

## ON THE ANATOMY OF CERTAIN SPECIES OF SOLENIIDÆ.

BY H. H. BLOOMER.

(Plate x.)

I am indebted to the late Professor E. von Martens of the Berlin Museum, for the privilege of examining the specimens now described which he so kindly placed at my disposal. When sending them he gave the following particulars:—

- “2. *Solecurtus dombeyi*, Lam. Peru, from Professor Dunker's collection.
2. *Solen corneus*, Lam. Indian sea, from the collection of Lamare Piegnot made about 1836.
1. *Solen gouldi*, Conr. Yeddo = Tokio, Japan, collected by Professor Hilgendorf in 1873—76.
2. *Cultellus javanicus*, Lam. Singapore, collected by myself in 1860—62.
2. *Solen delerscoti*, Chemn. (= *brevissimus*, Marts., 1865), Singapore, collected by myself at the same time.
1. *Solen (Solena) rudis*, C. B. Adams, Panama, very near to *S. ambiguus*, Lam. from the West Indies.”

### *Solecurtus dombeyi*, Lam.

Pl. x, figs. 1—3.

*External characters.*—The animal curves outwardly along the dorsal surface. The length from the anterior side of the anterior adductor muscle to the posterior side of the posterior adductor muscle is 51 millim. and the depth 19.

The mantle lobes are joined together at the anterior side of the anterior adductor muscle. Then, separately, they pass with a curve around the anterior end, and proceed posteriorly until they reach a position a little anterior to the proximal portion of the siphon, where they become concresced, consequently, the pedal aperture occupies the anterior and nearly the whole of the ventral surface. Laterally, and some distance anteriorly to the posterior edge, the mantle lobes are connected on their inner sides with the proximal portion of the siphon, which enables them to contain the free portions of the siphon when contracted, and the greater portion of them when extended (fig. 1. *P.L.P.*)

In the specimens examined the free portions of the siphon are nearly enclosed, the exhalent (fig. 1. *Ex. S.*) portion being contracted, and folded on itself, and the inhalent one (fig. 1. *In. S.*) partly inverted, so that the

whole of it is withdrawn into the pallia chamber. The proximal portion of the siphon is short, but of greater depth than that of *Tagelus rufus*, while the free portions, though long and muscular, are shorter and thicker than those of the same species. Internally they show both longitudinal and fine transverse ribbing, but externally only the transverse ribbing.

There are large siphonal retractor muscles. The foot (fig. 1. *F.*) is massive and of medium length, being longer and of a more uniform depth than in *T. rufus*.

The gills reach to the proximal portion of the siphon. The inner sides of their bases are joined together, and divide the exhalent from the inhalent chamber. The teeth of the shell are buried in the viscera about the centre of the dorsal surface.

*Musculature.*—The musculus cruciformis (fig. 1, *M.C.*) is present at the extreme ventral edge of the siphon, but it is not so pronounced as in *T. rufus*.

i. *Pallial muscles.*—The muscles of the pallial edge commence at the anterior adductor muscle as a deep band, and gradually decrease in depth as they proceed posteriorly. The muscles of the siphon are strongly developed, and the siphonal retractor muscles, where they adhere to the valves of the shell, present a large surface.

The anterior adductor muscle (fig. 1, *A.A.*) is a broad, comparatively long, but shallow muscle, flattened dorsally, and curved ventrally. As in *T. rufus* it is divided by the ventral integument passing through it. The muscle is connected anteriorly with the mantle lobes, and posteriorly with the dorsal and ventral integuments.

The posterior adductor muscle (fig. 1, *P.A.*) is more oval in shape than that of *T. rufus*, and is joined anteriorly by connective tissue with the bifurcations of the pedis retractor posterior muscle and dorsal integument, and posteriorly with the dorsal integument, the siphon, and the mantle lobes.

Just below the siphon there are two transverse muscular bands—the musculus cruciformis of Von Ihering (fig. 1, *M.C.*), which quickly converge and unite at the centre, the four distal ends after passing through the mantle lobes, are attached to the valves of the shell, thereby resembling the same muscle found in *Solecurtus strigillatus*, but more particularly that in *T. rufus*, though on a very much smaller scale than the former, and in not having the posterior portion shortened as in the latter.

ii. *Pedal Muscles.*—The muscles of the foot are strongly developed, and structurally approximate nearer to those of *Pharella (Cultellus) orientalis* than those of *T. rufus*.

The pedis retractor anterior muscles run ventrally inside the longitudinal muscles (that is, they are exposed when viewed from the pedal cavity). The free portions are thick and short, and pass dorsally to the shell. There are no bifurcations.

The pedis retractor posterior muscle (fig. 1, *P.R.P.*) is also short and thick. The bifurcations are short too, and rest on the antero-dorsal surface of the posterior adductor, where they are connected with the valves of the shell.

There appears to be some indication of the presence of the branchial retractor muscles as noticed in *S. strigillatus*, but in the specimens examined they are so indistinct that it is impossible to state definitely whether they exist or not.

*Alimentary Canal.*—The lips (figs. 2 and 3, *A.L.* and *P.L.*) are broad and not very long. The oesophagus (figs 2 and 3, *Oe*) is short and soon opens into the oesophageal division of the stomach (figs. 2 and 3, *Oe. St.*). The latter is large and of irregular shape. Posteriorly it is separated from the cardiac (fig. 2, *C. St.*) and central (fig. 2, *C.D.*) divisions by a slight muscular ridge. On examining the left side of the stomach (fig. 2) it will be observed that the cardiac division, which is small, lies between the oesophageal and pyloric (figs. 2, *P.St.*) divisions, and antero-dorsally to the central division. Further the central division is bordered dorsally by a more muscular ridge (fig. 2, *M.P.*), the homologue of the muscular papilla of *Solen.* On the right side of the stomach (fig. 3) the demarcation of the cardiac division is incomplete. The pyloric division (figs, 2 and 3, *P. St.*) is large, and posteriorly proceeds as the caecum of the crystalline style (figs. 2 and 3, *C.C.*) The latter is also large, and, gradually curving, traverses anteriorly some distance along the pedal cavity.

The intestine (fig. 3, *In.*), as in *S. strigillatus* and *T. rufus*, appears as a groove on the right anterior side of the caecum of the crystalline style, but as far as can be made out, the projection of the muscular layer between the two cavities is greater, and consequently reducing the channel of communication. At the distal end of the caecum the intestine becomes distinct and returns a part of the way along the dorsal surface. Leaving the caecum, it pursues a loose folded course to the dorsal surface of the pyloric division, then, turning posteriorly, continues as the rectum (fig. 1, *R.*) over the posterior adductor muscle to the exhalent siphonal chamber.

The liver (fig. 1, *L.*) lies laterally and ventrally to the stomach, but by far the greater part is underneath it.

*Nervous system*—The nervous system seems to closely resemble that of *S. strigillatus*.

*The Gills.*—As in the species of *Solecurtus* examined by Dr. Ridewood, the lamellae are highly plicate, resembling more particularly those of *Solenocurtus (Tagelus) rufus*, in the interlamellar septa rising high up the demibranch, and in possessing a blood vessel at the apex of the plica. The number of filaments in a plica are, however, less. It is not possible to make out the structure in further detail as the gills are not well preserved.

**Solen corneus**, Lam.

Pl. x, fig. 4.

When compared with *S. vagina* shows the following differences:— The animal is not so muscular. The ventral part of the mantle lobes at the anterior end projects more anteriorly than the dorsal part (fig. 4, *M.L.*), whereas, in *S. vagina* they are not as angular. The anterior adductor muscle is proportionately not so wide, the distal portion of the foot is still shorter, and the posterior adductor muscle is much narrower, while the part of the animal posterior to the posterior adductor muscle is considerably longer. The internal structure apparently is the same.

**Solen gouldi**, COHR.

Pl. x, fig. 5.

Only one specimen of the above in the collection, which unfortunately had been pressed out of shape, and is in a very bad state of preservation.

It appears to be very similar to *S. vagina*, only differing from it in the anterior projection of the ventral portion of the anterior part of the mantle lobes (fig. 5, *M. L.*), more so than in *S. corneus*, Lam.

**Cultellus javanicus**. Lam.

Pl. x, fig. 6.

There are two specimens of the above in the collection, but, owing to their imperfect preservation, it is impossible to make out with any degree of certainty a great deal of the internal structure, particularly the alimentary canal.

The animal is slightly curved outwardly along the dorsal surface, and inwardly along the ventral surface, the centre of the latter being a little compressed. The anterior and posterior parts are tapered, and the ends rounded.

The mantle lobes are constricted along the whole of their ventral surface, so that the pedal aperture is confined altogether to the anterior end, and there is no fourth aperture. The muscles of the pallial edge form only a shallow band, and are not strongly developed. At the posterior end is the siphon, which likewise is not very muscular. In its proximal part the exhalent (fig. 6, *Ex. S.*) is separated from the inhalent chamber (fig. 6, *In. S.*) by a muscular wall, having its anterior side joined to the gills. The free portions of the siphon are very short, and encircled by a tentacular fringe.

The foot (fig. 6, *F.*), which at the distal end is axe-shaped, is long and of a nearly uniform depth.

The inside edges of the bases of the gills are joined together, while the outside edges have become disconnected with the pallial wall, as so frequently happens in the case of *S. vagina*.

One of the chief characteristics is the proportionately greater length of the posterior part of the animal.

The anterior adductor muscle (fig. 6, *A.A.*) is a somewhat oval shaped muscle, flattened dorsally, connected anteriorly with the mantle lobes, and posteriorly with the dorsal integument, and by connective tissue with the proximal portion of the foot.

The posterior adductor muscle (fig. 6, *P.A.*) is a comparatively wide and shallow muscle, connected anteriorly with the dorsal integument and the pedis posterior retractor muscle, and posteriorly with the dorsal integument and the siphon.

The retractor pedis anterior muscle, which is connected with the shell, is very short and not bifurcated, while the retractor pedis posterior muscle (fig. 6, *P.A.*) is very long, with long bifurcations, which are joined to the posterior adductor muscle and the valves of the shell.

As far as can be made out the alimentary canal has the appearance of consisting of a short oesophagus, large stomach with the usual divisions, and the caecum of the crystalline style and the first portion of the intestine either possessing separate passages with the outside of the organs joined together, or communicating with each other as in *S. strigillatus* and *dombeyi*.

**Solen delerscoti**, Chemn.

*S. delerscoti* is very short, the length being not more than three and a half times the depth, and, judging from the specimens examined, a much smaller animal than *S. vagina*—though it has the appearance of being comparatively largely built, with a large foot and siphon. It very closely resembles *S. vagina*, differing from it in the shortness of the anterior part, particularly the anterior adductor muscle, and the greater length of the posterior part, more especially the proximal portion of the siphon. The specimens are not in a good state of preservation, but as far as can be seen of the alimentary canal, the only noticeable point is that the caecum of the crystalline style does not extend as far anteriorly along the pedal cavity.

**Solen (Solena) rudis**, C. B. Adams.

Pl. x, figs. 7—9.

*External characters.*—The specimen was removed from the shell before being sent to me. The animal measures 7 c.m. from the anterior end of the mantle lobes to the posterior end of the posterior adductor muscle, and 21 millim. from the dorsal to the ventral surface. It is nearly of a uniform depth.

The mantle lobes are constricted along their ventral surface. The pedal aperture is situated at the anterior end and does not extend posteriorly, either dorsally or ventrally. The periostracum is only attached to the mantle lobes bordering the pedal aperture. Inside the lobes are two muscular flaps, which close the pedal aperture when necessary. There is no fourth aperture.

At the posterior end the mantle lobes form the proximal portion of the

siphon (fig. 7, *In. S* & *Ex. S.*). The latter is of considerable length and very muscular. Nearly the whole of the free portion is missing, so it is not possible to form any idea as to its length, or to say, if the exhalent portion is separate from the inhalent one as in *S. strigillatus* (fig. 7, *Ex. S'* and *In. S'*).

The labial palps are relatively short and wide. The gills pass posteriorly from the labial palps to the posterior end of the proximal portion of the siphon, and, on the outside of them, the bases are connected with the lateral siphonal ridges (fig. 7, *S R.*), while on the inside they are joined together as in *S. strigillatus*.

A strong muscular dorsal integument is present resembling that of *Solen* and *Ensis*.

The kidneys extend slightly laterally along the mantle lobes as in *S. strigillatus*.

The foot (fig. 1, *F.*) is long and of nearly uniform depth. It, however, gradually increases in width towards the distal end, near which it is almost round, but suddenly tapers off at the extremity.

*i. Pallial muscles.*—The muscles of the mantle lobes form a deep band of muscles lying at right angles to the pallial edge, and are further strengthened by a band of longitudinal muscles along the concresced ventral part. The proximal portion of the siphon (fig. 7, *Ex. S.* and *In. S.*) is long, the arrangement of the muscles being similar to that of *S. strigillatus*, viz., large longitudinal muscles, covered internally by a muscular lining, and externally by the muscular integument.

Anteriorly the longitudinal muscles converge to form the siphonal retractor muscles, but they do not present nearly so large a surface where they adhere to the shell as in *S. strigillatus*. Between the proximal portion of the siphon and that representing the free portion are two muscular flaps or valves. This applies to the exhalent as well as to the inhalent chamber.

The anterior adductor muscle (fig. 7, *A.A.*) is a broad and deep muscle, flattened dorsally, and curved ventrally. It is joined anteriorly with the dorsal integument and mantle lobes, and posteriorly with the ventral integument. The posterior adductor muscle (fig. 7, *P.A.*) is similar to the anterior adductor muscle, but is not so deep. It is joined anteriorly with the retractor pedis posterior muscle and the dorsal integument, and posteriorly with the siphon, the mantle lobes, and the dorsal integument.

*ii. Pedal muscles.*—The longitudinal muscles of the foot are strongly developed and interspersed with a great number of transverse ones, the latter, however, are not so numerous as in *S. strigillatus*, but more so than in *Solen*.

The free portions of the retractor pedis anterior muscles (fig. 7, *P.R.A.*) are short and large. When the muscle reaches the foot it spreads out ventrally, and passes between the longitudinal pedal muscles, and the pedal integument.

The pedis retractor posterior muscle (fig. 7, *P.R.P.*) is short and bifurcated at the free end. The bifurcations pass over the anterior part of the posterior adductor muscle. The muscle on reaching the foot continues as the longitudinal pedal muscles.

*Alimentary Canal.*—The lips (figs. 8 and 9, *A.L.* and *P.L.*), formed by the labial palps, are comparatively wide and project anteriorly.

The oesophagus (fig. 8 and 9, *Oe.*) is of medium length, proceeds posteriorly, and opens into the oesophageal part of the stomach. The oesophageal division (figs. 8 and 9, *Oe. St.*) is long and narrow, and dorsally is almost completely separated from the cardiac division by a thick muscular tissue (figs. 8 and 9, *Oe. C.R.*) passing right across the stomach, while on the left side, at the posterior end, is the central division (fig. 8, *C.D.*). The cardiac division (figs. 8 and 9, *C. St.*) lies dorsally to the oesophageal one, and on the left side is separated from the pyloric division by the ridge of the central division and another ridge proceeding dorsally from the muscular papilla (fig. 8, *M.P.*). On the right side of the stomach of the specimen examined the separation of the oesophageal, cardiac, and pyloric divisions from each other is not so clearly defined. The pyloric division (figs. 8 & 9, *P.St.*) at its posterior end, continues as the caecum of the crystalline style, (figs. 8 and 9, *C.C.*). It is large and long, passing with a large curve, first ventrally, then anteriorly, and terminating near the dorsal surface of the pedal cavity.

The intestine (fig. 7, *In*) leaves the pyloric division slightly to the right of the anterior side of the caecum of the crystalline style. It forms a large number of folds ventrally to the stomach, and, in a more or less folded condition, passes along the dorsal surface of the caecum, returning along its ventral surface, then, taking a large curve goes to the dorsal side of the pyloric division, makes on it a large loop, and, turning posteriorly, proceeds as the rectum (fig. 7, *R.*) It terminates at the posterior side of the posterior adductor muscle with a bi-lobed anus (fig. 7, *A.*).

The liver (fig. 7, *L.*) lies closely to the stomach extending down the sides and along the greater portion of oesophagus, but the mass of it is underneath the stomach. The large bile-duct enters the central division, and the smaller one on the ventral surface of the oesophageal division, under the muscular ridge separating it from the cardiac division.

*Nervous system.*—The cerebro-pleural ganglia are situated close to the ventral integument, laterally to the mouth. They are joined to each other by a commissure running just in front of the mouth. Anteriorly each ganglion gives rise to only one anterior pallial nerve, which passes along the ventral integument, then under the anterior adductor muscle to the mantle lobe. Posteriorly the ganglion gives off the cerebro-pedal and cerebro-visceral connectives, the latter passes between the viscera and the pedal integument to the retractor pedis posterior muscle, penetrates its wall, and, emerging, goes along the ventral surface to a visceroparietal ganglion.

The visceroparietal ganglia are situated anteriorly to the posterior adductor muscle, and between the bifurcations of the retractor pedis posterior muscle. The branchial nerves run laterally direct to the gills. Each ganglion apparently gives rise to one posterior pallial nerve, which passes along the ventral surface of the posterior adductor muscle to the proximal portion of the siphon. There do not seem to be so many large branches as in *S. strigillatus*. It is not possible to make out the pedal ganglia or the circumpallial nerves.

*Circulatory system.*—The heart is situated over the protractor pedis posterior muscle, more posteriorly than in *S. strigillatus*.

On the structure of the gills of *Solen* Ridewood states that "in the five species of *Solen* examined the lamellae are heterorhabdic and plicate, the plication being shallower in *Solen orientalis* than in the others. The numbers of filaments in a plica are nearly the same in the two demibranchs and run approximately 26 in *Solen vagina*, 17 in *Solen ensis*, 12 in *Solen jonesi*, 22 in *Solen (Solena) rudis* and 16 in *Solen (Pharella) orientalis*. In *Solen rudis* alternate interlamellar septa fail to reach more than half-way up the demibranch, but in all the other four species rise high."

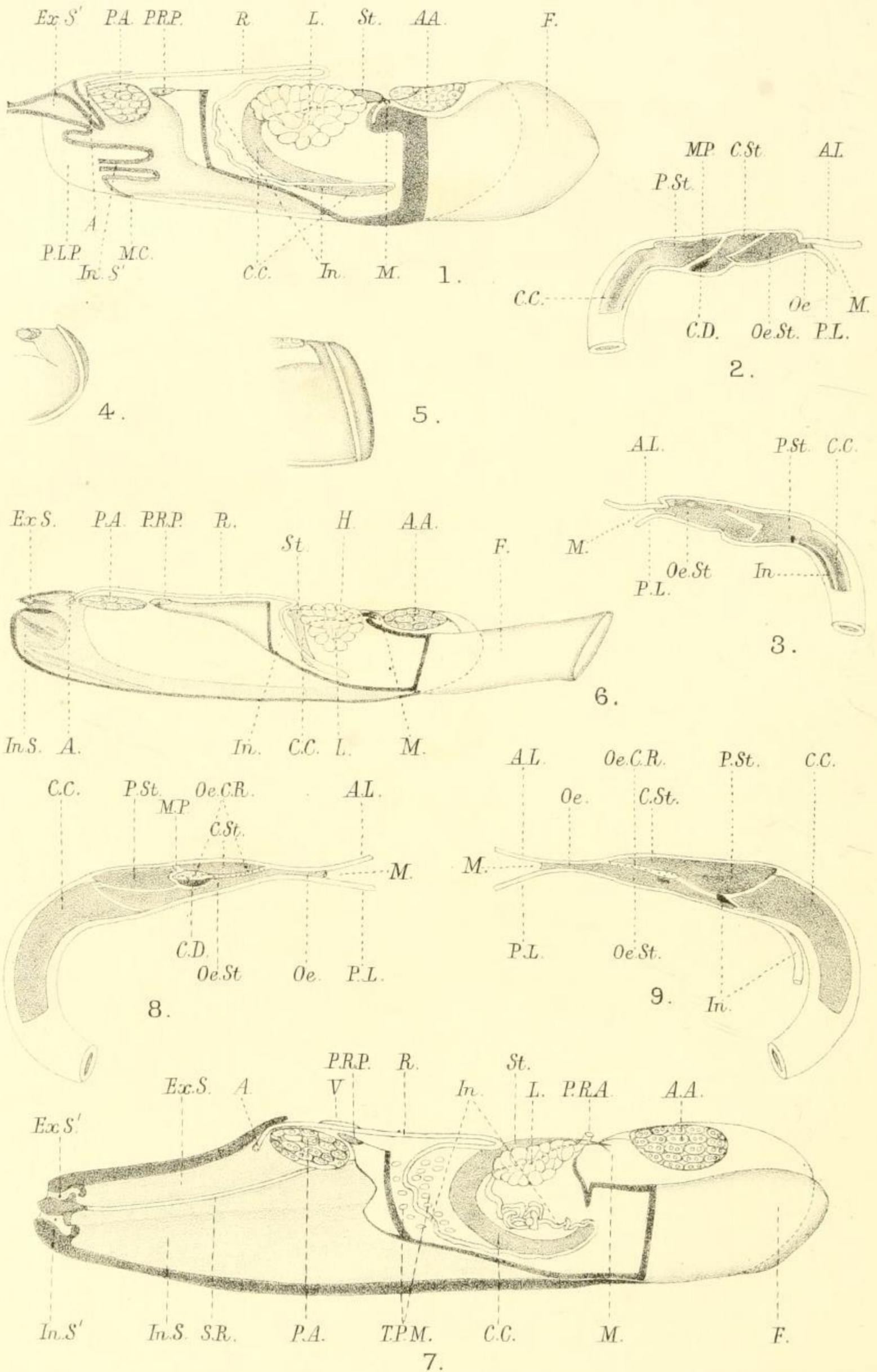
## EXPLANATION OF PLATE X.

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|---------|---|--|
| Fig. 1. | <i>Solcuretus dombeyi</i> , Lam.          | View from the right side, showing the alimentary canal, &c. Natural size.                                  |
| Fig. 2. | " "                                       | Longitudinal section of the stomach, showing internal structure of the left side. $\times 1\frac{1}{2}$ .  |
| Fig. 3. | " "                                       | Longitudinal section of the stomach, showing internal structure of the right side. $\times 1\frac{1}{2}$ . |
| Fig. 4. | <i>Solen corneus</i> , Lam.               | External view of the anterior end of the right mantle lobe.  |
| Fig. 5. | <i>Solen gouldi</i> , Conr.               | External view of the anterior end of the right mantle lobe.  |
| Fig. 6. | <i>Cultellus javanicus</i> , Lam.         | View from the right side, showing the alimentary canal, &c. Natural size.                                  |
| Fig. 7. | <i>Solen (Solena) rudis</i> , C. B. Adams | View from the right side, showing the alimentary canal, &c. Natural size.                                  |
| Fig. 8. | " "                                       | Longitudinal section of the stomach, showing internal structure of the left side. $\times 2$ .             |
| Fig. 9. | " "                                       | Longitudinal section of the stomach, showing internal structure of the right side. $\times 2$ .            |

## REFERENCE LETTERS.

<i>A.</i>	Anus.	<i>M.P.</i>	Portion of muscular ridge representing the muscular papilla of <i>Solen</i> and <i>Ensis</i> .
<i>A.A.</i>	Anterior adductor muscle.	<i>Oe.</i>	Oesophagus.
<i>A.L.</i>	Anterior or upper lip.	<i>Oe. C.R.</i>	Muscular ridge separating the oesophageal from the cardiac division of the stomach.
<i>C.C.</i>	Caecum of crystalline style.	<i>Oe. St.</i>	Oesophageal division of the stomach.
<i>C.D.</i>	Central division of the stomach.	<i>P.A.</i>	Posterior adductor muscle.
<i>C. St.</i>	Cardiac division of the stomach.	<i>P.R.A.</i>	Retractor pedis posterior muscle.
<i>Ex. S.</i>	Proximal portion of the exhalent siphonal chamber.	<i>P.L.</i>	Posterior or lower lip.
<i>Ex. S'.</i>	Representing the part present of the free portion of the exhalent siphonal chamber.	<i>P. St.</i>	Pyloric division of the stomach.
<i>F.</i>	Foot.	<i>R.</i>	Rectum.
<i>In.</i>	Intestine.	<i>S.R.</i>	Ridge dividing the inhalent from the exhalent chamber of the proximal portion of the siphon.
<i>In. S.</i>	Proximal portion of the inhalent siphonal chamber.	<i>St.</i>	Stomach.
<i>In. S'.</i>	Representing the part present of the free portion of the inhalent siphonal chamber.	<i>T.P.M.</i>	Transverse pedal muscles.
<i>L.</i>	Liver.	<i>V.</i>	Ventricle.
<i>M.</i>	Mouth.		





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Huth, Lith<sup>r</sup> London.

ANATOMY OF CERTAIN SPECIES OF SOLENIDAE.