HELMINTH PARASITES OF THE PACIFIC TERRAPIN, CLEMMYS MARMORATA (BAIRD AND GIRARD)

by

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TABLE OF CONTENTS

HELMINTH PARASITES OF THE PACIFIC TERRAPIN, CLEMMYS MARMORATA (BAIRD AND GIRARD)

INTRODUCTION

Clemmys marmorata is relatively restricted in range. The species is almost entirely confined to the area west of the Cascade and Sierra Nevada ranges of Washington, Oregon, and California. This may, in part, account for the dearth of helminthological data for the species up to now.

Apparently the only previous examination of C. marmorata for parasites was that of Ingles (14, pp.101-103) who dissected two of these turtles from California in 1929. He described the species of the trematode genus Telorchis which is reported in the present paper.

Six of the helminths found in this study represent new host records. Among the numerous investigators who have previously examined other species of North American turtles, and have found some of the same parasitic worms are: Stunkard (36, pp.97-117) in Florida; Harwood (8, pp.98-101; 9, pp.1-71) in Oklahoma and Texas; Rausch (27, pp.434-442) in Ohio; Bennett and Sharp (2, p.241) in Louisiana; and Caballero (5, pp.275-282) in Mexico.

Investigators who have contributed valuable taxonomic works on these chelonian parasites include: MacCallum (18, pp.103-120) and Stunkard (34, pp.1-46) on polystomid monogenes; Byrd (4, pp. 116-160), Stunkard (35, pp.165-221), Ward (42, pp.114-128), and MacCallum (20, pp.97-103) on digenetic trematodes of the family Spirorchidae; and Wharton (43, pp.497-518) and Stunkard (33, pp.57-66) on Telorchidae; and Baylis and Clayton (1, pp.245-310), Hedrick (10, pp.397-409) and Walton (40, pp.49-163) on nematodes.

Life histories have been determined for some of the helminths encountered in the present study. Notable in this respect are the studies of Pieper (25, pp.310-325) on Spirorchis artericola and McMullen (22, pp.248-250) on Cercorchis medius (equals Telorchis corti).

METHODS AND MATERIALS

Most of the pond turtles used in the study were obtained by trapping. Traps used were made of inch and a half wire mesh. The traps were cylindrical in shape, and were two feet in diameter by three feet in length. To add rigidity, three iron rings were wired in to each trap. One end of the device was closed, also by wire mesh, while the other end was equipped with a wire mesh funnel which sloped inward and constricted the opening to about five inches.

In using this type of trap, one should go up stream from the known or suspected concentration of turtles. When setting in a slough or pond it is best to go to the side where the water flows in. By this means the aroma or taste of the bait can flow with the water current and attract turtles from some little distance.

Fresh meat was used for bait. Since chicken was found to be quite effective, it was used exclusively. The bait was carefully suspended mid-way in the trap so that turtles could not reach it without going inside. It was found that bait left out more than two days was completely ineffective in attracting turtles.

In setting, it was customary to place the trap longitudinally in such a manner that the water came up half way and just covered the bait. It was necessary to have an air space in the trap so that the reptiles would not drown, but at the sametime, the bait had to be in the water so its flavor could disseminate.

Turtles were anesthetized, prior to dissecting, in a killing jar containing either chloroform or ether. The former seemed to work a little faster, and was therefore used most often. However, the ether had the advantage of leaving the animals in a more relaxed state. Immediately before dissecting, the longitudinal length of the carapace and the sex of each turtle were determined and recorded.

The hard bony exterior of the animals used in the study presented some difficulties to dissection not found in other groups. The first step followed was to cut through the area where the plastron joins the carapace on both sides with a hacksaw. With this done it was possible to remove the plastron by cutting loose the ventral musculature with a scalpel.

At this point in the operation the head and neck were usually severed and placed in a separate dish. The jaw was then loosened by cutting through the joint on each side with a diagonal cutter, and the inner surfaces of the throat and mouth were exposed by a longitudinal slit down one side. These areas were carefully examined under low power of a dissecting microscope for monogenetic flukes.

After this the specimen was eviscerated. The heart, lungs, liver, and oviducts, if any, were placed in separate dishes of water for later examination while the digestive tract was slit longitudinally and examined carefully. After all the visible helminths were removed from the opened digestive tube, both the large and small intestines and their contents were washed in separate dishes of water. Often additional worms were found in this way that had been missed during the preliminary inspection. Considerable care was taken never to discard a dish of water, which had contained any of the organs, before it had been inspected under the dissecting scope.

The heart, lungs, and larger mesenteric arteries and veins were customarily examined for blood flukes. To facilitate examination of the lungs it was found advisable to compress them between two small panes of glass. With a lung cut open, spread, and compressed in this way it was possible to examine both sides and quickly ascertain if any flukes were present.

Trematodes, upon removal, were compressed moderately between slides or under a coverslip and fixed in an Alcohol-Formalin-Acetic acid solution. Whole mount preparations were made using Mayer's carmalum stain, and serial sections ten microns in thickness were stained with Harris' haematoxylin and eosin.

Nematode slides were prepared by transferring the worms directly from the fixative solution to a slide, and mounting them in Polyvinyl Alcohol medium prepared according to Rubin (28, pp.257-260).

The drawings of the worms were made with the aid of a B. and L. triple-purpose projector.

PRESENTATION OF DATA

Between May 18 and October 1, 1953, a total of 64 Pacific terrapins were trapped in western Oregon and dissected for helminth parasites. A total of 1,236 adult trematodes and nematodes were collected. Some 263 larval nematodes and 2 larval trematodes were also found. The larval worms could not be identified with certainty, but the adults were found to comprise seven species.

Turtles were collected from two separate river systems which are about two hundred miles apart. Twelve turtles were taken from the Calapooya River, in Linn County, which is a part of the Willamette River drainage. The remainder of the turtles were trapped along the Rogue River and its tributaries in southern Oregon. Five of the specimens were from Kelly's Slough, immediately above Gold Ray Dam; 3 were from Antelope Creek at a distance of about four miles from its confluence with the Rogue River; 11 were out of Big Butte Creek at a distance of one-half mile from the river; 28 turtles came from Emigrant Creek near the irrigation project known as Emigrant Dam; and the other 5 were from a small unnamed slough along the Rogue River about two miles upstream from Dodge Bridge. All of these sites are in Jackson County, Oregon.

Systematic List of Species

Phylum Platyhelminthes Gegenbaur 1859

Class Trematoda Rudolphi 1808

Subclass Monogenea Carus 1863

Family Polystomidae Gamble 1896

Neopolystoma orbiculare Stunkard 1916

Only two specimens of this species were found in the present study. These flukes were collected singly from the urinary bladders of two turtles trapped on the Rogue River drainage. One host was from Big Butte Creek while the other was from Emigrant Creek. Both localities are in Jackson County. This represented only about three per cent of infection for this species in the material studied.

The present specimens do not differ in any significant way from Stunkard's description (34, pp.31-34) for the species. However, this apparently represents the first record of it for Clemmys marmorata. The species was described from Pseudemys scripta and Chrysemys bellii marginata, and has also been reported from Pseudemys elegans, P. troosti, Chrysemys picta, Amyda ferox, and Malaclemys centrata.

This monogene has been reported previously from North Carolina, Iowa, Illinois, New York, Minnesota, Oklahoma, Florida, and Texas.

Genus Polystomoides Ward 1917

Polystomoides coronatus (Leidy 1888)

This fluke was found to be a fairly common parasite of C. marmorata. Sixty-one of these worms were collected from the oral cavities of 20 turtles. This was an infectivity of about 32 per cent. The Calapooya River turtles were somewhat more heavily infected than were the Rogue River ones. Exactly half of the Calapooya River turtles were found to be infected, and greater numbers of worms per individual were encountered. The heaviest infection was seventeen worms from a single host. The average number per infection in Calapooya River material was six individuals while the average for Rogue River hosts was two with a maximum number of six.

Present specimens agreed with Stunkard's description (34, pp.40-42). Hughes et al. (13, p.133) recorded the previous hosts for the species as: *Chrysemys picta*, *Graptemys geographica*, *Pseudemys scripta*, *Trionyx ferox*, and *T. spinifera*.

It has been reported from the states of Texas, Iowa, North Carolina, and Massachusetts, to which may now be added Oregon.

Subclass Digenea Carus 1863

Order Fasciolata Nicoll 1936

Family Paramphistomidae Fischoeder 1901

Ophioxenos dienteros Sumwalt 1926

Twelve specimens tentatively identified as *O. dienteros* were taken from three Calapooya River terrapins. Infections numbered one, four, and seven flukes per host, respectively. None of these paramphistomes was encountered in Rogue River material.

Although several of the specimens were plainly immature, three of them had well-developed testes, ovary, and vitellaria, even though no ova were present. Since Sumwalt's paper is incomplete, and present material differs somewhat, a description is included here.

All measurements are of the most mature specimen found, and are given in millimeters. In living material the posterior sucker is large and spherical. The body is tapering and is round in cross section. The entire worm measures 2.40 x 0.88. The widest part of the body is at the level of the anterior edge of the posterior sucker. The posterior sucker is circular in outline and measures 0.67 in diameter.

The oral sucker is 0.31 long x 0.22 wide. The oral pouches are two in number, and are 0.145 long x 0.078 wide. The esophageal bulb is large, spherical, muscular, and 0.117 in diameter. The esophagus measures 0.202 from the posterior end of the oral sucker to the anterior end of the esophageal bulb. The intestinal caecae extend to within 0.08 of the edge of the posterior sucker. The caecae vary in width with the amount of food within, but are 0.12 in the larger specimen.

The anterior testis is ovoid, and is 0.31 long x 0.23 wide. The posterior testis is slightly ovoid and measures 0.26 long x 0.24 wide. The anterior testis is slightly displaced toward the right side of the body while the posterior one is displaced toward the left. This is not invariable, however. In one individual the anterior testis is the one on the left. The two testes are 0.0027 apart. The cirrus sac lies on the midline just posterior to the intestinal bifurcation, and it is 0.162 long x 0.0775 wide.

The ovary is ovoid, posterior to the testes, and is 0.137 long x 0.112 wide. The vitellaria are about 24 in number and average 0.07 in diameter. The vitellaria surround the ovary, are posterior to the testes, and are confined between the intestinal caecae.

The excretory vesicle is sac-like and is situated medially near the anterior edge of the posterior sucker. A short duct leads from the excretory vesicle to the excretory pore which is dorsomedial in position. Two collecting ducts from the region of the intestinal bifurcation lead down each side of the body immediately dorsal to the median borders of the caecae. These enter the excretory vesicle from the sides.

Sumwalt (38, pp.73-102) described the genus Ophioxenos and the species O. dienteros from a garter snake (Thamnophis sp.) which came from San Juan Island, Puget Sound, in 1926. Travassos (39, p.101) in his 1934 synopsis of Paramphistomes, recognized the genus as valid. Skriabin (30, p. 451) in his monograph on trematodes, also considered the genus valid, and he placed it in his family Diplodiscidae (Subfamily Schizamphistomatinae Looss 1912). Both of these papers included Sumwalt's description.

The present material appears to fit Sumwalt's species in that it is of similar size, has a large posterior sucker, large oral pouches, an esophageal, or pharyngeal, bulb, non-linear arrangement of the testes and ovary, intestinal caecae which reach to near the posterior sucker, a genital pore at the level of the intestinal bifurcation, vitellaria which are limited to the area posterior to the testes and between the intestinal caecae, and a sac-like excretory vesicle at the anterior edge of the posterior sucker.

Apparently, the only other species ascribed to this genus is that of Parker (23, pp.27-44). He described O. singularis, also from a garter snake, taken in Tennessee in 1941. The principal similarity between O. dienteros and O. singularis seems to be one of host. In O. singularis the oral pouches are reported as small, and the vitellaria overlap the intestinal caecae to a considerable extent. These two characteristics should be sufficient to exclude the species from the genus Ophioxenos. At any rate, these two facts make O. singularis quite dissimilar to present material.

The present paper apparently represents the only record of O. dienteros from a chelonian host. Present material differs from Sumwalt's description in having larger testes, and smaller vitellaria. It is possible that this is a developmental difference or one caused by the different physiological environment of an unusual host.

Family Plagiorchiidae Ward 1917

Subfamily Telorchiinae Looss 1899

Genus Telorchis Luhe 1899

Telorchis corti Stunkard 1915

Considerable numbers of this distome were found in the small intestine of terrapins from every collecting site. This was the commonest fluke encountered. Five hundred and twenty-nine of T. corti were collected from 21 host reptiles which is an infectivity of 33 per cent. The largest single infection consisted of 153 worms. Ingles (14, pp.101-103) was the only previous investigator to examine C. marmorata, for parasites. He dissected 2 turtles from California and described a fluke which he called Telorchis stenonoura. Hughes et al. (13, p.126) listed Ingles' species as a synonym of Stunkard's (33, pp.57-66) earlier species, T. corti. Present material fits either description equally well, which supports this opinion.

McMullen (22, pp.248-250) recorded the life cycle of a fluke which he called Cercorchis medius. This fluke is also listed by Hughes et al. (13, p.126) as a synonym of T. corti.

The hosts of T. corti include these North American turtles: Chelydra serpentina, Chrysemys picta, Clemmys gutata, C. insculpta, C. marmorata, Deirochelys reticularia, Graptemys geographica, Malaclemys pileata, and Pseudemys scripta.

Order Sanguinicolata Nicoll 1939

Family Spirorchidae MacCallum 1921

Genus Spirorchis MacCallum 1918

Spirorchis artericola Ward 1921

This blood fluke was found only in the arterioles of the lungs. Ova of the worm are relatively large, and are brownish in color which makes them easy to see in the tissues. Eggs were numerous in a large percentage of the turtles examined. They were found to occur in greatest numbers throughout the lungs, but they were present also in the intestinal walls, urinary bladder walls, heart, liver, and other organs all over the body. The adult flukes, on the other hand, are thin and nearly transparent, and can be seen in the arterioles only under ideal conditions. Only 20 flukes were recovered from nine infected turtles. This is a total of only 14 per cent of infectivity even though ova were visible in over eighty per cent of the turtles examined. The presence of ova in a given host would not necessarily indicate the presence of adult flukes, however. The eggs would be likely to remain in the body long after the worms which produced them had perished.

Other investigators, notably Ward (42, p.116) have encountered this difficulty of locating S. arter icola. There seems to be no way of being certain of getting all of these flukes that may be present. It was found that the lungs could be examined with a fair degree of thoroughness by the method, already mentioned, of compressing them between panes of glass. The flukes are quite active, however, and could easily crawl out into the peripheral blood vessels where they would be hard to find. Doubtless many were missed in this way.

Present material is in no way different from the descriptions given by Ward (42, pp.114-128), or Skriabin (31, pp.24-32).

The life cycle of this worm has recently been worked out by Pieper (25, pp.310-325). She used specimens from the turtle Chrysemys picta.

The hosts of S. artericola include Chrysemys picta, Graptemys geographica, G. pseudogeographica, Pseudemys floridana, and P. scripta, to which the present paper adds Clemmys marmorata.

Phylum Nematoidea Rudolphi 1808

Class Phasmidia Chitwood and Chitwood 1933

Order Rhabditida Chitwood 1933

Suborder Ascaridata Skriabin 1915

Family Kathlaniidae Travassos 1918

Spironoura affine Leidy 1856

Three hundred ninety-four round worms of this species were taken from the large intestine of 20 specimens of C. marmorata. The largest single infection numbered 107 worms. The incidence of infection for this species was about 31 per cent.

Leidy (17, p.42) described the species from the turtle Emys orbicularis in eastern North America. In 1915 Lane (16, p.109) described the genus Falcaustra which is considered a synonym of Spironoura by both Mackin (21, p.7) and Caballero (5, p.276). Harwood (9, p.44), however, retained the genus Falcaustra because Leidy's type specimen for the genus Spironoura (S. gracile) has subsequently been lost and never rediscovered or redescribed. Therefore, it would be impossible to tell if the two genera are synonymous. The present paper recognizes that Harwood had justification for his view, but it follows the classification of the more recent writers, Mackin and Caballero.

Boulenger (3, pp.49-53) described Falcaustra chapini, which Harwood (9, p.55) considered a synonym of the present species, from Terrapene carolina. Mackin (21, pp.1-64) described S. concinnae from Pseudemys concinna. Caballero (5, p.276) considered this species another synonym of S. affine. Rausch (27, p.434-442) added Emys blandingii and Graptemys geographica to the host list.

Suborder Spirurata Railliet and Henry 1913

Family Gnathostomidae Railliet 1895

Spiroxys contortus Rudolphi 1819

This was the commonest parasite encountered in the present study. Although the largest single infection consisted of only nineteen worms, the incidence of infection was over 84 per cent. The total number of worms of this species collected was 214, and the average number per infection was four.

This nematode was almost always found with its anterior end buried in the wall of the stomach. The worms seemed to prefer the anterior end of the stomach near the entrance of the esophagus. The worms commonly occurred in groups of 3 to 6 with their anterior ends anchored close together in the mucosa, and with the rest of their bodies much coiled and entwined.

Rudolphi (29, p.439) described the species from material out of the stomach of Chrysemys picta. Rausch (27, p.440) listed as hosts of S. contortus these Ohio turtles: Amyda spinifera, Chelydra serpentina, Chrysemys bellii, Graptemys geographica. Harwood (9, p.66) added Pseudemys elegans, Deirochelys reticularia, and Sternotherus odoratus from Texas to the list. Caballero (5, p.281) reported the species from Chrysemys ornata in Mexico. The present paper apparently is the first record of the species in C. marmorata.

Resistance to Parasites

One of the interesting things brought to light by the present survey was the apparent age, or size, resistance of C. marmorata to its parasites. During the dissecting it soon became strikingly obvious that the chance of finding helminths was much greater for the small turtles than for the large ones. This trend is best seen in data of the intestinal fluke Telorchis corti, but of the four large terrapins examined (16 to 18 cm. in length) none contained any specimens of T. corti, Polystomoides coronatus, or Spironoura affine.

Considering only the 52 turtles from the Rogue River drainage, the incidence of infection with T. corti could be seen to decline markedly with increased size of the host. Above about 12.5 cm. in length, there was a sharp drop in the rate of infection. Turtles from 10 to 13 cm. (16 specimens) were 81 per cent parasitized with T. corti while those between 13 and 16 cm. (31 specimens) showed only 10 per cent infection by this species. Four terrapins larger than 16 cm. were examined and none contained any specimens of this fluke.

Table I shows this apparent resistance of the larger terrapins to infection by Telorchis corti.

TABLE I

Carapace length in cm.	No. of turtles examined	No. infected with *T. corti*	Rate of infection
10 to 11	6	5	83%
11.1 to 12	5	4	80%
12.1 to 13	5	4	80%
13.1 to 14	8	2	25%
14.1 to 15	17	3	18%
15.1 to 16	6	1	17%
16.1 to 18	4	0	0

DISCUSSION

There are two possible explanations for the apparent age resistance in turtles. One would be that of actual physiological age immunity which is rare for intestinal helminths. Another more plausible theory is that there could be differences in food or feeding habits of small turtles as compared to their larger relatives. This view may be partially supported by the fact that the small terrapins were often found to contain snails of the genus Physa in their stomachs and intestinal tracts while large turtles usually contained food such as insects and small fish. It is reasonable to assume that larger turtles could capture more active prey.

Direct infection of an animal by the cercarial stage of a fluke is possible, and this could account for the large numbers of T. corti and the high rate of infection in the small snail-eating turtles. McMullen (22, pp.248-250) reported the redial and cercarial stages of this species from a similar small snail.

Of the larval nematodes which were found, there were two types, Both were encountered encysted in the walls of the stomach and small intestine. It was surmised that these were the developing larvae of the two species of nematode which were found as adults, but this could not be definitely proved. An attempt to infect an Alligator lizard, Elgaria sp., with one type of larvae failed to produce results. Although some of the worms survived several weeks, they did not grow or mature.

SUMMARY

During the period of May to October, 1953, 64 Pacific terrapins, *Clemmys marmorata*, were dissected for helminth parasites. Of these 52 were trapped on the Rogue River drainage, Jackson County, Oregon, and 12 came from the Calapooya River in Linn County.

A total of 1,236 parasitic worms were collected, and were found to comprise 7 species. There were two species of monogenetic fluke, including 2 specimens of *Neopolystoma orbiculare*, and 61 specimens of *Polystomoides coronatus*. There were three species of digenetic fluke, including 12 specimens of a paramphistome tentatively identified as *Ophioxenos dienteros*, 529 specimens of *Telorchis corti*, and 20 of *Spirorchis artericola*. Two species of nematode were encountered, namely, *Spironoura affine*, 394 specimens, and *Spiroxys contortus*, 214 specimens.

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APPENDIX

PLATE I.

Neopolystoma orbiculare, ventral aspect

PLATE I

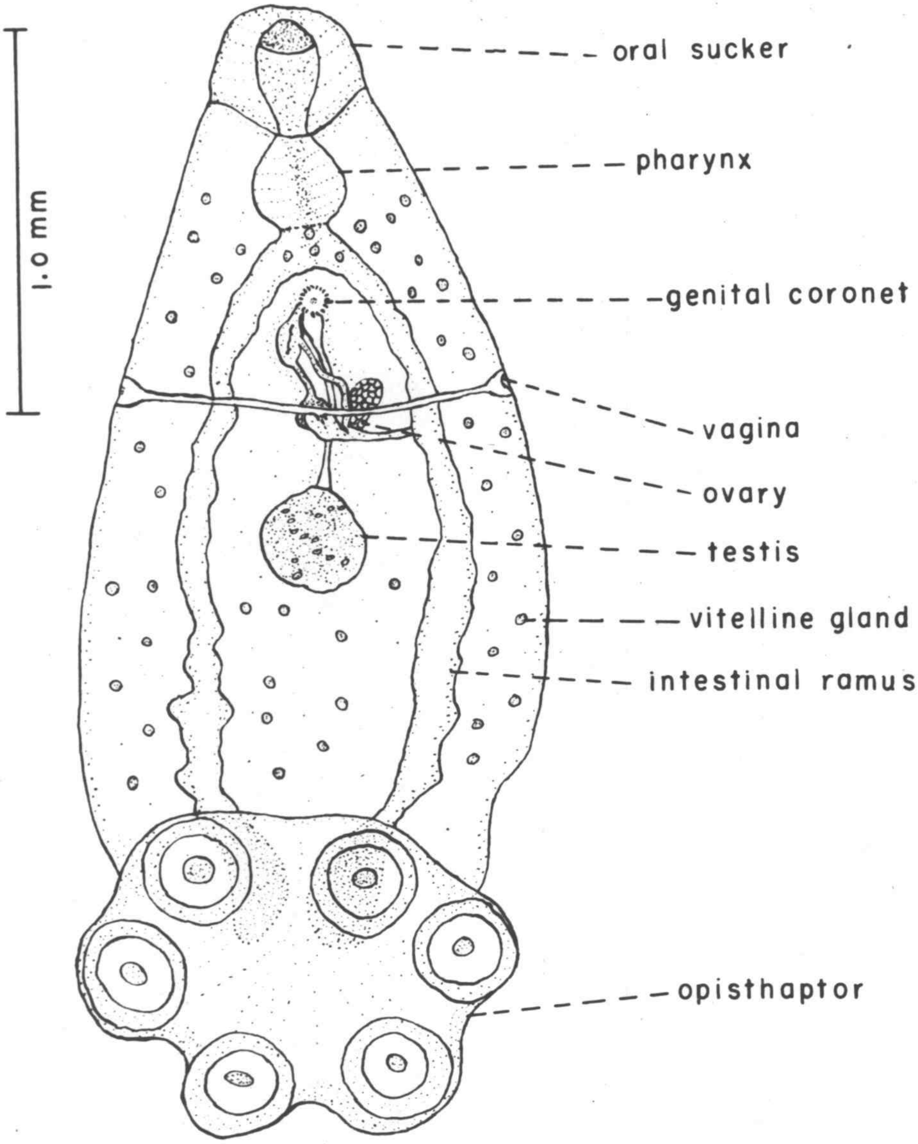
1.0 mm
oral sucker
pharynx
genital coronet
vagina
ovary
testis
vitelline gland
intestinal ramus
opisthaptor

PLATE II.

Polystomoides coronatus, ventral aspect

PLATE II

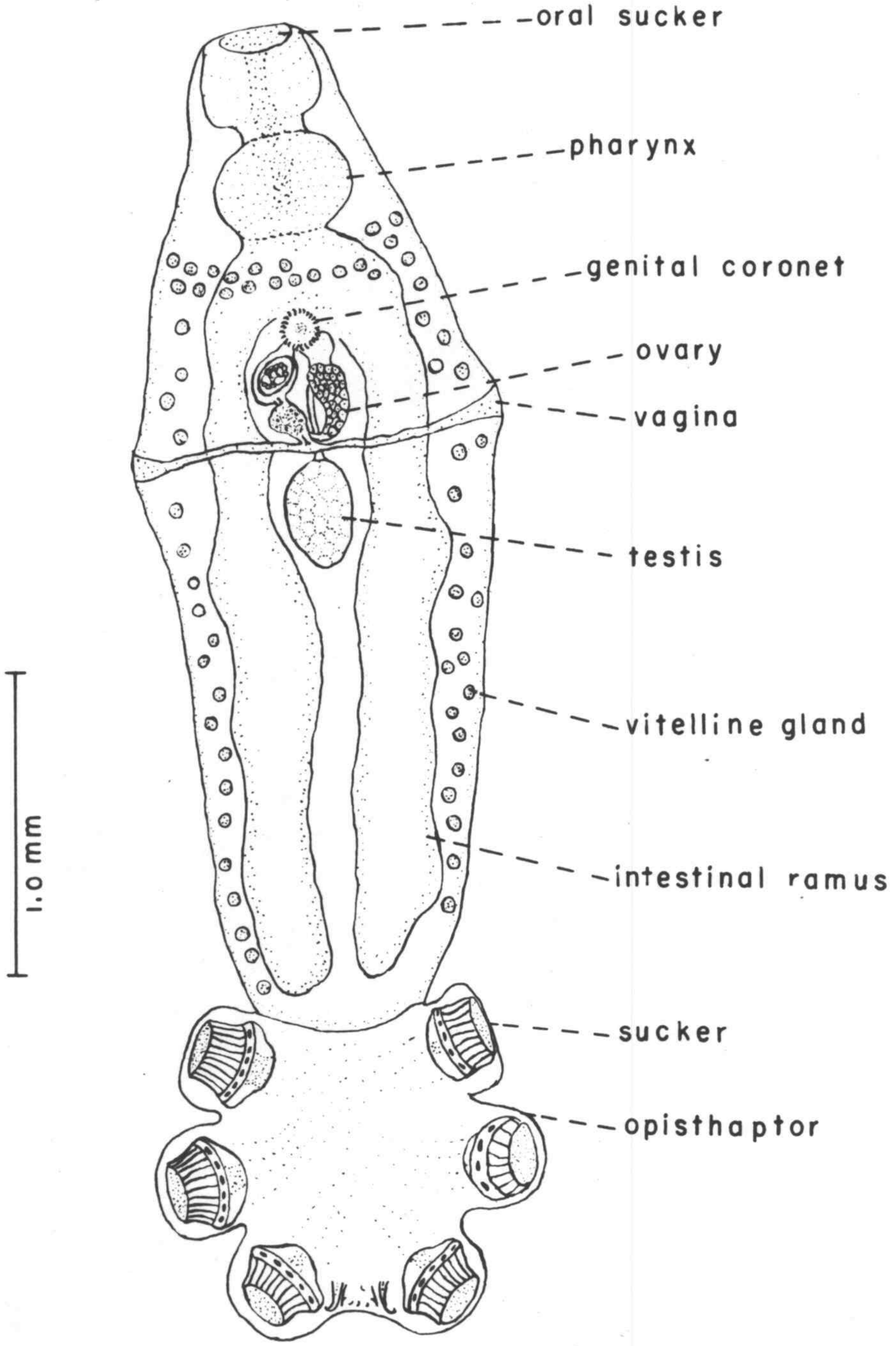
oral sucker
pharynx
genital coronet
ovary
vagina
testis
vitelline gland
intestinal ramus
sucker
opisthaptor
1.0 mm

PLATE III,

Ophioxenos dienteros, ventral aspect

PLATE III

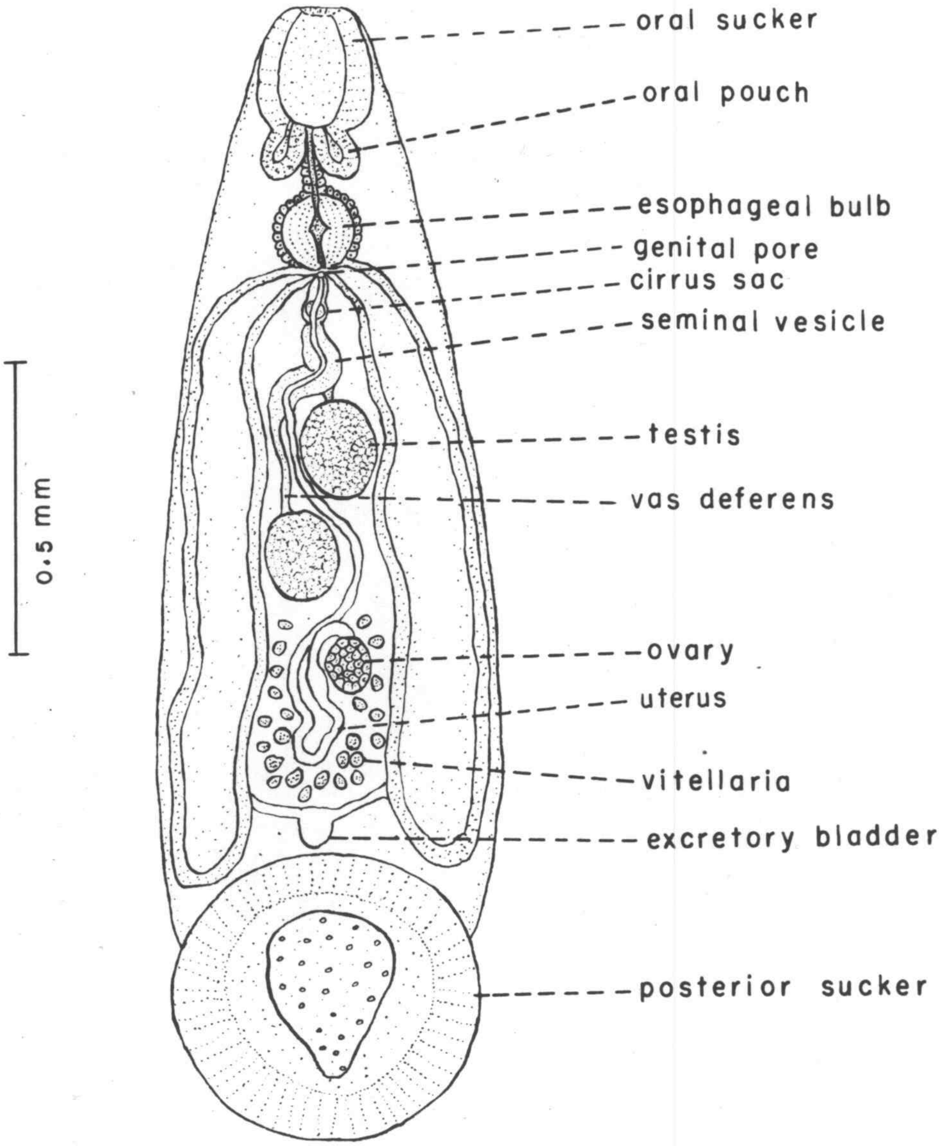
oral sucker
oral pouch
esophageal bulb
genital pore
cirrus sac
seminal vesicle
testis
vas deferens
ovary
uterus
vitellaria
excretory bladder
posterior sucker
0.5 mm

PLATE IV.

Telorchis corti, ventral aspect

PLATE IV

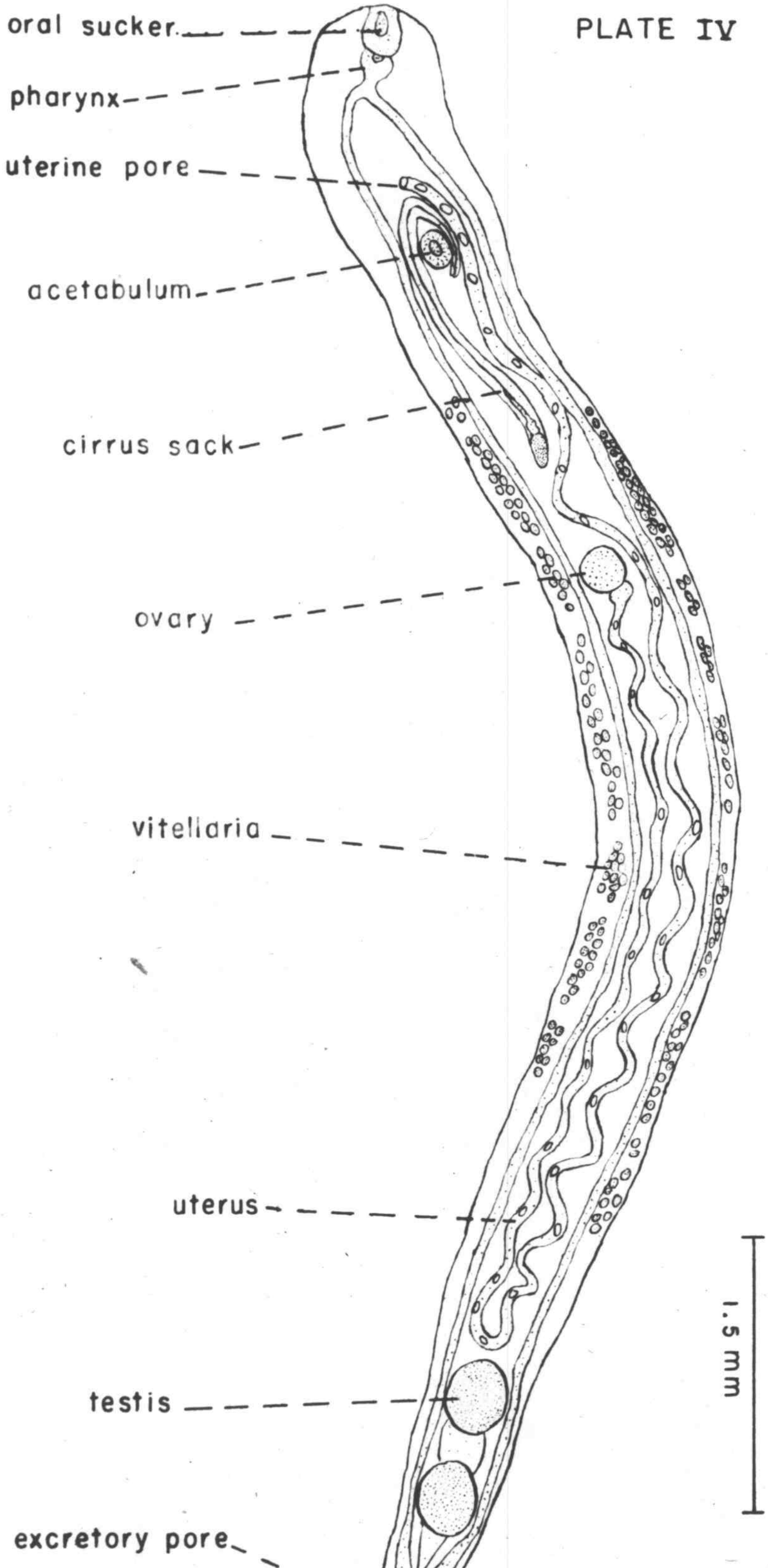
oral sucker
pharynx
uterine pore
acetabulum
cirrus sack
ovary
vitellaria
uterus
testis
excretory pore
1.5 mm

PLATE V.

Spirorchis arterícola, ventral aspect

PLATE V

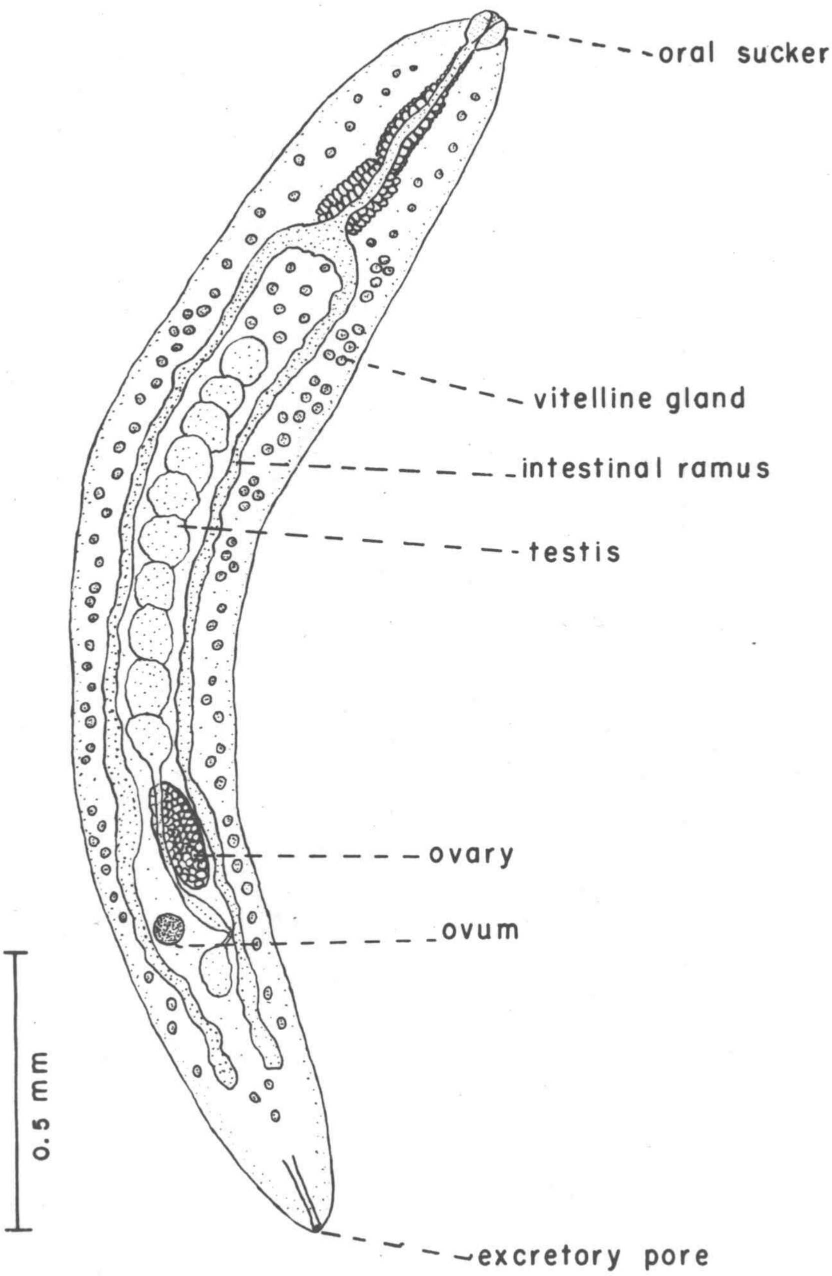
oral sucker
vitelline gland
intestinal ramus
testis
ovary
ovum
0.5 mm
excretory pore

PLATE VI

Spironoura affine

Figure 1.

female, anterior end

Figure 2.

female, reproductive organs

Figure 3.

female, posterior end

Figure 4.

male, posterior end

PLATE VI

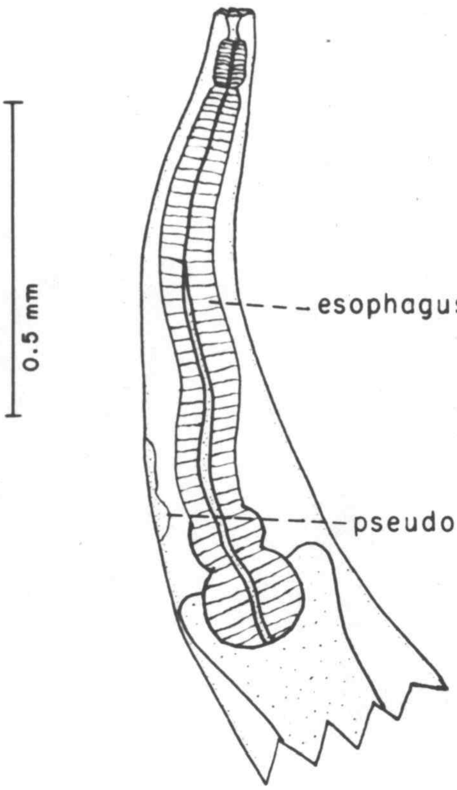

Fig. 1.

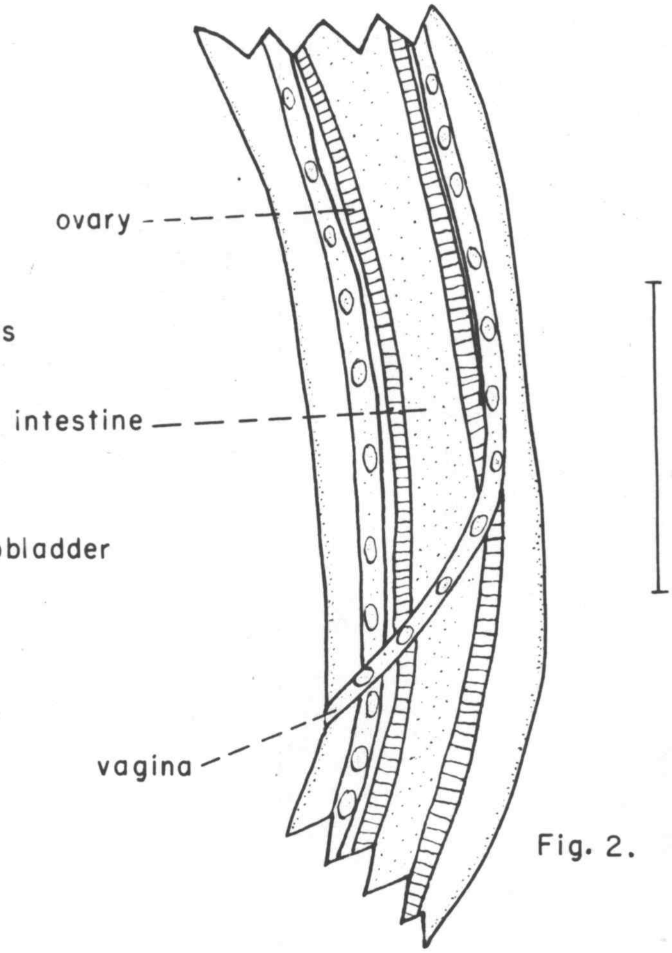

Fig. 2.

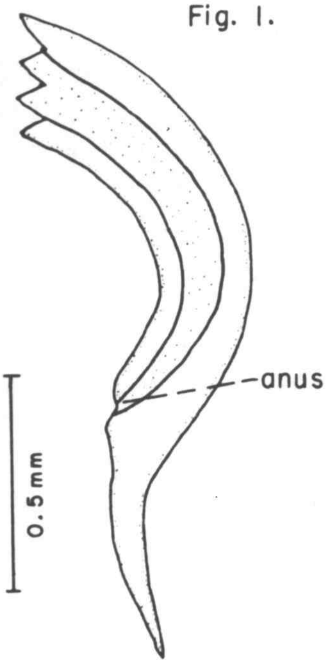

Fig. 3.

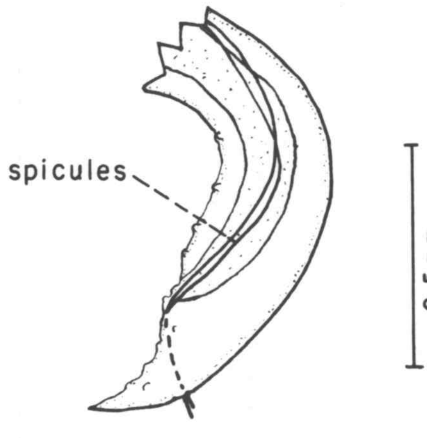

Fig. 4.

PLATE VII

Spiroxys contortus

Figure 1.

female, reproductive organs

Figure 2.

male, anterior end

Figure 3.

female, posterior end

Figure 4.

male, posterior end

PLATE VII

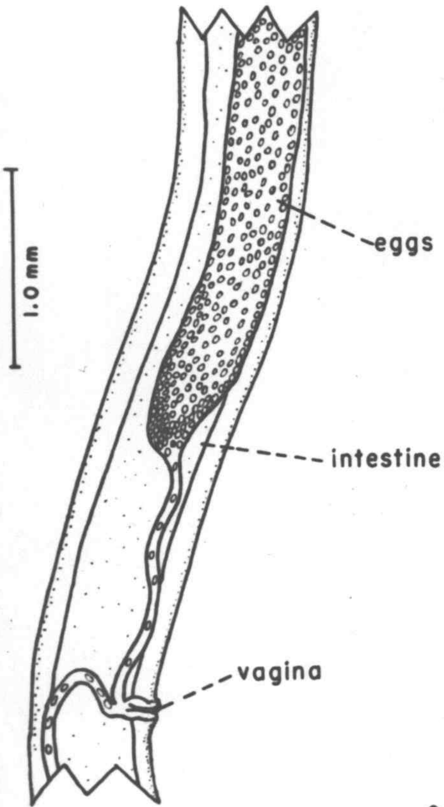

Fig. 1.

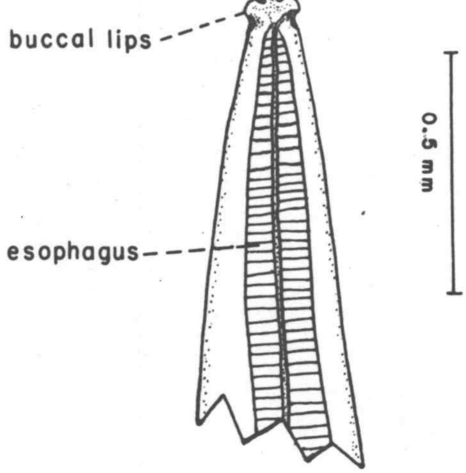

Fig. 2.

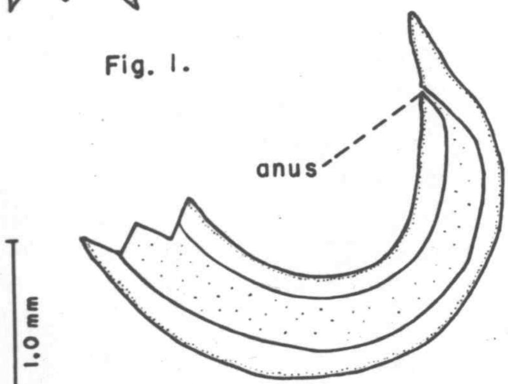

Fig. 3.

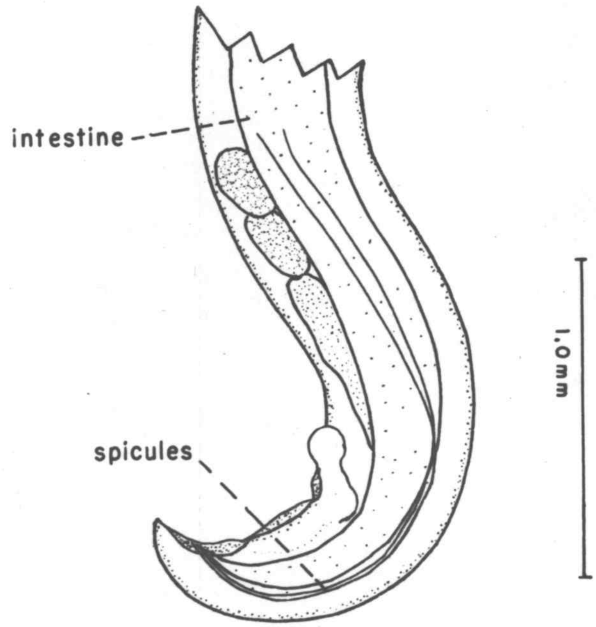

Fig. 4.