium is also ciliated but the cilia do not form an even coating as in the case of the cells of the style-sac. The cells lining the right and left sides of the slit are also ciliated. In the groove the cells on the right side are long, narrow and crowded, and show very few cilia. The style is cylindrical and longer than the style-sac.

The style-sac of *Amnicola* (*Alocinma*) is similar to that of *Mysorella* and needs no special description.

A comparison of the style-sacs of *Paludomus*, *Melanoides*, *Mysorella* and *Amnicola* clearly indicates the morphological significance of the longitudinal groove of the style-sac, as I have discussed at length in my paper on the stomach of *Paludomus* (6). A comparison of these forms with Lamellibranchs like *Mya* shows that the groove in the two groups, Gastropods and Lamellibranchs, is homologous.



Text-fig. 4.—Transverse section of the anterior chamber of the stomach of *Mysorella* anterior to the termination of the pylorus.

c. gr., ciliated groove ; ep_1, long cells on the right side of the ciliated groove ; *st. s.*, style-sac.

It has been suggested by Ghosh (1) that the style-sac might have evolved as an outgrowth of the stomach and that the course of evolution might be from an original separation to union between the pylorus and the style-sac in the more highly evolved forms. The structure of the style-sacs in the forms mentioned above does not lend any support to this view, as it does not offer any satisfactory explanation for the longitudinal ciliated groove, whose nature as a vestige of a former pyloric connection is so clearly indicated in *Mysorella* by its presence on the pyloric side of the sac, anterior to the termination of the pylorus and in continuation of the pyloric communication of the style-sac.

In conclusion I have to acknowledge my great indebtedness to Dr. Baini Prashad for encouragement and for the interest he has taken in the progress of my work.

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