AMERICAN MUSEUM NOVITATES

Number 39 May 25, 1922

59.51,22S (7)

TWO NEW GENERA OF NORTH AMERICAN BLOOD FLUKES[1]

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For a long time the writer has been engaged in a study of the blood flukes of North American turtles. An extended description of these forms is nearing completion but, since the publication of the longer paper may be delayed, the discovery of two new trematodes found in the vascular system of the snapping turtle *Chelydra serpentina* is announced at this time. These blood flukes are so unlike all previously described forms that they can not be assigned to any existing genera and differ so much from each other that they can not be included in the same genus.

SPIRORCHIDÆ

The family Spirorchidæ has the following characteristics.

Slender blood-inhabiting trematodes, with slightly developed musculature and one or two weak suckers. Pharynx absent. Testes lobed, multiple, anterior and sometimes also posterior to the ovarian complex. Ovary lobed; Laurer's canal present; uterus short. Eggs large, thick-shelled, discharged singly.

HAPALOTREMINÆ

The subfamily Hapalotreminæ is characterized as follows.

Hermaphroditic, blood-inhabiting distomes. Esophagus often with dilated portion or portions, without a pharynx, and surrounded by secretive cells. Ceca end blindly near the posterior end of the body. Excretory vesicle branches behind the posterior testes. Ovary and oötype situated near the middle of the body and between the testes; genital pore dorsal and sinistral near the level of the ovary; vitellaria numerous, both lateral and medial to the ceca throughout most of their course; Laurer's canal present; uterus short containing a single egg which bears either filaments or processes.

HAPALORHYNCHUS, new genus

This genus is characterized by the presence of a protruding oral sucker; acetabulum situated near the posterior end of the anterior third of the body; terminal excretory pore and short median excretory vesicle; testes separated by the ovary; large seminal vesicle and prostate gland anterior to the testes; dorsal genital pore located near the middle of the body and slightly left of the median line; vitellaria extensively developed in front of the acetabulum and behind the ovary; small seminal receptacle and Laurer's canal; and also by the absence of a pharynx, cirrus sac and cirrus.

[1]Contribution from the Biological Laboratory, New York University.

Hapalorhynchus gracilis, new species

Figures 1 and 2

The material upon which this description is based consists of over one hundred individuals collected from the washings of the visceral organs, lungs, liver, kidneys, mesenteries, and alimentary tract of turtles from North Judson, Indiana.

Fixed and mounted specimens measure from 1.5 to 1.9 mm. in length and from 0.15 to 0.23 mm. in width. Living specimens in an extended condition are slightly longer and more slender. The worms are fusiform in shape tapering anteriorly and posteriorly in a similar manner. The region of greatest width is near the middle of the body where the reproductive organs are located. Before and behind the limits of the vitellaria the body narrows considerably. In cross-section the body is oval, flattened ventrally.

The cuticula is thin and unarmed. The musculature is weak and poorly developed.

The acetabulum is slightly protrusible but not stalked and is situated near the posterior end of the anterior third of the body. It is cup-shaped, normally circular in outline but sometimes elongated or flattened as a result of pressure or contraction. It measures from 0.061 to 0.069 mm. in diameter and its depth is approximately equal to its diameter.

The oral sucker is slightly subterminal and capable of considerable extension and retraction. In fixed and mounted specimens, usually about one-half of the sucker protrudes from the body. In shape it is ovate, wider anteriorly and measures from 0.073 to 0.084 mm. in length and from 0.054 and 0.058 mm. in extreme width. The esophagus extends posteriorly from the oral sucker to the bifurcation of the alimentary tract midway between the oral and ventral suckers. It is straight in extended specimens, often with two or three dilated portions. The lining is cuticular and it is surrounded by secretive cells. No pharynx is present. The digestive ceca meet anteriorly to form an angle and end blindly about one-fifth of the body length from the posterior end. They are somewhat dorsal in position and the left crux is flexed median and dorsad near the middle of the body, passing on the median side of the genital pore.

The excretory pore is located at the posterior end of the body and a large median collecting vesicle passes forward dividing a short distance behind the intestinal crura to form two lateral collecting ducts.

The testes are situated one behind and the other before the ovary. The posterior testis is the larger; it has an elongated oval form and measures 0.18 to 0.21 mm. in length, 0.05 to 0.06 mm. in width and 0.06 to 0.07 mm. in depth. The anterior testis is situated obliquely, immediately in front and slightly at the right of the ovary. It is ovate to triangular in outline, the widest portion is anterior and median and the organ narrows laterally and posteriorly. The posterior end occupies the right side of the body at the ovarian level. Its long axis measures from 0.064 to 0.084 mm. and its transverse axis 0.04 to 0.05 mm.

There is a large seminal vesicle which extends from the level of the acetabulum about one-half of the distance posteriad to the ovary. On the right side it has an indentation and is partially covered by a lobe of the vitellaria. From the median

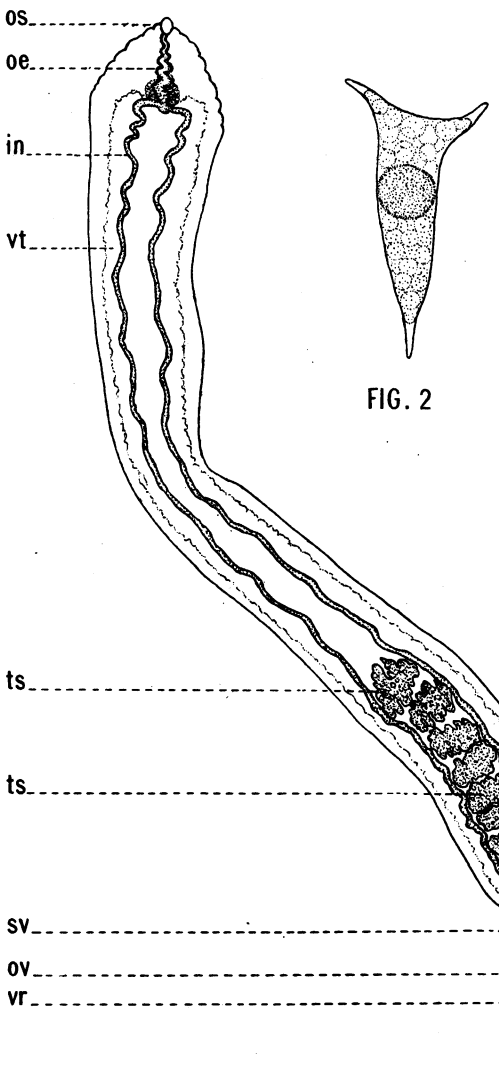

FIG. 2

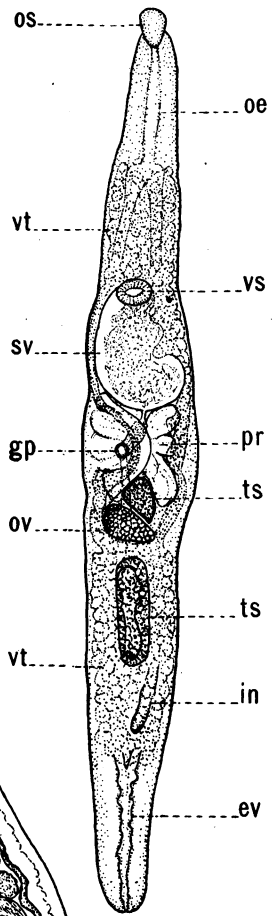

FIG. 1

FIG. 3

Fig. 1. *Hapalorhynchus gracilis*, dorsal view. *Ev*, excretory vesicle; *gp*, genital pore; *in*, intestine; *oe*, esophagus; *os*, oral sucker; *ov*, ovary; *pr*, prostate; *sv*, seminal vesicle; *ts*, testis; *vr*, vitelline receptacle; *vs*, acetabulum; *vt*, vitellaria.

Fig. 2. Egg of *Hapalorhynchus gracilis*.

Fig. 3. *Henotosoma hæmatobium*, ventral view. Abbreviations as for *Hapalorhynchus gracilis*

posterior margin of the vesicle the vas deferens emerges as a small tube. It enlarges almost immediately and passes posteriad, dorsad and sinistrad to the genital pore. The anterior part is often filled with spermatozoa while the terminal part is usually empty. This terminal part is lined with cuticula and contracts to a small duct which opens to the surface just median and anterior to the opening of the uterus. The pore is double, the male and female canals opening separately although the wall separating them is very thin and they appear to discharge through a common orifice. A cirrus sac and cirrus are lacking. The vas deferens and the terminal part of the seminal vesicle are enclosed in a large prostate gland which occupies most of the body space between the anterior testis and the seminal vesicle.

The ovary is situated slightly at the left of the median line and posterior to the middle of the body. Its long axis is almost at right angles to the long axis of the worm. It measures from 0.1 to 0.12 mm. in length and from 0.06 to 0.08 mm. in extreme width. It is ovoid to pyriform in shape, the wider end is lateral and slightly anterior, and the oviduct arises at the median posterior margin. The oviduct passes posteriad almost to the level of the posterior testis. Here is gives off a small seminal receptacle and Laurer's canal passes dorsally opening to the surface near the median line. Immediately following the origin of Laurer's canal, the vitelline duct discharges into the oötype and the canal then passes forward on the dorsal side of the body and leads directly to the genital pore. The vitellaria consist of masses of follicles extending on either side of the body from the bifurcation of the alimentary tract to the bifurcation of the excretory vesicle. They extend to the median line forming a solid mass in front of the acetabulum and behind the ovary except for a small area where the posterior testis occupying almost all the space between dorsal and ventral walls of the body limits their presence. Between the acetabulum and the ovary they are restricted to narrow tracts at the sides of the body lateral to the intestinal diverticula.

The genital pore is dorsal in position, situated near the middle of the body, slightly at the left of the median line. The diverticulum of the intestine and the vitelline tube of that side are bent mediad at the level of the pore, and lie median to it. This condition suggests strongly that the genital pore has migrated from a ventrolateral or lateral to a dorsal position pushing the intestinal and vitelline structures before it.

The uterus is short and in only one out of many individuals examined has an egg been found in the body. Considering the size of the egg it appears certain that not more than a single egg can be present in the uterus at one time. The egg (Fig. 2) is tricornuate, the shell is thick and resistant to pressure although almost colorless. In the body the egg lies in the uterus with the single horn forward and the forward tip is often bent or slightly coiled. The eggs reach the outside world with the feces of the host and are often present in large numbers. Eggs in the feces measured 0.27 mm. in length, 0.07 mm. in width at the level of the embryo and 0.2 mm. between the tips of the posterior horns.

Holotype.—No. 125, Dept. Lower Invertebrates, Amer. Mus. Nat. Hist.

SPIRORCHINÆ

The subfamily Spirorchinæ is characterized as follows.

Hermaphroditic blood inhabiting monostomes with small oral sucker. Esophagus without pharynx and surrounded by secretive cells which are more numerous near its posterior end. Ceca end blindly near posterior end of body; excretory

vesicle small, dividing almost immediately into lateral collecting ducts. Testes numerous (usually ten) arranged in a linear series in the intercecal area anterior to the ovary; cirrus sac small; ovary dextral in position between the testes and the genital pore; seminal receptacle and Laurer's canal present; vitellaria both extra and intercecal; genital pore ventral, sinistral, near the posterior end of body; uterus short, containing a single oval egg.

Henotosoma, new genus

This genus is characterized by the small oral sucker and relatively short esophagus; absence of pharynx; terminal excretory pore and excretory vesicle which divides almost immediately to form lateral collecting ducts; testes usually ten in number, irregularly lobate or sinuate, arranged in linear series anterior to the ovary but situated in the posterior half of the worm; seminal vesicle posterior to the testes with only the terminal part of the vas deferens enclosed in a small cirrus sac; genital pore ventral, sinistral, near the posterior end of the body; vitellaria numerous, extending from the bifurcation of the alimentary tract almost to the posterior end of the body; ovary oval, lobed, on the right side of the body; small seminal vesicle and Laurer's canal. The uterus is short and contains a single oval egg.

Henotosoma hæmatobium, new species

Figure 3

The first specimen of this form was found December 1, 1914, in the lung of a large turtle collected near Raleigh, North Carolina. In the fall of 1916, six specimens were removed from the left subclavian artery of another turtle from the same locality. Since that time other specimens have been removed from the heart and larger arteries of turtles collected in New York and New Jersey. In November, 1921, a shipment of turtles was received from North Judson, Indiana, seventy-five per cent of which harbored the parasite. Records of dissection show one turtle in which twelve specimens were found in the lungs, four in the pulmonary arteries, two in each auricle, sixteen in the ventricle, eight in the mesenteric arteries and twenty eight at the posterior end of the aorta. Where several worms were found together, they were often entangled and very hard to separate. Those found in the ventricle frequently were partially embedded in the muscular wall.

These worms are elongate, flattened trematodes with almost parallel sides, rounded posterior and pointed anterior ends. The anterior end in extended condition narrows uniformly to the tip and when contracted becomes broad and blunt with crenated margins. Extended individuals are widest in the region occupied by the testes and have a narrow zone in the central part of the body. On contraction, the body anterior to the testes becomes approximately the width at their level. Living worms may extend to a length of 12.5 mm. and contract to less than 6 mm. Fixed and mounted specimens measure from 5 to 9 mm. in length and from 0.48 to 0.75 mm. in width. The width is from two to three times the dorso-ventral measurement.

The cuticula is thin and smooth, lacking spines or other modifications. The musculature is light and delicate.

The oral sucker is the only organ of attachment. It is situated at the anterior tip and in extended specimens slightly protrudes from the body. It is ovoid in shape, wider anteriorly and measures from 0.077 to 0.1 mm. in length and from 0.071 to 0.084 mm. in width. The mouth opening is subterminal. Depending on the amount of contraction in the anterior region of the body, the esophagus is slightly or exceedingly sinuous, the sinuosity varying with the extent of contraction. In length it measures from 0.39 to 0.77 mm. It increases in diameter posteriorly although the size of the lumen is not uniform, frequently having one or more dilated portions. The lining is cuticular and throughout its length the esophagus is surrounded by secretive cells. At the posterior end for about one-fifth of its length the gland cells become more numerous forming a conspicuous enlarged portion. No pharynx is present. The intestinal diverticula arise just before the posterior end of the esophagus and pass laterad about one-half of the distance to the body wall where they turn sharply posteriad and extend almost to the end of the body. Their course is notably sinuous and they are spread farther apart in the region occupied by the reproductive organs, passing lateral to the testes and ovary. They have an almost uniform diameter and are filled with decomposing blood which gives them a black appearance.

The excretory pore is situated at the posterior end of the body and the vesicle divides almost immediately to form two lateral collecting ducts which pass anteriorly.

The reproductive organs resemble in many respects those of *Spirorchis*. The testes number ten in mature individuals although after a time certain testes degenerate. They are arranged one before the other in the intercecal area in the posterior half of the body. The most anterior testis is about three-fifths of the body length from the anterior end and the posterior testis is separated from the posterior end of the body by slightly less than one-half the distance between the anterior and posterior testes. The testes are irregularly lobed, contiguous structures. In the anterior testes the lobes are deep and the testes are distinctly separated, while in the middle of the group the lobulations are smaller, less conspicuous, and the organs closer together. The testes are flattened antero-posteriorly, and this is particularly noticeable at the center of the group where the pressure is greatest. In the testicular area they occupy practically all the space between the ceca but do not extend laterally beyond the intestinal diverticula. Because of their shape it is difficult to make satisfactory measurements of the testes but they vary in size from 0.12 by 0.27 mm. to 0.27 mm. by 0.43 mm. The posterior testis opens directly into a large ovoid or pyriform seminal vesicle. The broader end is anterior and the posterior end tapers to a duct which passes on the left side of the body and near the mid-ovarian level enters the cirrus sac. The cirrus sac is small and the muscular wall slightly developed. It is pyriform in shape, wider anteriorly, and the prostate if present is represented by only a few cells. The cirrus sac varies in length from 0.154 to 0.22 mm. and in width from 0.05 to 0.077 mm. The genital pore is ventral, just posterior to the level of the ovary, and situated beneath the cecum of the left side. The opening of the cirrus is anterior to that of the uterus.

The ovary is a lobed oval structure situated on the right side of the body between the seminal vesicle and the genital pore. It measures from 0.154 by 0.22 mm. to 0.23 by 28 mm. The oviduct arises at the median posterior margin and passes dextrad and posteriad. After continuing a short distance it turns mediad where Laurer's

canal is given off and the common vitelline duct is received. The oötype region is short and the tube then passes forward, laterad and ventrad to the genital pore. The vitellaria are extensively developed and consist of masses of follicles extending from the bifurcation of the alimentary tract almost to the posterior end of the body. They are not separated into lobes but form a continuous sheet of cells extending on the lateral side of the crura throughout their length and filling the intercecal area anterior to the testes and posterior to the vitelline receptacle. Just behind the level of the genital pore vitelline ducts pass mediad on the ventral side of the body and unite to form a large reservoir, the vitelline receptacle, which opens into the oötype through the common vitelline duct.

The uterine portion of the female canal is short and contains a single oval egg. A metraterm is present although not strongly developed. The eggs are thick shelled, brown in color and are discharged into the blood vessels. The smallest egg measured in the uterus was 0.77 mm. in length and 0.06 mm. in width, the largest 0.086 mm. in length and 0.065 mm. in width. Eggs in the tissue of the host and found in the feces have an average measurement of 0.115 mm. in length and 0.081 mm. in width. The eggs increase in size after deposition and usually become darker in color. They are provided with a cap which opens to allow the escape of the embryo.

Holotype.—No. 126, Dept. Lower Invertebrates, Amer. Mus. Nat. Hist.

In the abstracts of papers presented at the annual meeting of the American Association for the Advancement of Science, December 28–30, 1921 and published in the January number of the Journal of Anatomy, G. A. MacCallum reported the discovery of trematodes in the heart of *Chelydra serpentina*. He says: "On July 17, 1921, I found within the heart of a *Chelydra serpentina* (western form) five Spirorchidæ which were attached to the walls of the ventricle, but all coiled together as if in coition. These worms were the largest of any Spirorchidæ I had seen, being in length 8.50 to 9 mm. × 1 mm. wide, and which I have named *S. chelydræ*. The peculiarity about these worms is the much bent esophagus, also the numerous glands at the junction of the esophagus and ceca and possibly posterior also on the outside of the esophagus to the mouth." The statement of MacCallum is so brief and indefinite that it is hardly possible to recognize a species from his description. The last sentence would indicate that the mouth is posterior, which certainly is not the case. The only data upon which a determination from his description could be based are size and location in the host. The course of the esophagus is dependent upon the amount of extension or contraction in the anterior part of the body and the esophageal glands mentioned are characteristic of blood flukes in general. Consequently these features can not serve as specific criteria.

It seemed barely possible that the species reported by MacCallum might be the same as the larger of the forms here described, and to avoid error on this point I wrote Dr. MacCallum asking for a loan of his

material. Although his final description had not as yet been published he kindly loaned material for examination and comparison. The specimens examined manifest the features designated as characteristics of the new genus *Henotosoma* and should, I believe, be assigned to that genus. They are not, however, in my opinion specifically identical with *H. hæmatobium* and their completed description will be made by Dr. MacCallum.