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The American Representatives of *Distomum cygnoides*.

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With plate 19.

Distomum cygnoides ZEDER, from the urinary bladder of European frogs, has been known since 1785, when it was discovered by LOSCHGE in *Rana esculenta*. Its name dates from ZEDER'S work of 1800. RUDOLPHI, DUJARDIN, DIESING, PAGENSTECHER, VON LINSTOW, and LOOSS should be especially mentioned in connection with its literature.

In America reference has been made to this species by LEIDY, BENSLEY, and myself. The brief notes of LEIDY are confined to external appearance and habitat; and as nearly as I can judge the species he described was No. 4 of this paper. As he reported, however, from *Rana pipiens*, *Rana palustris*, *Rana hylecinia*, *Salamandra maculosa*, *Salamandra rubra*, and *Salamandra salmonea*, it may be taken for granted that he did not always have the same species. BENSLEY described "Two forms of *Distomum cygnoides*", but hesitated to regard them as distinct from each other. Variety A he took for the commonly described European form, while variety B

he thought had been seen but not definitely recognized by both PAGENSTECHER and LOOSS. In a later work LOOSS perceived that the forms described by BENSLEY were distinct American species and named them *Gorgodera amplicava* and *Gorgodera simplex*. The earlier publication by myself simply records the occurrence of this Distome. In the present paper I shall attempt to show that there occur no less than 5 species of *Gorgodera* in our frogs and toads. Gladly accepting the generic and specific nomenclature of LOOSS, and supplying as well as I can designations for the other three species, they may be arranged in order of size thus:

1. *Gorgodera translucida*.
2. " *opaca*.
3. " *simplex*.
4. " *attenuata*.
5. " *amplicava*.

In order to facilitate comparison, the drawings are made as nearly as possible to the same scale of magnification of an average full-grown specimen in each case. They show the most easily detected characters which are likewise the ones that are at greatest variance in the different species and consequently best suited for instituting distinctions. When one comes to the finer microscopic anatomy one expects to find, in a group whose members are so closely related as these, only few and slight differences; consequently descriptions of the Integumentary, Parenchymatous, Muscular, Glandular, Excretory and Nervous Systems are here neglected. The Intestinal System of the American forms, although agreeing in its parts (mouth, œsophagus, cæca) with the European species, may yet have certain different relations to other organs, as e. g. in the cæca being wide apart, near the sides of the body, or approximated towards the centre. The most important sources of contrast are to be sought in the External Features, the Reproductive Organs, and the Hosts. The Cuticle and the Egg, sometimes so convenient and so trustworthy in distinguishing species, are in this case either useless or unsatisfactory. In all five species the cuticle is perfectly smooth, without a trace of spines. Its thickness varies with the region and the state of contraction of the part. The egg of *Gorgodera cygnoides*, as observed by SCHAUINSLAND and LOOSS, increases in size while passing through the long uterus. In these

worms there is likewise great variation in the size of eggs — even in the same individual, and in the ripe eggs pressed from the terminal part of the uterus. It becomes necessary to select the largest and most normal in appearance, those containing well developed embryos, and to measure them under exactly the same conditions. The eggs of *Gorgodera* shrink considerably under the influence of preserving reagents, so that it is necessary to take measurements of the living egg. Since these views have developed with my experience I am unable to supply from my notes measurements of eggs of all five species that admit of trustworthy comparison. This I shall promise to do later.

Of External Features the Size, the Shape and the Suckers are valuable for contrast, but the Colour is similar in all — somewhat gray, with suckers and genital organs showing darker.

Many parts of the Reproductive System are not markedly different from those described for the European species; ovary, oviduct, fertilization space, LAURER'S canal, ootype, shell-gland, receptaculum seminis uterinum, uterus, vagina, sinus genitalis, and porus genitalis; together with the vitelline glands, their ducts and reservoir; and the testes, vasa deferentia, vesicula seminalis, ductus ejaculatorius, and prostate glands are all present in each species; but it is only in the Ovary, Vitellaria, Testes and Uterus that one can ordinarily notice any characteristic differences. The latter are especially connected with the size, shape and relative positions of these organs. The absence of a penis-sac, and of a receptaculum seminis, and the small size of the vitellaria are to be noted.

1. *Gorgodera translucida* n. sp.

This species occurs in the urinary bladder of the toad (*Bufo lentiginosus*) and also of the green frog (*Rana virescens*). In the former I have only upon one occasion found it in abundance: this was about two years ago, at Ashbridges Bay, Toronto, the toad harboring, I should think, between fifty and sixty, mostly of large size — the great number as well as the large size of the parasites struck me as remarkable. I have not found this form more than two or three times since and then only one or two specimens each time. I have obtained but one rather small individual from the green frog. Unfortunately I have been unable to get measurements

of the living worms for whenever I came upon these I had not the means of measuring them to hand. Of 18 mounted specimens, remarkably alike in size and shape, the longest measures 9·45 mm by 1·20 mm, while the one I have figured was $8\cdot06 \times 1\cdot55$ mm. I think the living worm might sometimes measure up to 15 mm, the greatest length reported for the European species; but as far as I can judge the breadth of this exceeds that of *G. cygnoides*. The greatest breadth is about the middle of the length of the animal from which point it tapers off towards both ends. A most noticeable feature is that the body is quite flat and transparent, so that animals killed in glacial acetic acid and then kept in alcohol permit the chief organs to be distinctly seen without any further treatment. In a series of sections, one selected from the region of the anterior testis measures 1·4 mm broad and ·46 mm deep. The thickness decreases slightly from this region backwards and increases forwards till through the back part of the ventral sucker the worm measures ·75 mm in depth but in front of that it becomes thinner again — the body passing gradually into the neck.

In the specimen figured, which is quite representative, the mouth-sucker measures ·465 mm long by ·418 mm broad, while the ventral sucker, whose centre is 1·5 mm from the anterior end, measures ·728 mm each way. In a sagittal section the ventral sucker is a deep, rounded cup extending more than half way through the section. It must be noted that the oral sucker opens downwards and forwards, so that the measure of the whole length in a mounted preparation is not the true length of the sucker, which, counted from the ventral margin of the opening to the posterior end of the sucker, is much less, approximately two-thirds as much. The ventral sucker is normally round, having the same length and breadth, so that the most useful comparison is in the breadths of the two organs. In a good number of cases the ventral measured from 1·5 to 1·75 times the breadth of the oral sucker.

In this species the genital organs are very distinct and easily seen, even in alcoholic specimens that have not been stained and cleared. The great breadth and thinness of its body permit the organs to lie clear of each other and to be transparent. The lateral shanks of the intestine divide the body, let us say, into thirds — a middle third, which, however, is rather more than a third, lying between the caeca, and two lateral thirds, left and right,

between the cæca and the side-walls of the body. The so-called genital glands lie in the middle third, while the greater part of the uterus lies in the lateral thirds. First behind the ventral sucker are the paired vitelline glands, connected with each other by the transverse vitelline duct. There are frequently two follicles on one side and three on the other, sometimes three on both sides, but other variations occur, and occasionally one can only detect an irregular mass in place of one or both sets of follicles. The shell-gland is an inconspicuous organ situated between the posterior follicles of the vitellaria. The single ovary and the two testes are always conspicuous bodies regularly alternating from one side to the other of the middle longitudinal line. The ovary may be right or left: in 18 preparations which I have to hand 7 have the ovary on the left and 11 on the right. It is a compact oblong organ which may vary into oval, and in one case I have seen it about twice as long as usual and somewhat bent upon itself. It lies about the same distance behind the ventral sucker as this is behind the oral sucker. The first testis is behind and on the opposite side from the ovary, and the second testis is on the same side as the ovary. They are long bodies with irregular sides as if lobed but this may be partly due to the shortening or other muscular contractions of the animal. It seems probable that when the worm is extended to its greatest length that the testes, and perhaps the ovary too, would become long and rod-like. But, while this may be in a measure true for every individual, it is not always the cause of one individual possessing longer testes than another. In some cases the anterior end of one body lies on a level with the posterior end of the preceding one, but in other cases all three organs are separated by an interval. In the animal figured the anterior testis measured 1 mm in length and the posterior one nearly 1.4 mm. In another individual, especially lengthened and correspondingly narrowed, the posterior testis measured nearly 2 mm.

A characteristic of the uterus of this species seems to be its arrangement in numerous folds along each side of the body, outside of the intestinal cæca, and from the region of the vitellaria to the hind end of the animal, while between the cæca there are comparatively few folds. The uterus throughout its course has a very narrow calibre, but the two or three folds of the terminal portion, lying between the vitellaria and the ventral sucker, may be somewhat broadly distended. Between the ventral sucker and the egegnal

pore is to be found the conspicuous, but very short and broad, vesicula seminalis.

I have no measurements of living eggs, and, according to my experience with other members of this group, preserved eggs are considerably shrunk. Those liberated from alcoholic specimens measured up to 0.4×0.28 mm. The unstained worms preserve a gray colour with the uterus, testes, ovary, vitellaria, vesicula seminalis, and suckers darker, approaching to a light brown.

2. *Gorgodera opaca* n. sp.

This species occurs with the preceding, in the bladder of *Bufo lentiginosus*, but not so abundantly. In the lot of 50 or 60 already mentioned there were but 3 of this form. They are easily distinguished on account of their shorter, deeper, rounder, heavier, and completely opaque bodies. The largest I have measures 7.59 mm \times 1.24 mm, while the one figured is 6.58×1.39 mm. They are thus a little shorter and generally a little narrower than No. 1. The point of greatest breadth is displaced backwards and the hind end is not so narrow or pointed. Transverse sections prove that this species is 1.5 times as thick as the former (comparing worms of equal length), which partly accounts for its opacity.

The suckers are essentially the same as in No. 1 with the exception that the ventral sucker seems to have a slightly smaller proportion to the mouth sucker (oral: ventral = 1:1.5).

After making the worms transparent by the use of a clearing reagent, the disposition of the reproductive organs can be determined. Corresponding with the level of greatest breadth of the body the genital glands are displaced backwards, so that the distance between ventral sucker and ovary is nearly twice as great as in the preceding species, and the area occupied by ovary and testes is greatly reduced. These organs are situated left, right, left, and a greater distance lateralwards from the median line than in No. 1. They are all short, compact bodies, slightly longer than broad and, especially in the testes, in marked contrast to the corresponding parts of *G. translucida*. The paired vitellaria lie immediately in front of the ovary and are irregular, lengthened bodies, connected at their middles by the transverse vitelline duct. Perhaps the first thing to attract ones attention is that the folds and coils of the uterus

occupy the middle region of the body, from the ventral sucker backwards, surrounding and concealing the genital glands, and constituting the chief cause of the opacity of the animal. Close observation reveals the fact that the intestinal caeca are displaced laterally, so that there is scarcely a fold of the uterus to be discovered between them and the lateral body-walls. This position of the intestine as well as the greater thickness of the body are characteristic of transverse sections. The anterior part of the uterus is generally much distended as in the figure and, whereas in No. 1 there are only two or three transverse folds between vitellaria and ventral sucker, in this species there are five or six. So far as I can judge from mounted preparations of the worm the eggs of this form are of the same size and shape as in the preceding one.

3. *Gorgodera simplex* Looss.

Attention was first directed to this form by BENSLEY in the paper already mentioned. The figure (fig. 1. Photo-microg. of *Dis. cygnoides* var. B) given there is a good representation of a young worm about 5 mm in length. The drawing I give is from an adult 7.5 mm long (killed, stained, dehydrated, cleared, mounted). It is drawn to a scale which will represent the relative size of average adults as compared with the other species of the group. Living worms may be found measuring 12 mm in length, but the greater number vary around 7 or 8 mm.

This species inhabits the Bull-frog (*Rana catesbiana*). It resembles No. 2 in a great many respects, and indeed intermediate, transitional stages are not hard to conceive, however difficult they may be to find. In external appearance it is always long and slim, having a pretty uniform breadth, and being somewhat cylindrical. A mounted specimen, 8×7 mm, uniformly extended throughout its length, measures 1.63 mm to the middle of the ventral sucker and 6.36 mm from this point to the end of the body. The mouth and ventral suckers measure respectively .465 and .620 mm (= 1:1.3 to 1.5). The centre of the ovary was 2 mm from the centre of the ventral sucker, and from the anterior end of the ovary to the posterior end of the second testis was 2.6 mm. It resembles No. 2 in having the genital glands at a distance from the ventral sucker but, on the other hand, these are separated from each other at a considerable distance. The ovary is often heart-shaped but in some

it is lengthened; the testes are longer than broad; the vitellaria are a pair of rods connected at their centres by the vitelline duct. At the fullest state of extension of the animal the vitellaria would be straight, but under ordinary conditions they are more or less wavy or folded or spirally twisted, consequently frequently appearing much like two rows of beads. The cæca have a like position to those of No. 2, and the similarly distributed uterus forms a series of short, transverse folds, down one side and up the other.

Eggs, taken from the vagina, and containing living miracidia that when liberated swim about with great rapidity, measure about $\cdot 065 \times \cdot 042$ mm. The largest figures, obtained by cutting up alcoholic worms of this species and measuring the liberated eggs, were $\cdot 037 \times \cdot 025$, showing a very great shrinkage. In some Distomes, e. g. the genus *Haematoloechus*, the egg-shell is so dense in structure that it does not shrink under the influence of reagents. The contents may shrink, allowing the shell to wrinkle or fold, but one can safely compare measurements of fresh and preserved eggs. In *Gorgodera* it is otherwise — the softer nature of the shell permits a withdrawal of water or other substance from it, and consequently a shrinkage. That the shells of the two genera named are to some extent different in their constitution can be judged by their colour — that of *Haematoloechus* is deep brown, that of *Gorgodera* gray.

4. *Gorgodera attenuata* n. sp.

This species resembles the last in its long, narrow, and deep body and the proportional size, shape and position of its genital organs. It differs especially in its average size, the exact shape of the body, in the vitellaria being closer to the ventral sucker, and in the size of the ventral sucker. Although living worms may exceed 8 mm in length, an average individual among mounted specimens measures about $4\cdot 5 \times \cdot 55$ mm. The centre of the ventral sucker is about 1 mm from the anterior end, and the sizes of oral and ventral suckers $\cdot 280$ and $\cdot 670$ mm. It thus differs from all the preceding species in the relatively large size of the ventral sucker, which extends past the sides of the body and stands out like a bowl attached by its narrowed, closed base. The part of the body behind the sucker may be of pretty uniform breadth for some di-

stance, and then ordinarily tapers to a point. The intestinal cæca approach each other from the ovary backwards, but at the vitellaria they are near the side-walls of the body. The vitellaria are sometimes close after the ventral sucker, and never allow more than two or three folds of the uterus to be seen anterior to them. They are small, rod-like, or crescentic in shape. The ovary, immediately behind them, is round, oblong, or reniform, while the two testes are rather larger than the ovary, and are oblong, or are considerably larger and then more irregular in outline. The portion of the body behind the ventral sucker is usually so much crowded with eggs that one can not make out the structure, and it is only by very special means or in an occasional case that this can be done. In the drawing I have represented the mode of folding of the uterus rather than the distribution of eggs. The latter, measured as in the last species, were $\cdot 510 \times \cdot 360$ mm. The worms described were taken from the bladder of *Rana virescens*, where they may occur in varying numbers — I have notes showing as many as 15 in one frog. They also occur in *Rana catesbiana*, where, according to my experience, they are smaller and more narrowing from the sucker backwards and have longer and more irregular testes.

5. *Gorgodera amplicava* Looss.

This species was called *Dist. cygnoides* var. A by BENSLEY, who regarded it as the true species of ZEDER. LOOSS recognized from BENSLEY's description that it is not the European form but a distinct American species and gave it the above name. It can not be easily confounded with any of the preceding species from which it is especially distinguishable by its small size, its characteristic shape, its large ventral sucker, and its nine testes. A glance at my figures will show that this is the smallest of the five species of *Gorgodera* occurring here. Mounted preparations range about 3.75 mm in length and .75 mm in greatest breadth — just behind the ventral sucker. In shape, except for the sucker, it might almost pass as a miniature of No. 1. The part anterior to the sucker is very narrow, and in the living worm very active, the part posterior broad, flat, and sluggish. In extended individuals the hinder portion increases backwards to the region of greatest

breadth and then tapers off to a point; in many contracted individuals it tapers from the sucker backwards. The large ventral sucker, .70 and .75 mm in length and breadth, will alone distinguish it from every other species, with the possible exception of No. 4. Even here, when we think of the sucker compared with the length of the animal, we find that in No. 5 it is considerably the larger. In living worms the sucker, especially when flattened against any object, may considerably exceed the dimensions given for the average size of animal. It is about 2.5 to 2.66 times the size of the mouth sucker in preserved animals, and these give the most constant proportions for the reason that in them it is never at maximum extension, but in living animals it varies much more in shape than the mouth-sucker does. It stands out from the body like a broad bowl fixed by a narrow base and with the free edge curved in.

The only point in which this species particularly resembles the European one (*G. cygnoides* ZEDER) is in the possession of 9 testes, 4 on the one side and 5 on the other. So distinct a character is this that *G. cygnoides* and *G. amplicava* should be associated as a sub-group and separated from the rest — perhaps under a different generic name.

The intestinal caeca are, in the middle part of their course, pressed far apart by the interposed genital organs. Of these the first in order behind the sucker is the vitellarium, consisting of two lateral bunches of eight or ten follicles each, connected by the transverse duct which opens at its middle through the vitelline reservoir into the oviduct. The ovary, as in the other species, may be left or right — in 25 mounted specimens it is left in 13 and right in 12 — and is of irregular shape, consisting of three to five main lobes which may themselves bear two or three notches each. The testes form two parallel rows lying behind the ovary and between the caeca — five in a line with the ovary and four on the opposite side. They are likewise notched along the sides, presenting an irregularly lobed appearance. Between the two series as well as between the testes of each series and along the intestines at each side of the body are the coils and folds of the uterus. The distal part of the latter accompanies the large vesicula seminalis and opens at the common genital pore midway between the ventral sucker and the bifurcation of the intestine. The habitat of

this species is the urinary bladder of the Bull Frog (*Rana catesbiana*).

The European species, *Gorgodera cygnoides* (ZEDER), in size, shape, suckers, position of intestinal caeca etc., most closely resembles Nos. 2 and 3. The multiple testes clearly distinguish it.

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Description of Plate.

Fig. 1. *Gorgodera translucida* n. sp., from bladder of *Bufo lentiginosa*.

MS Mouth-Sucker.

Oe Oesophagus.

I Intestinal Cæca.

GO Genital Opening.

SV Seminal Vesicle.

VS Ventral Sucker.

U Uterus.

VG Vitellaria.

SG Shell Gland.

O Ovary.

T₁, T₂ Testes.

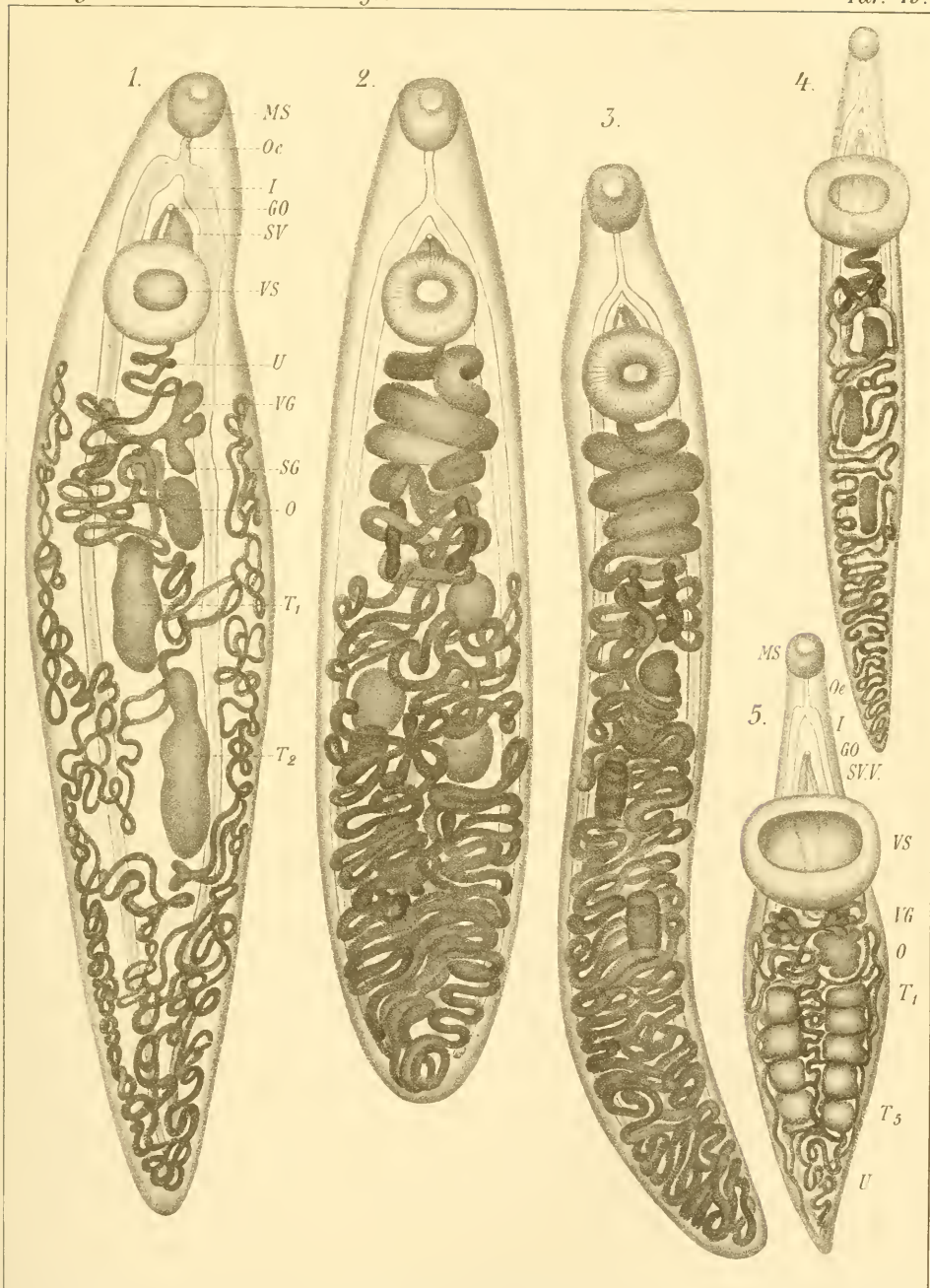
Fig. 2. *Gorgodera opaca* n. sp., from bladder of *Bufo lentiginosa*.
Organs to be recognized by comparison with Fig. 1.

Fig. 3. *Gorgodera simplex* LOOSS, from bladder *Rana catesbiana*.

Fig. 4. *Gorgodera attenuata* n. sp., from bladder of *Rana virescens*
and *Rana catesbiana*.

Fig. 5. *Gorgodera amplicava* LOOSS, from bladder of *Rana catesbiana*.

All from the ventral surface, magnification about 12:1.



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