

ON A NEW SCLEROSTOME FROM THE  
LARGE INTESTINE OF MULES

BY

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*S. tetracanthum*, combined with its weaker depletory efforts, had more to do with the death of some of the animals examined than the loss of blood occasioned by this larger species.

It is likely enough that this species too encysts, as all met with were mature; but the *Trichonemes* would probably be indistinguishable from those of *S. tetracanthum*, which was always associated with it, and it would require a case in which this species was alone present to establish this point, and to make out any differences that may exist between their *Trichnema* stages. Their free stage life-history is also probably similar; but from the size I have recorded for the ova, I am satisfied that it was at any rate mainly with *S. tetracanthum* that my cultivations were concerned.

**Description.—*Sclerostomum robustum*. sp. n.**

Male about 13 mm. long by 0·8 mm. at the thickest part, which is situated about the middle of the body.

Female about 22 mm. long by 1·1 mm. at the thickest part, which is a little in front of the middle of the body.

The male is more tapered anteriorly than posteriorly, while the female is equally so. Both sexes are usually tinged a rather deep reddish brown from the blood on which they feed. Head subglobose, with a slightly constricted neck.

The margin of the oral aperture is irregularly tuberculated, and carries four papillæ armed with soft setæ, which, from the large nerve fibres that can be traced to them, are probably tactile in function. Within the tubercular margin is a circlet of vertically placed denticles forming a trephine, like that of *S. equinum*, only the teeth are much larger and less numerous (about 18). Within this, guarding the oral aperture, are a series of horizontally placed fimbriæ (about 48 in number). These almost meet in the centre, so as to nearly close the opening of the mouth. Below this, is a cup-shaped cavity which ends below in the opening of the thick muscular pharynx, within the entrance of which are three powerful, exactly similar teeth. Each of these teeth presents a falciform crown, placed on a considerably longer and stouter root, which latter is fixed in a sort of sheath-like pocket of the pharyngeal wall. They are probably capable of being protruded.

The bursa copulatrix of the male is markedly bilobed, no trace of a median lobe being present, though the dorsal fissure is not very deep. Ventral costa bifid, combined with the ventro-lateral, and lateral costæ to form a group, the lateral consisting of two subequal branches, with occasionally a smaller branch placed near their roots on the dorsal edge of the costa. Dorso-lateral, and dorsal costæ alike deeply bifid, and combined together to form a group of four, of which, the most anterior division of the dorso-lateral is considerably the largest, while the remaining three are subequal. Caudal extremity of female, rather abruptly mucronate: anus close to the point of the tail: vulva about one millimeter in

front of it. Ova very large, of regularly elliptical outline, 0·152 mm. in length × 0·082 in breadth; laid as a morula.

*Sclerostomum equinum* (Rud.)

I will first quote the description given in Diesing,<sup>1</sup> and will then add some fuller details derived from the examination of a male specimen, from a verminous aneurism of the mule:—

"CAPUT *globosum truncatum; os limbo denticulis rectis dense armato. CORPUS rectum retrorsum attenuatum, bursa maris triloba, lobo intermedio minore, lobis singulis quadriradiatis, radiis lanceolatis; extremitate caudali feminæ obtusiuscula, apertura genitali in tertia parte corporis postica. OVULA elliptica medio constricta. COPULA sub angulo recto admissa.*

*Longit. mar., 1" (26 mm.); fem. 1½—2" (—52 mm.)."*

Unfortunately I was unable to find among my materials any mature intestinal specimens; but the specimen taken from an aneurism agreed in all points with the above descriptions except, of course, that, in length, it coincides with the measurements he gives for his Var. *Minor aneurismaticus*. The most advanced intestinal specimens of *S. equinum* that I have been able to discover among my collections are still far from mature, and differ in no way save in size from the aneurismal specimens described below. Only a very few ova approaching maturity could be found, and these wanted still the median constriction, and had evidently not reached their full size, being about the size of the ova *Dochmius duodenalis*, measuring but 0·067 mm. in length.

In the specimen figured, the margin of the mouth carried six, nearly equidistant, tactile papillæ, exactly similar in structure to those of the previous species. On one side, showing through the skin, may be seen a long powerful buccal tooth, shaped like a rat's incisor. Within the six marginal papillæ is the cirlet of the boring trephine, which is armed with minute, but proportionally stout, semi-circular teeth. Within this again are the horizontal fimbriæ, guarding the opening of the mouth, which are exactly similar in number and form to those of the preceding species. The buccal cavity too is of nearly the same form, though rather more funnel-shaped; while the armature of the entrance of the pharynx is quite different, and very peculiar.

This consists of two great teeth; but, instead of being arranged at equal intervals round the entrance of the pharynx, they are placed, one behind the other, on the same side. The outer tooth, the form of which has been already described, is enclosed in a sheath, formed in the wall of the buccal cavity; while the inner tooth forms an unilateral projection from the margin of the opening of the pharynx.

This latter is bidentate and nearly three times as wide as the outer tooth, though less than half as long. It is very stoutly made, and carries on its axial face a low ridge, irregularly tuberculated on both edges, running down from the

<sup>1</sup> Diesing: *Systema Helminthum* (1851), Vol. II, page 303.

notch between the dentations, and broadening out below, where it meets the circllet of denticles guarding the actual entrance of the pharynx. These last consist of a circllet of chitinous plates, rather larger than those of the triphine, but of very irregular shape, especially those on the side opposite to the great tooth.

The male bursa copulatrix is, as will be seen from the figure, markedly trilobed, the lateral lobes being rounded, while the median lobe is pointed, though somewhat abruptly so. The ventral and ventro-lateral costæ form a group almost exactly similar to that formed by the corresponding costæ of the preceding species. The dorso-lateral consist of one large and one small branch, which embrace between them the notch between the median and lateral lobes; while the dorsal costæ are also represented by two branches, the inner of which has a small rudimentary branch on its inner margin, rather nearer its root than its point.

*Sclerostomum tetracanthum* Dies.

*Descriptions.*—This species differs considerably from the preceding, and is, in some respects, more nearly allied to *Æsophagostoma columbianum*, an ovine parasite, to be described below, as the cause of nodular disease of the intestine in sheep. This resemblance is most marked in the arrangement of the parts about the external mouth opening; but, at the same time the two species cannot be considered to be congeneric, as the present species has a shallow, but at the same time distinct, buccal cup; whereas in *Æsophagostoma* the armed peristome is followed immediately by the œsophagus.

Diesing's<sup>1</sup> description is as follows:—

"CAPUT truncatum; oris limbo interno denticulis rectis densis, externo aculeis 4 majoribus obtusis cruciatim dispositis armato.

"CORPUS rectum utrinque attenuatum, bursa maris triloba, lobo intermedio valde producto, lobis singulis multiradiatis, radiis furcatis; extremitate caudali fœminæ recta, truncata, breve mucronata, apertura genitali supra caudæ apicem. Copula sub angulo recto admissa."

This description is quite sufficient to identify the species; but, for purposes of contrast with the other species, the following details may be added:—

Cobbold's<sup>2</sup> remarks:—

"The fore-gut has a complicated structure, more strikingly so than has hitherto been stated. The mouth leads into a strong buccal cup, supporting a circular series of short bristles (described and figured by Schneider, but only indicated by a dark line in my (Cobbold's) drawing), which separately have an extreme length of  $\frac{7}{16}$  of an inch. The cup rests upon a muscular ring, which also supports a circular row ( $o^1$  in the present figure) of small chitinous processes. The ring is succeeded by an anterior œsophageal bulb the lumen of which is bordered by chitin plates ( $o^2$  in the present figure).

<sup>1</sup> DIESING: *Loc. cit.*, Vol. II, page 305.

<sup>2</sup> DR. T. S. COBBOLD.—*Journal Linn. Soc.*, London, XIX, 1886, pages 284—93. It is remarkable that Cobbold in this paper, which I have recently obtained, with true and scientific insight, actually foretells as probable some of the points established in the preceding paper.

"Then follows a broad muscular pharynx (*p* in the present figure), through which the narrow chitinous cylinder of the lumen (*sic*) glimmers distinctly, leading down to the somewhat broader posterior bulb, which also displays thick dental plates."

This description deals only within the mouth parts below the level of the "straight denticles" (*f* in my figure) described by Diesing, Schneider's series of bristles being that marked (*b*) in my figure. Thus we have from without inwards—

*First*.—The four great labial spines, occupying the position of the tactile papillæ of the other species, but forming, in this, formidable weapons.

Next comes the rank of horizontal fimbriæ, present in all three species, and also in *Æsophagostoma columbianum* Curtice, described below. These fimbriæ are very characteristic of the sclerostomes, and are often described as teeth. They are, however, long thin plates, and do not in any way function as teeth, but rather as a sort of sieve, between the plates of which blood corpuscles and other fine particles suitable for food can pass easily, but which serve to exclude all the coarser intestinal matter with which the animals are surrounded.

We now come to the buccal cup proper, armed with Schneider's Bristles, and corresponding to the circlet of bidentate teeth of *Æsophagostoma columbianum*. The boundary between the buccal cup, and Cobbold's anterior œsophageal bulb is marked by a circlet of somewhat irregularly-shaped chitinous plates, mostly rather broader at their free edges than at their origin; and, in the same way, the junction of the bulb with the pharynx is marked with a second row of more regularly shaped plates, each of which consists of a flat, stout plate, of semi-circular outline, with a small tubercle forming a point to the crown.

The ova of *S. tetracanthum* have a very characteristic oblong outline, rather exaggerating the flattened sides, in fact, of *Dochmius duodenalis*, but are much larger, measuring  $0.1 \times 0.05$  mm. They are usually laid as a many-segmented morula. Large as they are, they cannot possibly be mistaken for the very much larger and elliptical eggs of the new *S. robustum*.

The form of the male bursa varies considerably, while always remaining of the same type.

There is no distinct notch between the lateral and median lobes, as in *S. armatum*; but the median forms a bold curve back from the laterals and, especially in small specimens, is often prolonged to a long point. In other specimens again the median lobe is comparatively short and blunt. I figure two specimens, illustrating this variability, and neither is an extreme instance of the forms they represent. With this variability the relative lengths of the dorsal and lateral groups of rays also vary. Their arrangement, however, remains the same, the dorsal costæ being bifid, the outer divisions considerably shorter. They form, with the simple dorso-lateral, a distinct group.

The lateral, ventro-lateral and ventral costæ form two other compact, paired groups, in which the anterior division of the bifid lateral far exceeds the



other members of the group in size. Between the dorso-lateral and lateral costæ are deep and broad semi-circular hollows, which are occupied, on either side, by a single large granular cell, probably of glandular character. I can find no previous notice of this gland cell, which is very easily seen in many specimens, and can only with difficulty be made out in others, its variable prominence probably corresponding to various stages in its secretive functions; the cell full of secretion being easily visible, while that which has recently discharged its contents being with difficulty so. In connection too with variations in the bursa, it may be mentioned that Cobbold (*loc. cit.*) mentions the occasional presence of an additional branch to the dorsal costæ, which may be nearly as long as the primary branch itself.

The figures given in the plates are all from original camera lucida drawings, and can therefore be trusted for the purpose of obtaining measurements of the various parts represented. Combined with the foregoing descriptions I do not think that any difficulty need be found in distinguishing the three species; nor do I think that any doubt can be felt of their specific distinctness.

At the same time, while to minute examination the differences are sufficiently obvious, it is by no means easy to distinguish between the three species by mere naked-eye examination. Between full-sized specimens of *S. equinum* on the one hand, and small specimens of *S. tetracanthum* on the other, *S. robustum* is easily distinguishable; but, in all three species the range of size is so considerable that it is extremely difficult to separate large specimens of *S. tetracanthum*, and immature intestinal *S. equinum* from the newly described species: indeed, short of absolute dissection and microscopical examination, I believe it to be impossible to do so. As a good naked-eye method of distinguishing between *S. robustum* and immature *S. equinum*, I may mention that the latter are usually much darker in colour, the small development of the generative organs permitting the blood filling the intestinal canal to be seen more easily through the skin than is the case with the mature *S. robustum* of the same size, where the intestinal canal forms but a very small proportion of the bulk of the body.

It is doubtless owing to its close external resemblance to the two species so commonly associated with it that it has not hitherto been recognised as a distinct species; and I shall not be surprised to hear that, now that attention has been directed to the point, it will sooner or later be found that its distribution is by no means confined to India.

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SANAWAR:  
*The 21st November 1891.*

# Explanation of Plate

## The three sclerostomes found in the edine large intestine.

I.—*Sclerostomum robustum* sp. n. Figs. 1—5.

- FIG. 1. Female and male specimens, natural size.  
 1a. Lines showing length of above.  
 " A pair in copula  $\times 6$  diams.  
 " Drawing of a preparation formed by splitting the anterior extremity of the worm  $\times 70$  diams.—  
 3. Circle of tubercles surrounding the mouth.  
 c. Coronet of chitinous denticles forming a tripling like that of *S. edinum*.  
 4. The four tactile papillae.  
 \ Circle of fimbriae surrounding the upper limit of the oral cup.  
 o. The three large buccal teeth.  
 p. Pharynx.  
 4. Bursa copulatrix of male spread out  $\times 30$  diams.  
 5. Ovary from uterus  $\times 440$  diameters. This figure is doubtless unnecessarily magnified, but is so represented for purposes of comparison with other ova delineated in this series.

II.—*Sclerostomum tetraentatum* Dies. (Figs. 6—11).

- FIG. 6. Two lines representing the length of female and male specimens.  
 7. Head showing the four spines  $\times 170$  diams.  
 8. One-half of a split preparation of the anterior extremity of the body  $\times 440$  diams.—  
 2. The four labial spines.  
 \ Circle of fimbriae surrounding upper limit of oral cup.  
 b. Schaeffer's circle of denticles.  
 1. \ Anterior and posterior circle of esophageal denticles.  
 p. Pharynx.  
 FIG. 9 & 10. Two specimens of male bursa copulatrix showing variability of outline  $\times 70$  diams. p. unicellular gland.  
 FIG. 11. Ovary from uterus  $\times 440$  diams.

III.—*Sclerostomum spinum* (Rud). (Figs. 12—15).

- FIG. 12. Lines representing the length of female and male of mature or intestinal stage.  
 13. Head  $\times 70$  diams. from a specimen taken from a vermiform aneurism from a male.  
 14. Split preparation of anterior extremity of the same  $\times 70$  diams.—  
 \ External circle of trephine denticles.  
 \ Circle of fimbriae guarding opening of oral cup.  
 4. The six tactile papillae.  
 2. The great external spine.  
 o. The great bidentate buccal tooth.  
 3. The circle of pharyngeal denticles.  
 12. Male bursa copulatrix  $\times 30$  diams.

## Explanation of Plate.

### The three sclerostomes found in the equine large intestine.

#### I.—*Sclerostomum robustum* sp. n. Figs. 1—5.

- FIG. 1. Female and male specimens, natural size.  
" 1a. Lines showing length of above.  
" 2. A pair *in copula* × 6 diams.  
" 3. Drawing of a preparation formed by splitting the anterior extremity of the worm × 70 diams.—  
    *t.* Circling of tubercles surrounding the mouth.  
    *c.* Coronet of chitinous denticles forming a triphine, like that of *S. equinum*.  
    *t, p.* The four tactile papillæ.  
    *f.* Circling of fimbriæ surrounding the upper limit of the oral cup.  
    *o.* The three large buccal teeth.  
    *p.* Pharynx.  
" 4. Bursa copulatrix of male spread out, × 30 diams.  
" 5. Ovum from uterus × 440 diameters. This figure is doubtless unnecessarily magnified, but is so represented for purposes of comparison with other ova delineated in this series.

#### II.—*Sclerostomum tetracanthum* Dies. (Figs. 6—11).

- FIG. 6. Two lines representing the length of female and male specimens.  
" 7. Head showing the four spines × 170 diams.  
" 8. One-half of a split preparation of the anterior extremity of the body × 440 diams.—  
    *s.s.* The four labial spines.  
    *f.* Circling of fimbriæ surrounding upper limit of oral cup.  
    *b.* Schneider's circling of denticles.  
    *o<sup>1</sup>.* ♂ *o<sup>2</sup>.* Anterior and posterior circling of œsophageal denticles.  
    *p.* Pharynx.

FIGS. 9 & 10. Two specimens of male bursa copulatrix showing variability of outline × 70 diams. *g.* unicellular gland.

FIG. 11. Ovum from uterus × 440 diams.

#### III.—*Sclerostomum equinum* (Rud.) (Figs. 12—15).

- FIG. 12. Lines representing the length of female and male of mature, or intestinal stage.  
" 13. Head × 70 diams. from a specimen taken from a verminous aneurism from a mule.  
" 14. Split preparation of anterior extremity of the same × 70 diams.—  
    *t* External circling of trephine denticles.  
    *f.* Circling of fimbriæ guarding opening of oral cup.  
    *t, p.* The six tactile papillæ.  
    *s.* The great external spine.  
    *o.* The great bidentate buccal tooth.  
    *o<sup>2</sup>.* The circling of pharyngeal denticles.  
" 15. Male bursa copulatrix × 30 diams.





