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Henry B. Ward
University of Nebraska - Lincoln

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On the Value of Measurements in Specific Determinations Among the Distomes.

. . . BY . . .

Henry B. Ward, Ph. D.,
Zoölogical Laboratory, University of Nebraska.

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ON *DISTOMA FELINEUM* RIV. IN THE UNITED STATES AND ON THE VALUE OF MEASUREMENTS IN SPECIFIC DETERMINATIONS AMONG THE DISTOMES.

A. The distomes of cats have received special attention of late in the two papers of Braun (94) and Stiles and Hassall (94). The latter authors give a most admirable account of our present knowledge of a dozen allied forms, and record two, *D. albidum* and *D complexum* n. sp., as found in cats in the United States. During the past year I have examined[1] the cats killed at this laboratory, and have found neither of the forms recorded from the east. *Distoma felineum*, however, which Stiles and Hassall did not find, and which has not been reported hitherto for the United States, is not uncommon here. Among a dozen cats examined last spring, two contained specimens of this species, and one of the four killed this fall was likewise infected. The first cat contained over one hundred of the distomes, and the others approximately one dozen each. The exact correspondence of the forms with the figures and descriptions of Braun[2] and Stiles and Hassall leave little doubt as to the identity of the two forms, and yet there are some points of disagreement which deserve mention, especially since the discovery of the European form in the liver of man in Siberia by Winogradoff[3] adds this species to the list of human parasites.

In order to make as accurate a comparison of the measurements as possible, ten perfect and apparently average specimens were taken, stained and mounted in balsam, and the various points observed on each ; in dimensions the average of all was also noted. The forms from Lincoln are decidedly larger than the European specimens, varying in length from 12 to 20 millimetres, and averaging 14.45 millimetres, instead of being "10 to 13 millimetres" long. The oral sucker averaged in our

[1] The search was conducted under my direction by my assistant, Mr. W. C. Hall, to whom I am indebted for his trouble and for his careful work.

[2] The figure copied by Stiles (94, Pl. I, Fig. 5) "from Braun" is not in the latter's article as originally printed, but was distributed later.

[3] For an account of this discovery, which was published in Russia, see Stiles and Hassall (94, note, p. 427), and Braun (94a).

specimens 0.355 x 0.414 millimetres, and the ventral 0.247 x 0.240; thus they are not, as in the others, "of the same size (0.28 millimetres in diameter)." The pharynx was also larger, 0.212 x 0.219 millimetres, instead of 0.204 x 0.161 millimetres, and the œsophagus shorter, 0.175 millimetres, instead of 0.2 millimetres. The eggs agreed more closely with the European form, but vary from 25 x 15 to 35μ x 12μ.

Considering the general form and relation of various organs, numerous minor differences may be noted. The testes are not, in many cases, distinctly lobed, and the statement of Braun that the anterior testis has uniformly four lobes I find to be true in only seven out of ten specimens, while the five lobes said to be characteristic of the posterior testis were present in but four cases out of ten; in the other specimens the organs were either round or with the reverse number of lobes. I have compared the position of the two testes with that of the ovary and receptaculum seminis, and find the left testis to be anterior in three cases, the right in seven; in each case the receptaculum was found on the side of the body opposite the anterior testis. A comparison of the figure given here with those cited by Stiles and Hassall (94, Pl. I, 5, 6, Pl. II, 7, 8) will show other minor differences in the general appearance of organs, such as the uterus, which here almost covers the acetabulum; Laurer's canal, which is a prominent object in the specimens found in Lincoln, is not shown at all in the figures of the European form. But these are minor points.

I have reserved for consideration by itself one particular in which this form is strikingly, and so far as I can find constantly, at variance with the descriptions and figures of both Braun and Stiles. Both authors describe the vitellaria as situated in the *middle third* of the body, and composed of eight to nine groups of acini with transverse ducts from *the next to the last.* The figures bear out the statements, and show the posterior end of the vitellaria as approximately co-incident with the position of the ovary and the transverse ducts as extending posteriad from the glands toward the ovary at an angle of about 45° with the main axis of the body. In the specimens found here the conditions, as represented in the figure, are as follows: The glands begin about half as far behind the acetabulum as that is from the oral sucker, that is, at approximately the same position as in the European form, but *they extend to the middle*

of the space between the two testes, or even sometimes as far as the anterior edge of the posterior testis. One break in the line of acini may always be recognized as most prominent; it is located just opposite the ovary on each side, and is in length more or less equal to the diameter of the ovary. This is the condition shown on the left side of the worm figured. This space divides the vitellarium into two portions, which may be distinguished as antovarial and postovarial. While it is in some cases possible to distinguish in the antovarial portion groups of acini, they seem to be usually rather indistinct, or at least very unequal in size, as if adjacent groups had become confluent by the growth of interlying acini. The postovarial portion, however, is usually distinctly divided into two or three groups of acini, though even these may be obliterated. In two or three cases a small group of acini was found, on one side only, in this intermediate space opposite the ovary, and was clearly separated from both antovarial and postovarial portions by a small space. This was the case in the right vitelline gland of the worm figured.

Corresponding to the two portions of the gland one finds on each side two ducts which, extending obliquely toward the ovary from a short distance before and behind it, form a "Y" or "V" according as they meet before or not until after reaching the ovary. These ducts on either side of the ovary form one of the most characteristic appearances of the stained specimen. The differences already described do not warrant the creation of a new species for this form. At most, if shown to be constant and constantly unlike the European type, they would entitle the American form to rank as a variety. This remains for further investigation.

Distoma felineum was found in Lincoln not only in the cat, but also in the gall ducts of a young coyote, *Canis latrans* Say, which had been kept here three months as a pet, and had met an untimely fate in consequence of overfeeding.

In every case the liver of the infected animal was carefully examined, and Mr. Hall reported that the worms all lay in the dilated ducts, and that even in the case of extreme infection there could be observed neither destruction of the tissue nor other pathological changes in it, a diagnosis which I was able to confirm from a subsequent examination of parts of the affected organ. In color the living distome is a clear amber,

with the vitelline glands, testes, ovaries and the posterior portion of the uterus of a chalky white. The last-named organ changes gradually toward the anterior end until it becomes a dark chestnut brown. The worms are very transparent, and all details of structure can be made out from the living specimen with great ease, so that this species is an exceptionally good one for the study of the characters of the group.

B.—Several writers of late have emphasized the value of topographical relations in the determination of species among Trematodes and Cestodes. The prevalent method of describing a new species in both groups may be said to be the mathematical; when, for a distome, *e. g.*, the author has enumerated the relative size of the two suckers, and their actual diameter, supplemented by a few data on length and breadth of the worm, size of the ova, etc., taken perhaps from a single specimen, the description is complete and the new species is duly baptized. This method, which may be fairly said to be a survival of the antique Rudolphi-Diesing regime, still prevails to an unfortunate extent in some quarters and especially in our own country. Often these details of measurement are given with great care even to the micron, while the topography of the body is either passed over with a few general words or at best only sparsely treated. In opposition to this I would urge that the *topographical relations alone are fixed*, and hence *the only points on which species may be founded*. It is against the apparent and deceptive accuracy of such mathematical descriptions and in favor of a fuller and more complete treatment of topography that I would present a few arguments drawn from actual cases.

The untrustworthy character of measurements alone is easily shown by my article (Ward, 94), on *Distoma Westermanni* in the United States; the specimens found at Ann Arbor disagreed with the published measurements of *Distoma Westermanni* in every particular: size of worm, of the suckers, and of the eggs; and the differences were so great that average of the Ann Arbor specimens surpassed the extremes given by Leuckart (89). Not only this but the oral sucker was decidedly larger than the ventral which is exactly the contrary of the case in Asiatic form. In spite of these apparent differences the Ann Arbor species was undoubtedly *Distoma Westermanni* as I was

able to say after comparing stained specimens and sections with the splendid description of that form given by Leuckart. Last fall this species was found in a shepherd dog near Columbus, O., and at my request specimens kindly sent me for study. A detailed report of the case has already been published (Ward, 95), and a comparison of the measurements given there show still more strongly the variability of these parts. The worms were larger even than the Ann Arbor specimens as were all organs measured, but the relative size of oral and ventral suckers shows this time agreement with the description of the Asiatic form given by Leuckart.

Not only do specimens of the same species thus obtained from different localities differ in these respects but those from the same locality and even from the same host vary almost as widely. Among the specimens of *Distoma felineum* mentioned above I was able to observe this fact. In some few the oral and ventral suckers were alike in size as is the case in the European form according to Braun ; in others the oral was somewhat larger and in the extreme case nearly twice as large as the ventral. Furthermore the measurements differ considerably accordingly as they are made from the living specimens or from those preserved and mounted, the oral sucker being in the living animal in one or two cases twice as large as in the mounted specimens. On purely *a priori* grounds one would expect this since the parts measured are highly muscular and may be in a state of relaxation or of contraction at the particular time of measurement. Specimens which are preserved when fresh and active invariably show smaller figures in size of the worm and of its parts than those which are kept some time in salt solution for study and fixed when almost if not fully relaxed. I have endeavored by drawing curves and calculating to determine for these specimens whether there was shown any relation between the length and breadth of the animal and the size of the suckers and pharynx, that is, whether these organs might be modified by the extension or contraction of the body ; but so far as I can see the variations in the size of these organs seem to be entirely independent of the body as a whole.

By examining the figures given above for *Distoma felineum* it will be seen that the suckers are not circular and the difference in the individual cases was even larger than the average

since one-third of the specimens contradicted the average. Unless both diameters are given another element of uncertainty is introduced.

It is clear, then, that these characters may vary both by chance and in consequence of the treatment employed or the time at which the measurements are made and that the figures possess at best only an apparent accuracy. Since then they are so variable they cannot even be regarded as convenient secondary characters for the determination of species. Of course no one would claim that a sub-division of the Distomidæ according to the relative size of the suckers was a natural classification, but the instances cited, to which many others might be added, show that it is misleading and should be discarded entirely. It is, however, just this method of dividing the group which is used in many keys not only in textbooks but also in works which are regarded as more exact.

Even if these data were sufficiently accurate to be used as secondary characters in determination it is none the less true that they are *secondary*, and that they have been preferred to the primary relations of organs and systems on which alone any natural classification of the group must rest. The preponderance of such mathematical data and the absence of anatomical descriptions have resulted in the confusion of different species and in the re-naming of well-known forms. This is nowhere better illustrated than in the article of Braun (94) or in the recent splendid monograph of Looss (94) on the distomes of frogs and fishes.

In connection with the mathematical descriptions, already sufficiently characterized, figures are often published which merely give the approximate position of the organs by circles or ovals without any indication of their ducts or connections. Thus Stiles and Hassall (94, p. 420) were unable to determine from many figures whether the anterior or the posterior testis belonged to the right side of the body. As Braun has said (93, p. 909) a solution of the genus *Distoma* on the basis of a single system is impossible. It is then equally true that this much desired solution must wait for the abandonment of the mathematical ideal and the substitution of topographical study. Much has been done in this direction by certain authors already cited, but I am convinced that the old method will persist in certain places until the issue is fairly met, and until no species

is accepted and regarded as established for which the author has failed to describe at least its general topographical anatomy or to publish a figure showing the same.

I have endeavored to show:

1. That the characters ordinarily employed in systematic descriptions of the Distomidæ are very variable.

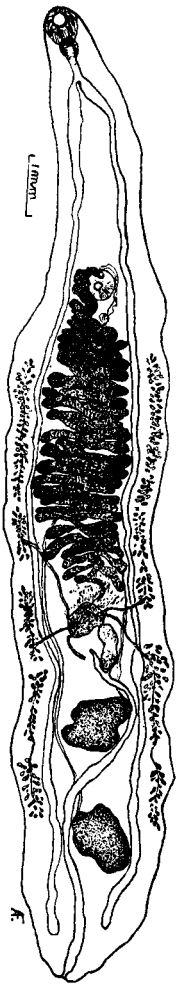
2. That the mathematical data usually given have an *apparent* accuracy which is responsible (*a*) for much confusion and (*b*) for the neglect of anatomical studies.

3. That these data are not even reliable for use as secondary specific characters.

4. That a solution of the group is possible only on topographical grounds.

5. That no new species should be accepted without a description, or a figure, giving the topographical anatomy of the form.

Lincoln, Neb., December, 1894.



Ventral view of *Distoma felineum* from the liver of a cat killed in Lincoln, Neb. (For this drawing I am indebted to Miss Anna Fossler.)

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