

VARIATION IN *MONIEZIA EXPANSA* RUDOLPHI

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In making a number of preparations of proglottids for class study at the stage when sex organs are mature and before embryos appear and obscure matters, an abnormal set of proglottids was found. None of the fragments mounted were connected with scolices. All had been preserved in formalin, stained with Delafield's hematoxylin, decolorized with one per cent HC₁ and mounted in balsam.

This piece is mounted dorsal side up with the free edges, right and left, showing the region of the genital pores. The interproglottidal pits surrounded by numerous glands, diagnostic of this group of species of *Moniezia*, show clearly at the distal boundary of each proglottid (that away from the scolex).

This is not the place to argue concerning what a proglottid is, whether a reduplicated sexual portion of a single worm or a sexual individual in itself. It will be enough to say that for the purposes of this paper a tapeworm strobila is considered similar to the strobila of the coelenterate *Aurelia* and a proglottid to a single medusa except that the proglottid is hermaphrodite and the medusa either male or female. In this I am merely classifying myself. According to the discussion in Bronn's *Thier-reich* the theory one will incline to is largely a question of temperament since the phenomena may be interpreted either way.

The abnormality was first noted on the left side where two sets of sex organs appear with no proglottid boundary fully separating them. There is an offset at the edge and a beginning interproglottidal separation which fades out as it reaches the region between the sex organs. Before it ceases it shows several normal pits with glands. On the right side and edge is a single normal set of sex organs. This area described will be spoken of as proglottid Complex Number Two.

On the right side of proglottid Complex Number One, distal to the Complex Two, a similar doubling of sex structures occurs but it is much less distinct and complete.

The sinus and sex ducts which should have appeared distally are not present but a disturbed area indicated by two lines is found where these structures should have arisen.

Anterior to this area is the start of an interproglottidal boundary showing two interproglottidal pouches facing each other. This boundary, however, is deficient in that it does not separate the proximal set of sex ducts from the distal group of sex organs without ducts of their own.

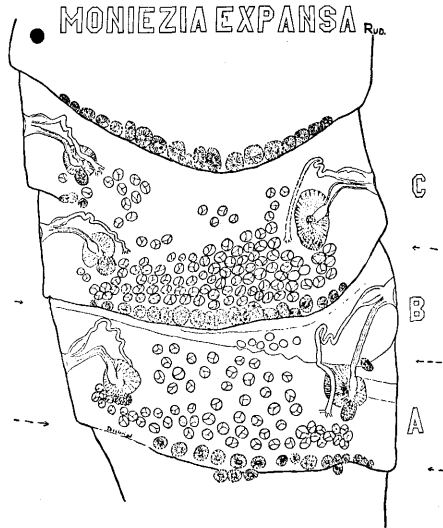


Fig. 1. Abnormal proglottids of *Moniezia expansa*. (+ 12).

Medially from this combination of structures the proglottid line between proglottids A and B is very faint with only a few interproglottidal glands and no pits or pouches. Tracing this line across the proglottid it fades out close to the left edge and very near the distal boundary of Complex Two. In the usual position on the left side of proglottid A is a normal set of sex organs and ducts.

So in what seems to be two consecutive proglottids, Complexes One and Two, there are three complete sets of sex organs on the left and on the right one normal group in proglottid C plus a complex in proglottids A and B which evidently represents two sets of organs.

What has happened may be explained as a disturbance of the divisions between proglottids so that by the dislocation

of parts of two boundaries three proglottids, A, B, C have been concentrated into the two complexes.

This disturbance must have been active at the time when the distal proglottid A was being marked off from the neck of the scolex and its influence persisted during the forming of proglottids B and C. Younger proglottids in this fragment of the strobila are normal.

Stiles and Hassall give data for the development of the *Moniezia* strobila which show when these modifications must have occurred.

The newly attached scolex is from 0.4 mm. to 0.7 mm. long. The first proglottid of the strobila appears 0.5 to 2.0 mm. distal to the constriction or "neck" of the scolex.

The first trace of genital organs appears about proglottid 150, from 7 to 12 mm. behind the scolex, as two clumps of

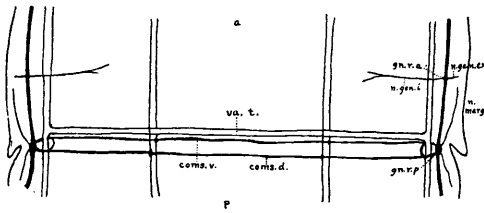


Fig. 2. The nervous system of the cestode *Moniezia expansa*. (Modified from Tower, Fig. 6, Taf. 22.) Coms. d., dorsal commissure of proglottis; coms. v., ventral commissure of proglottis; gn. r. p., right posterior lateral ganglion; gn. r. a., right anterior lateral ganglion; n. gen. ex., external genital nerve; n. gen. i., internal genital nerve; n. marg., marginal nerve; va. t., transverse water tube.

compact tissue 0.5 mm. in diameter, one lying just inside the longitudinal water tube on each side.

At 70 mm. from the scolex each of these clumps, still solid, ends medially in a double knob, the proximal part of which represents the future male organs and the distal portion the female organs. The appearance is roughly that of a pistol with the muzzle pointed outward toward the future genital sinus.

Separate testes are first seen in proglottids 100 mm. from the scolex. They must migrate inward as buds from the male fundament, each separate testis being connected to the vas deferens by its own vas efferens.

Since proglottids are indicated within 2 mm. of the scolex we should examine conditions at that level in interpreting boundaries.

What can be seen of the distal boundary of proglottid A indicates no especial irregularity, so the difficulty may have been with the agencies concerned in the location of the proximal boundary between B and A. Starting on the right this boundary shows two characteristic glandular pouches facing each other across the line. There are other glands not in pouches dispersed irregularly along the faint boundary half way across the proglottid.

The distal sex glands in A, which have no sex ducts, appear to have connected with the proximal ducts across the proglottid boundary.

Testes are present in abundance in proglottid A while only a few rather undeveloped testes appear in proglottid B. There may be a faint trace of an ovary in B proximal to the boundary of A.

The conspicuous distal boundary of Complex Two does not run directly across as one would expect but dipping sharply from the right towards Complex One makes a fairly straight line to the left just proximal and parallel to the rudimentary boundary described between A and B.

The area between these two boundaries is only part of what should have been proglottid B.

Whatever the deflecting influence modifying the direction of boundaries it was not strong enough to extract the small part of the boundary of C starting at the left edge and reaching as far as between the two ovaries. This shows several typical gland pouches along its brief course and ceases abruptly.

Testes are more than usually abundant in the distal portion of Complex Two since there are three sets of normal sex organs inside its boundaries and testes typically tend to develop nearer the boundary away from the scolex.

Is it possible to explain these abnormalities as results of deficient developments in the nervous system? Tower in his paper on the nervous system of *Moniezia* states on p. 373: "For the first five mm. behind the scolex the lateral nerves are of uniform diameter, they possess only a few ganglionic cells and no trace of ganglionic enlargements." "In the posterior part of the neck region where the proglottids begin to be distinguishable the nerves begin to assume the condition which they present in the mature segments." "Each lateral nerve begins to exhibit an enlargement at a point near the posterior margin of the proglottis." (The first indication

of the posterior lateral ganglion.) "The position of these ganglia is indicated in the preceding portion of the neck region by the presence of small branches from the lateral nerve which correspond in position to the posterior part of each young proglottis." (Undoubtedly the beginnings of the dorsal and ventral commissures, recognizable before the ganglia with which they connect have arisen.) "At a distance of 30 mm. from the scolex the posterior lateral ganglia are well marked."

These posterior lateral ganglia together with the dorsal and ventral commissures would seem to correspond roughly to the ring nerve in a medusa. This ring of nerve tissue is likely the especial correlating element when the single adult proglottid swims (as to my surprise I have seen it do).

Suppose that in some way the nervous tissue of the right side in proglottid B was damaged in such a way that the dorsal and ventral commissures never connected from the two sides. Since these commissures appear so early such a deficiency may explain the lack of a typical proximal boundary for proglottid A.

The absence of this boundary, or rather of the nervous tissues which initiate the forming of the boundary may have influenced the location of the proximal boundary which should have separated B from C. This starts normally on the right and is rapidly bent distally so that it reaches the left side almost upon the rudimentary boundary mentioned between B and A.

As a result most of the proglottid tissue which should have been in B, including the distal set of sex organs and ducts on the left side are now in Complex Number 2. Except for the sex ducts on the right in B it contains only a few insignificant testes and a trace of an ovary too indefinite to be represented.

On the left of Complex 2, in front of the distal sex structures just mentioned, there is definitely the start of the normal boundary between B and C showing several typical glandular pouches and then stopping abruptly.

The difficulty, whatever it was, seems to have started on the right side of the distal proglottid A. I am suggesting this since the lack of the external genital nerve from the anterior lateral ganglion at that point would result in the non-development of sex ducts and gonopore.

The connectives which should foreshadow the dorsal and ventral commissures of the right side of B, indicating the location

of the future posterior lateral ganglion, probably never appeared, so nothing was present to join the corresponding fibers from the left of B.

It is also likely that the internal genital nerve from the anterior lateral (right) ganglion of B was abnormal so no ovary and only a few testes are shown there. The regular sex ducts in B, for lack of their own glands, evidently connected through the rudimentary boundary to the sex glands of A whose ducts never developed.

Those branches on the right side which normally would have aided in forming the dorsal and ventral commissures of C probably developed freely out into the tissue between C and A making connection with the branches on the left side of B which had found no fibers on the right side of B with which to unite. This would explain the distal bending of the boundary half way through the proglottid and its straight path from that point to the left side. The glandular pits would develop along the line determined by the path of the dorsal and ventral commissures.

Since the fibers representing the left connectives of C had no opposites remaining to unite with, they probably degenerated after initiating the start of the left distal boundary sufficiently so that three glandular pits developed along that beginning. By the time the next proximal proglottid was to be divided off from C, the disturbance, whatever it was, had disappeared since the proglottid boundaries from this point on in the fragment are normal.

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