5. On the Scolex in the Cestode Genus *Duthiersia*, and on the Species of that Genus. By Frank E. Beddard, M.A., D.Sc., F.R.S., F.Z.S.

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(Text-figures 1–5.)

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The genus *Duthiersia* is fairly well known to us from the investigations of authors whose several contributions are quoted later *, but there still remain a few points to which attention has not yet been directed, or concerning which there is up to the present some difference of opinion.

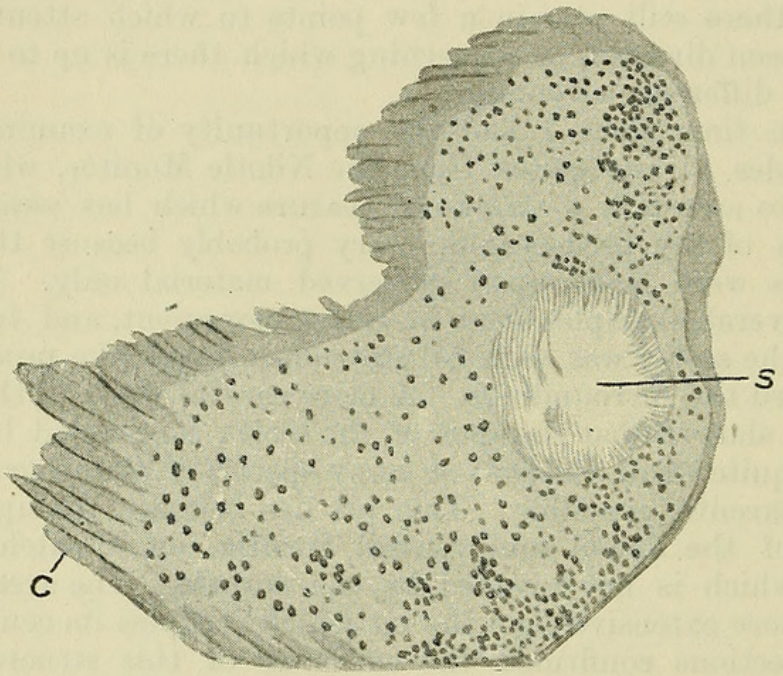
Some little time since I had the opportunity of examining living examples of the genus from the Nilotic Monitor, which enabled me to ascertain a structural feature which has escaped the attention of my predecessors—very probably because their investigations were made upon preserved material only. The scolices of several examples were in active movement, and from the apex of the scolex was seen to protrude a finger-like process which explored the surroundings. A more careful study of these living worms showed that the apex of the scolex is occupied by a circular pit, quite small like that of many species of *Ichthyotænia*, which is apparently eversible. This pit lies between the upper extremities of the dorsal and ventral bothria, on a patch of integument which is not invaded by the bothria. The area in question is more extensive than the pit which occupies its centre. Transverse sections confirmed the existence of this structure, which has not yet been described in the genus *Duthiersia*. The pit is so small that it only appeared in two sections of one series which I prepared, and only in five of another (thinner) series. And as these are naturally the very first sections of the series and very small in area, the apical pit might be easily missed, and possibly has been.

The two series of sections referred to were transverse. I have also found the apical pit in horizontal sections through the scolex. In all of these it appears as a mere pit ; certain special structures (text-fig. 1, *s*) were to be observed in the shape of delicate filaments arising from the margin of the pit, possibly of a sensory nature. As to the protrusion of the entire apex of the papilla, I believe it to consist of the tissues surrounding the pit as it was too large to be a mere eversion of that orifice. But possibly the pit was also everted, a fact of which I am not able to speak with certainty. The apical pit appears to me to be of a sensory nature, and thus

* Page 75, footnotes.

perhaps does not bear any relation to the rostellum of other Cestodes. Related genera belonging to the same division of the Cestodes (*i. e.* Pseudophyllidea) throw no light upon this question. It is true that an apical depression has been described in other genera; but where this has been carefully investigated it would appear to be produced simply by an apical fusion—or nearly complete fusion—of the lateral bothria. Thus, in *Bothriomonus* *, the presence of a dividing septum shows that the apical vertical slit is merely the abbreviated remains of the two bothria. Were the septum absent the homology of the depression in question might be more doubtful; I therefore believe this apical sensory (?) organ to be new to the Pseudophyllidea.

Text-figure 1.



A transverse section through the apex of the scolex of *Duthiersia fimbriata*.

c, cuticle; *s*, apical sense-organ.

While I found this structure in examples of *Duthiersia* from *Monitor niloticus*, I examined other specimens of *Duthiersia* in vain.

Two series of transverse sections of the scolex of specimens from *Monitor bengalensis* showed absolutely no trace of the organ. As these were much larger scolices, the probability of my having failed to recognise the organ is thereby reduced. I have in fact little doubt that the apical pit is in those specimens quite undeveloped. A comparison in other ways between the specimens from the two species of Monitors showed plainly that we have here to deal with two undoubtedly distinct species of *Duthiersia*.

* Cholodkovsky, Annuaire Mus. Zool. de l'Acad. Imp. Sci. Petrograd, xix. 1914, p. 520, figs. 6, 7.

This is not a novel conclusion; but it is not accepted by the majority of recent writers. Perrier*, the original describer of the genus, found differences in examples from different species of *Monitor* and recognised two species, viz. *Duthiersia expansa* from Eastern species of *Monitor*, and *D. elegans* from African. Perrier was perfectly right, and the majority of his successors are quite wrong. The confusion of two distinct species is connected with various assertions with regard to the form of the bothria in this genus. It will be necessary to clear up this confusion. In *D. expansa* the form of the scolex is more spear-shaped than in the other species, as is plainly shown in Perrier's figures. The bothrium on each side is closed posteriorly and opens again by a minute pore closely adpressed to the commencing strobila, thus producing a tube-shaped bothrium open widely in front and by but a narrow orifice posteriorly; this funnel-like arrangement has been justly compared by many to the tube-like bothria of *Bothridium* (*Solenophorus*). According to Perrier the same orifice exists posteriorly in *D. elegans*, but at some distance laterally from the fusion of the bothria with the strobila. Monticelli and Crety †, who examined only examples of *Duthiersia* from an Indian Monitor, confirmed the existence of the posterior pore in that worm; and, inferring its existence also in examples from *Monitor niloticus* from Perrier's statements, united both these worms into one species under the name of *Duthiersia fimbriata*; this name was given by Diesing ‡ to what he regarded as a species of *Solenophorus*, though tabulated as "species inquirenda." Diesing made his observations upon Perrier's "species" *D. elegans*. Just previously to the memoir of Monticelli and Crety, Lühe § took the opposite view and denied the posterior orifice of the bothrium, but agreed with the first mentioned authors in regarding the Cestodes from all species of *Monitor* as belonging to one species only, namely (of course) *D. fimbriata*. This view is accepted by Braun ‖ in Bronn's 'Thierreich,' who, in defining the genus *Duthiersia*, described the hinder region of the bothrium as "*nicht* perforirt," the italics being his own. It is true that in earlier numbers of the same volume Braun accepted Perrier's statements and even used his figures, but later altered his opinion by reason of Lühe's observations. Still later Shipley ¶ re-asserted the existence of a posterior opening of the bothria in specimens from *Monitor salvator* and *M. bengalensis*, as did Southwell ** "In *Varanus* spp." The latter regards as synonyms both of Perrier's species. Klaptocz ††, however, in 1906 again definitely denied the existence of the posterior orifice in the bothria of *Duthiersia* from

* Arch. de Zool. Expér. ii. 1873, p. 349.
† Mem. R. Acc. Sci. Torino, (2) xli. 1891, p. 381.
‡ Sitzungsb. Wien. Ak. xiii. 1854, p. 589.
§ Verh. Deutsch. Zool. Ges. 1899. p. 48.
‖ Klassen u. Ordn. des Thierreichs, Vermes, Bd. iv. Abth. 1 B. p. 1689.
¶ Spolia Zeyl. i. 1903, p. 47.
** Rec. Indian Mus. ix. pt. v. 1913, p. 281.
†† Sitzungsb. Wien. Ak. cxv. 1906, p. 133.

Monitor niloticus. The latest statement known to me is that of Cholodkovsky *, who has defined *Duthiersia* by (*inter alia*) the fact that the "Bothridia have the appearance of a funnel with blind narrow ends formed behind." This definition presumably implies the existence of only one species of the genus.

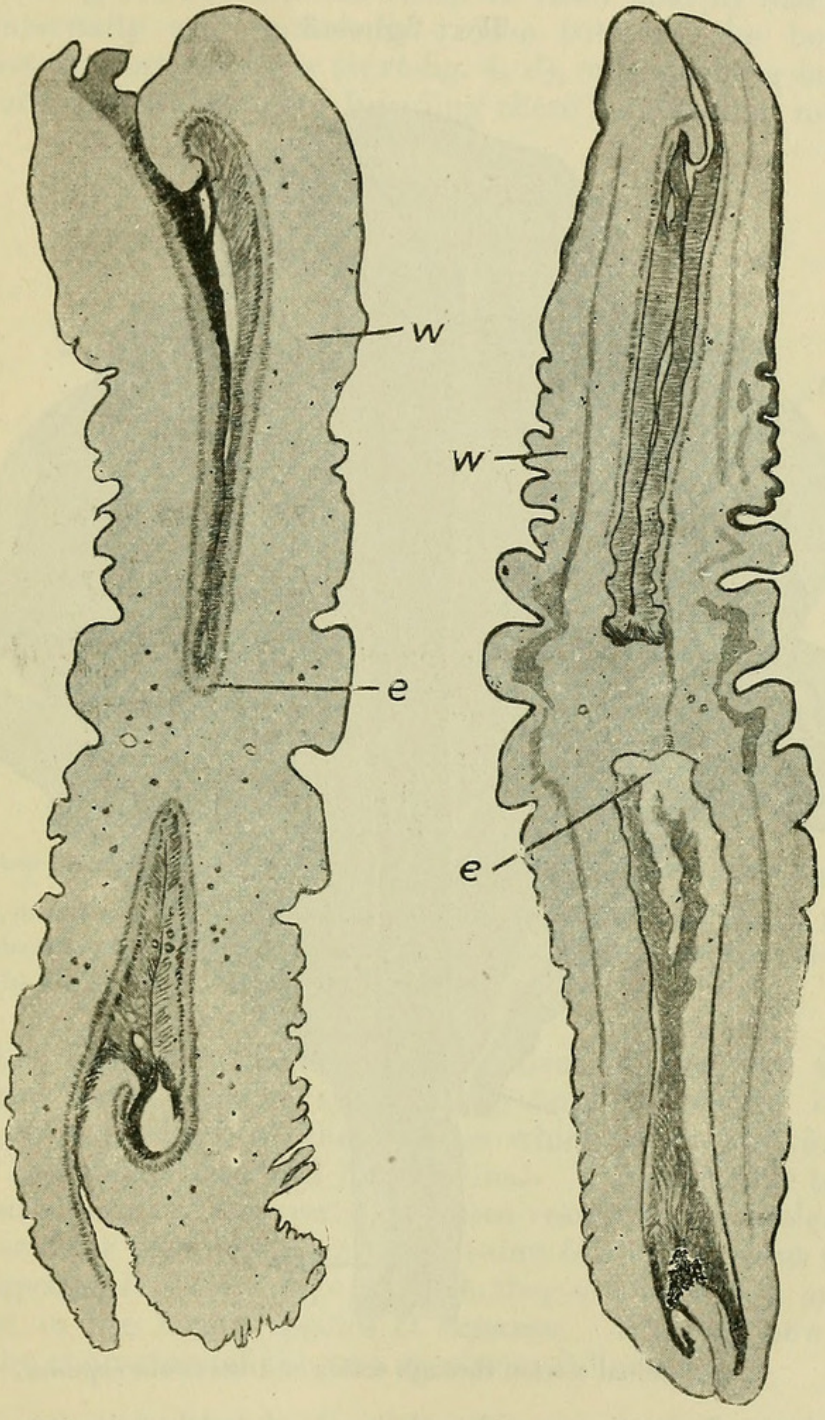
The above brief résume shows that, while Perrier examined examples of *Duthiersia* from both the Nilotic and the Indian species of Monitors and asserted the existence of the posterior orifice of the funnel formed by the partial coalescence of the two lips of the bothrium in both of these, subsequent observers based their results upon the personal examination of one only of the two alleged species; and also shows that there is a consensus of opinion that no posterior orifice exists in examples from *Monitor niloticus*, while it is asserted to exist in examples from Indian Monitors. These observers finally appear, on the whole, to have concluded that their own observations, though made upon one set of individuals only (whether from Africa or India), applied to the others examined by their fellow-workers, and that the genus *Duthiersia* was definitely to be characterised by the possession or non-possession of these orifices according to each observer's own discovery of fact. I have made myself an examination, as already stated, of examples of *Duthiersia* from both African and Indian species of *Monitor*, and I cannot see why the obvious differences pointed out by Perrier have not been universally accepted. To these I have some fresh observations to add which, as I think, entirely justify the position taken by Perrier.

Perrier's figures show the great difference in the general form of the scolex in the two species, which is, moreover, much larger in *D. expansa* than in *D. fimbriata* (as we must, of course, call Perrier's *D. elegans*). I have already described the apical pit in *D. fimbriata*, which is not to be found in *D. expansa*, and I agree with other observers that the posterior aperture of the bothria does not exist in *D. fimbriata*. I have examined several series of sections both transverse and longitudinal, and can find no trace of this orifice. In *D. expansa*, on the other hand, it is exceedingly obvious though very minute. It lies closely adpressed to the commencing strobila to which the posterior end of the folds forming the bothrium are attached, instead of, as in *D. fimbriata*, turning upwards to be attached at a point much higher up and within the shelter of the lateral folds forming the bothrium. At the point of opening of the orifice the fused bothrial folds project laterally as a papilla upon the side of the strobila; but the actual orifice is not upon the apex of this papilla, but upon its inner side. There are other differences between the scolices of these two species of *Duthiersia*. In *D. expansa*, in tracing a series of sections from the strobila region forwards, the axis of the scolex is more sharply defined than in the other species. This is seen in transverse sections to be due to the fact that the flaps of

* Trav. Soc. Imp. Nat. Petrograd, xlv. 1914, p. 62.

tissue which form the walls of the bothria do not unite at their attachment to the axis, but leave a space between their inner terminations. In *D. fimbriata*, on the other hand, the two walls

Text-figure 2.



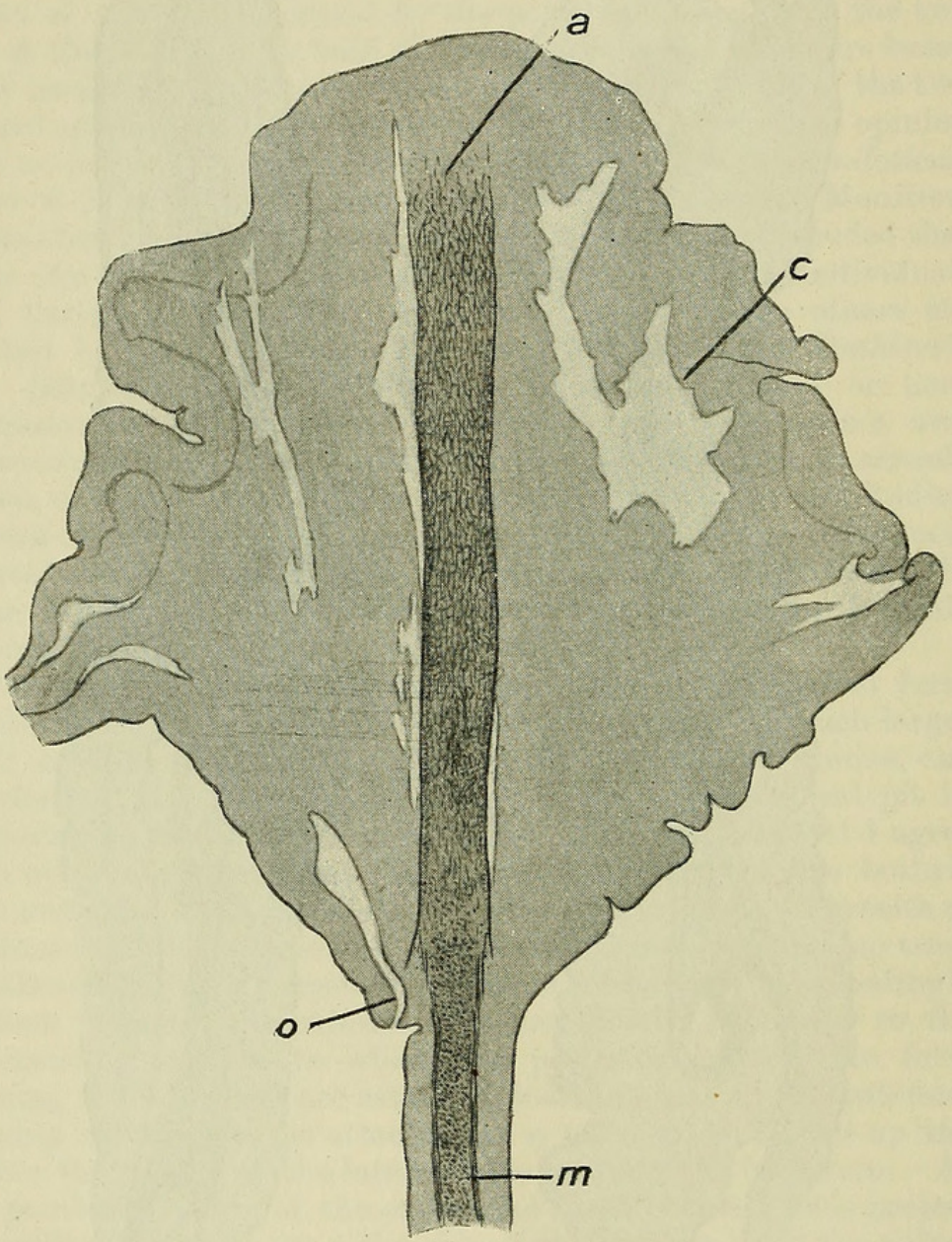
Transverse sections through scolex of (left-hand figure) *Duthiersia fimbriata* and (right-hand figure) *D. expansa*.

w, walls of bothria; *e*, junction of these with the axis of the scolex.

of the bothrium practically meet at their insertion (text-fig. 2, *e*). Thus, in both transverse and horizontal sections the axis assumes

a greater distinctness in *D. expansa*. This is also due to the fact that in the last-mentioned species the axis of the scolex is formed from the medulla only (text-fig. 3, *a*), while in *D. fimbriata* the axis is apparently formed from both medulla and cortical layer. The point of difference is further emphasised by the more modified

Text-figure 3.



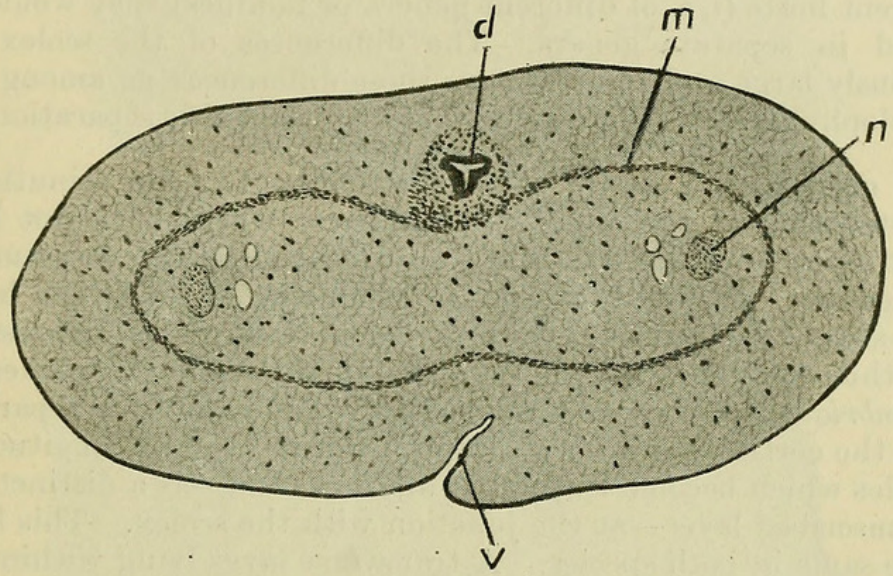
Longitudinal section through scolex of *Duthiersia expansa*.

a, axis of scolex continuous with medulla only of strobila region (*m*); *c*, cavity of bothrial groove displayed here and there; *o* posterior orifice of this cavity.

structure of the axis in *D. expansa*, where it presents the appearance of a more clearly defined network, the spaces being largely quadrilateral in outline. There is not this plain histological

differentiation in *D. fimbriata*. Finally, in transverse sections through the bothrial canal up to its point of opening on to the side of the strobila, the same restriction of the bothrium to the cortical layer is to be seen very plainly; this is due to the fact that here the medulla is marked off from the cortex by a thick layer of longitudinal muscles which is itself sharply marked off both internally and externally. The tube of the bothrium traverses the cortical layer (text-fig. 4, *d*), only pushing back but not in any way taking up or invading these longitudinal muscles.

Text-figure 4.



Transverse section through posterior extremity of scolex of *Duthiersia expansa*.

d and *v*, dorsal and ventral bothria forming a narrow canal in the cortical layer; the external orifice of *v* is shown; *m*, longitudinal muscular layer dividing the cortex from the medulla; *n*, nerve-cord.

Another difference between the scolices of the two species affects the water-vascular system. In both the scolex is permeated by a network of these tubes which is very obvious in sections both transverse and longitudinal. I am not able to give a detailed account of the course of these vessels in the scolex, but it is quite clear that the number of tubes is much greater in the smaller species *D. fimbriata*, and that they are here of a smaller size than in the larger species *D. expansa*. We may now summarise the characters of the two species as follows:—

Genus Duthiersia.

(1) D. fimbriata Diesing.

Solenophorus fimbriatus Diesing, SB. Ak. Wien, 1854, p. 589.
Duthiersia elegans Perrier, Arch. Zool. Exp. 1873, p. 360.

Scolex smaller; bothria opening by continuous antero-lateral

groove only; apical pit at extremity of scolex; water-vascular system of scolex an abundant network of small tubes.

Hab. *Monitor niloticus.*

(2) D. EXPANSA Perrier.

Duthiersia expansa Perrier, Arch. Zool. Exp. 1873, p. 359.

Scolex larger; bothria opening by continuous antero-lateral groove and by separate posteriorly situated pore, being thus funnel-shaped; apical pit not present; water-vascular system of scolex a less abundant network of larger tubes.

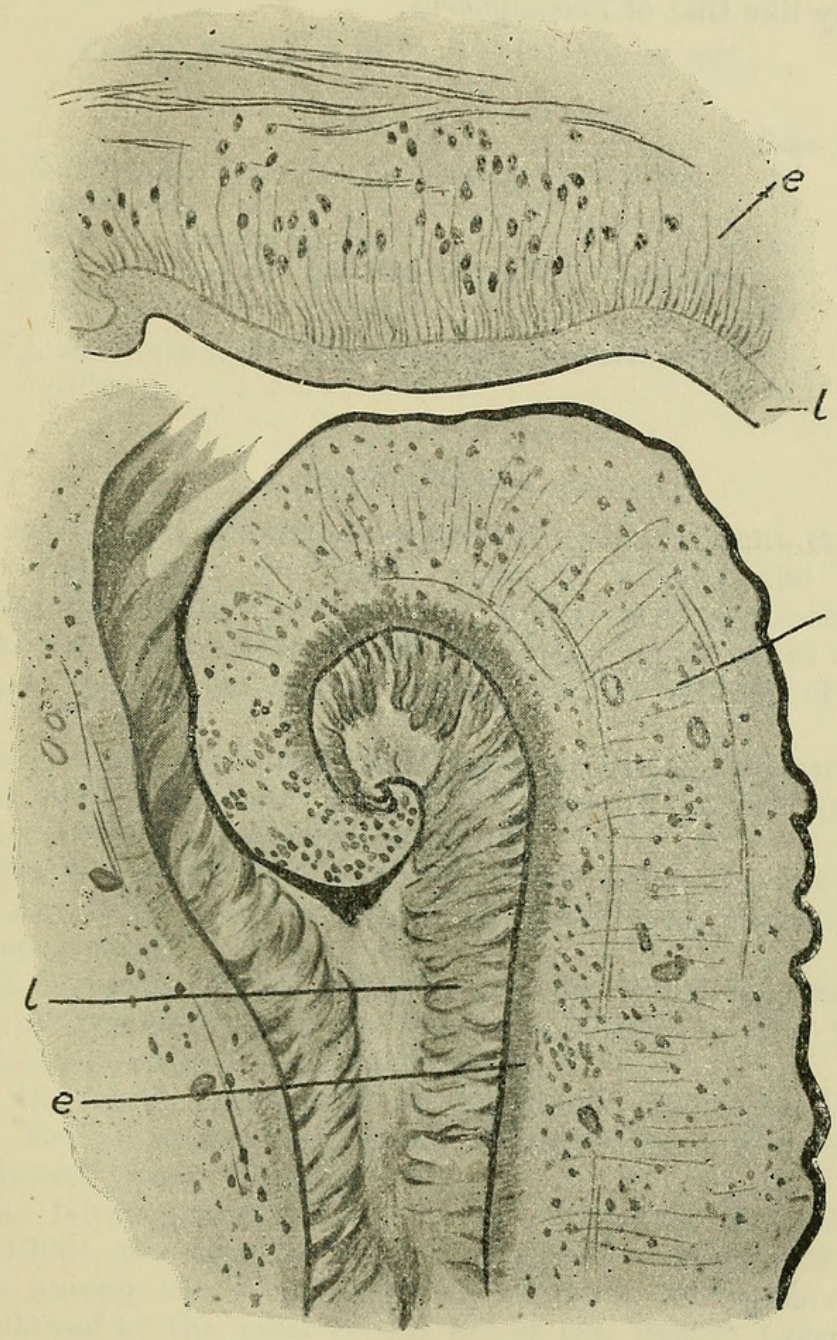
Hab. *Monitor bengalensis* and other Indian forms.

It is quite possible that were these two species found in quite different hosts (*i. e.* of different genera or families) they would be placed in separate genera. The differences of the scolex are obviously large and important as these differences go among the Pseudophyllidea. I do not, however, attempt this separation.

In conclusion I desire to draw attention to a few minutiæ in the structure of the scolex of *Duthiersia* which have not been dwelt upon by those who have already studied the structure of this genus. The strobila near to the scolex is somewhat hour-glass-shaped in section, having a dorsal and ventral depression, and thus a bulging at the two sides; this is more marked in *D. fimbriata* than in the larger species. The medulla is separated from the cortical layer by a sharply marked band of longitudinal muscles which become frayed out and thus end—as a distinct and circumscribed layer—at the junction with the scolex. This layer is the same in both species. A transverse layer lying within this is to be seen in longitudinal section, but does not form a continuous coating of muscular fibre: there is simply a slender bundle of fibres at the posterior end of each segment. This layer escaped my attention in *D. expansa*, where it cannot at any rate be so obvious as in the other *Duthiersia*. This state of affairs contrasts with what obtains in *Solenophorus*, believed to be closely allied to *Duthiersia*. In the former the longitudinal layer is very much thicker and with more scattered and at the same time larger fibres, and the extent of the medulla is reduced. In transverse sections the strobila of *Solenophorus* contrasts with that of *Duthiersia* by its stouter form and oval to circular outline. This thickening of the muscular layer in *Solenophorus* is, no doubt, connected with the strong muscular supply of the walls of the bothrial tubes in this genus. But in *Duthiersia*, in transverse section, a thinnish layer of fibres is seen to extend along the projecting walls of the bothria and represents the constricting muscles seen in *Solenophorus*, though diminished in importance. Within the bothrial tubes of *Solenophorus* the hypodermic cells (subcuticular layer) are covered by a structureless stained (by reagents) and slightly opaque cuticle, outside of which is a clearer but still rather granular yellowish cuticle of chitinous appearance, of which the outermost layer is stained by reagents. In

Duthiersia the layer which is thrown off most externally by the outermost layer in the bothrial groove is quite different. It is much deeper and greatly stained by reagents. It presents (text-fig. 5) the appearance of closely approximated plates, thinner towards

Text-figure 5.



Upper figure a section through a portion of the wall of the bothrial tube of *Bothridium* (*Solenophorus*) *megacephala*.

Lower figure a similar section of *Duthiersia fimbriata*.

l, membrane immediately lining bothrial groove and secreted by (*e*) epithelial lining: between the two lies another membrane, shown as a darker line. The difference of the outermost of the two membranes in *Duthiersia* and *Bothridium* is clearly shown.

the outside but reinforced by thicker bars. When the walls of the bothrium are closed upon each other there is absolute contact between the cuticular layers of the two sides. The appearance is totally different from what is to be seen in *Solenophorus*, and thus presents a striking difference between the two genera. It should be added that in *Duthiersia*, as in *Solenophorus*, a second layer lies within the outer cuticular layer just described which is precisely like that of *Solenophorus*.