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A TAXONOMIC STUDY OF THE HELMINTH PARASITES OF THE TURTLES OF LAKE TEXOMA

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INTRODUCTION

This investigation is a comprehensive survey of the helminth fauna of six species of turtles taken from Lake Texoma and its Washita tributary, including a redescription of *Proteocephalus trionyechinum* Lonnenberg, 1894. The species of turtles involved as hosts are *Pseudemys scripta elegans* Schoepff, *Graptemys pseudogeographica* Gray, *Chelydra serpentina* Linnaeus, *Kinosternon subrubrum* Lacepedé, *Trionyx ferox emoryi* Agassiz, and *Trionyx spinifera* Le Sueur. Although I have included the snapping turtle as a host, no effort was made to collect this species in numbers corresponding to those for the other five, since Williams (1952) has published the results of a survey of the parasites of this form in Oklahoma. However, I did collect and autopsy 20 specimens of this species and recovered several species of trematodes belonging to the genus *Telorchis* which were not reported by Williams. These and other species of helminths taken from the snapping turtles are included in this study. Insofar as I can determine, no previous comprehensive study of the helminths of the turtles in Oklahoma has been attempted. In fact, only four publications dealing extensively with the parasites of the aquatic forms of this order of reptiles appear in the literature. Mackin (1927) described a new nematode, *Dracunculus globicephalus*, from *Chelydra serpentina* taken from the Ada City Lake, Ada, Oklahoma, and three years later Mackin (1930) reported a new pronocephalid fluke, *Macrovestibulum obtusicaudum*, from *Pseudemys scripta elegans* taken from Blue River near Connerville, Oklahoma. In 1936 Mackin reported two new species of nematodes, Spironoura wardi and S. concinnae, from Chelydra serpentina and Pseudemys concinna in Southeastern Oklahoma. Harwood (1931) described a new species of trematode, Polystoma stunkardi, from Pseudemys hieroglyphica taken from Lake Taliwanda, McAlester, Oklahoma, and Williams (1952) published the results of a survey of the helminths of Chelydra serpentina in Oklahoma. The present study contributes additional information to our knowledge of the helminthes of this order of reptiles, especially in Oklahoma.

A large amount of work has been done on the parasites of turtles from other areas of the United States and from other countries. Rudolphi (1819), working in Europe, reported Camallanus microcephalus, Atractis dactyluris, Spiroxys contorta, and Kathlania leptura from Emys lutaria, Testudo graeca, Emys spp. and Chelonia midas respectively. Leidy (1851) and Barreto (1917) reported Cissophyllus roseus and a new acanthocephalan, Echinorhynchus emydis, from Chrysemys scripta and Emys geographica respectively. Drache (1884) recovered five new species of nematodes Tachygonetria conica, T. dentata, T. longicollis, Mehdiella microstoma, and M. uncinata all from Testudo graeca. Linstow (1899) reported for the first time a new species of nematode, Tachygonetria macrolaimus, from Testudo tabulata. Van Beneden (1906) reported a new species of nematode, Proleptus tortus, from Cistudo ornata, and Raillet and Henry (1912) described a new nematode, Cissophyllus laverani from Testudo emys. Lane (1914) reported Tonaudia tonaudia from Chelonia midas and Gedoelst (1916) discovered a new species of Labiduris africana, from Cinixys erosa. Travassos (1917) reported Oswaldocruzia leidyi, a new nematode parasite from Cistudo carolina, and Seurat (1918) described six new species of the genus Tachygonetria, T. lambdiensis, T. nicollei, T. numidica, T. setosa, T. pusilla, T. weissi and a new species of the genus Spironoura, S. lambdiense, all from tortoises. Baylis and Lane (1920) described Spiroxys gangetica from Trionyx gangetica and in 1922 Baylis and Daubney reported four new species of nematodes: Spironoura testudinis and Zanclophorus kempi from Testudo elongatus; Spiroxys annulata and Zanclophorus annandalei from Chitra indica and Testudo travancorica respectively. Massino (1924) reported three new species of nematodes from Emys orbicularis, two of which belonged to the genus Spironoura, S. araxiana and S. armenica, and one to the genus Zanclophorus, Z. ararath. Thapar (1925) reported two new species belonging to the genera Tachygonetria (T. stylosa and Sauricola, S. echinopharynx) from Testudo ibera and T. tabulata respectively. Mackin (1927) described, Dracunculus globicephalus, from Chelydra serpentina, and in 1936 reported two new species, Spironoura wardi and S. concinnae from Chelydra serpentina and Pseudemys concinna respectively. Harwood (1932) reported Spironoura chelydrae from the snapping turtle, and Williams (1952) described the male of Capillaria serpentina.

A number of trematodes have been described from turtles. The first of these was described by Leared in 1862 and was designated Distoma constrictum from Thalassochelys caretta. In 1896 Monticelli suggested the name mistroides for Leared's species and transferred it to the genus Mesogonimus. In 1886 Poirier erected the genus Cephalogonimus to accommodate two new species of trematodes, C. americanus and C. vescaudum, from Amyda spinifera. Leidy (1888) described Polystomoides coronatum, a trematode recovered from Cistudo carolina. Hassall in 1896 redescribed the fluke, Monostoma molle Leidy, from Aromochelys odoratus as Pleorchis mollis.

Looss (1899) recovered several specimens of Mesogonimus Leared and Monticelli from Thalassochelys coricata from Egypt, but redescribed them as a new genus Hapalotrema. Goto (1899) reported a new trematode Polystomoides hassalli from Kinosternon pennsylvanicum, Aromochelys carinatus, and A. odoratus. Looss (1899) in his revision of the Class Trematoda proposed the sub-family Telorchiinae. In 1900 Stafford described Auridistomum chelydrae, from Chelydra serpentina, and MacCallum (1902) described Heronimus chelydrae from this host. Van Beneden, Baker and Covey (1911) erected the telorchid genus Protenes to accommodate two new species, P. leptus from Chrysemys marginata and P. augustus from Chrysemys marginata and C. picta. In the same year Goldberger (1911) reported three additional species of telorchid flukes, T. attenuatus, and T. stossichi from Emys orbicularis, and T. robustus from Cistudo carolina. Baker and Parsons (1914) reported two new flukes, Aorchus extensus from Chrysemys marginata and Cotylaspis cokeri from Malacoclemmys lesueurii. In 1915 Stunkard described Telorchis lobosus, T. corti, T. medius and T. diminutus from Kinosternon pennsylvanicum, and in 1916 he described six new flukes: Polystomoides orbiculare, from Chrysemys marginata and Pseudemys scripta; Polystomoides opacum from Trionyx ferox; Malacoclemmys lesueurii and Polystomoides microcotyle from Chrysemys marginata; and Allosostoma magnum and A. parvum from Pseudemys scripta and Chelydra serpentina respectively. MacCallum (1918) created a new genus, Spirorchis, to receive a fluke recovered from Chelopus insculpta Le Conte. Although this fluke was recovered from the intestine, it was reported as hematophagic due to the caecal content. In creating this genus MacCallum neglected to give a specific designation to the type species. In 1921 Ward proposed the genus Proparorchis with P. artericola Ward as the type, for materials collected from Pseudemys scripta, Malacoclemmys lesueurii, Pseudemys elegans, and Chrysemys marginata. In his 1921 paper Ward also suggested that the name S. innominata for the unnamed species of MacCallum's genus Spirorchis. Ward, recognized the close relationship between P. artericola and MacCallum's S. innominata, and in spite of the fact that MacCallum's fluke was recovered from the intestine, he assumed that it was a blood fluke and proposed a new family Proparorchiidae to accommodate these species. Stunkard (1921) announced the identity of the genera Spirorchis MacCallum and Proparorchis Ward and proposed the name Spirorchiidae for the family. Stunkard accepted the views of Ward concerning the genus Hapalotrema, and proposed to divide the family Spirorchiidae into the sub-families Spirorchiinae to accommodate the genus Spirorchis and Hapalotrema. Later the same year MacCallum (1921) added a third species, Spirorchis emydis, to the genus Spirorchis.

The next year Stunkard (1922) announced the discovery of two new genera of the family Spirorchiidae. They were Henotosoma, with the type haematobium belonging to the sub-family Spirorchiinae and Hapalorhynchus with the type gracilis belonging to the sub-family Hapalotreminae. In 1923 Stunkard created another new genus, Haematotrema, of the sub-family Spirorchiinae to contain a new species, H. gracilis, as type from Chrysemys picta, and in the same paper described three new species of the genus Spirorchis; S. scripta, S. elegans and S. picta. In 1925 he erected the fourth genus of the sub-family Spirorchiinae, Unicaecum, with the type U. ruszkowskii from Pseudemys scripta. In 1926 he proposed still another genus, Vasotrema, with V. amydae as the type species, from Amyda spinifera. This genus was the third to be proposed for the sub-family Hapalotreminae. MacCallum (1926) described three new species belonging to the genus Spirorchis; S. pictae, S. chelydrae, and S. blandingi. Commenting on the species, S. chelydrae, MacCallum observed that his species was identical with that described by Stunkard under the genus Henotosoma as H. haematobium. Ejsmont (1927) noted the differences of opinion expressed by various authors concerning the blood flukes of turtles and a study was made of certain European turtles for their blood flukes. In his report he removed Spirorchis blandingi MacCallum from the genus Spirorchis, since this species showed the presence of a testicular follicle posterior to the ovary and genital ducts, and created a new genus Diarmostorchis for its reception. In addition to this generic change, Ejsmont proposed a second new genus, Spirhapalum, with S. polesinanum as the type species. This genus was placed in an intermediate position between the genera Spirorchis and Hapalotrema, since the species showed body characteristics belonging to the Hapalotreminae but possessed spherical ova and miracidia with pigmented eye spots, which characterize the sub-family Spirorchiinae. Ejsmont (1927) called attention to the fact that in many cases it is practically impossible to detect the minor differences authors use as a basis for their claims of separation of species of the family Spirorchiidae. Stunkard (1928) recorded new observations on blood flukes of the genus Vasotrema with descriptions of two new species V. attenuatum and V. robustum from Amyda spinifera. In 1930 Harwood reported a new species of trematode which he designated Polystomoides stunkardi from Pseudemys heiroglyphica. Mehra (1933) proposed the genus Coeuritrema for two Indian representatives of the sub-family Hapalotreminae, C. lyssimus, and C. odhnerensis. In the same year, Thapar (1933) proposed the genus Tremarhynchus for the reception of T. indicus. Price (1934) described three new genera; Neospirorchis, with N. schistosomatoides as type belonging to the Spirorchiinae; Amphiorchis with A. amphiorchis as type; and Learedius with L. learedi as type and L. similis and L. europaeus as additional species belonging to the Hapalotreminae. Price (1934) reduced the genus Tremarhynchus Thapar to synonomy with Hapalorhynchus Stunkard, since he considered the differences between the species Hapalorhynchus gracilis and Tremarhynchus indicus to be specific rather than generic, and transferred the latter species to the former genus. In 1934 Mehra created the genus Plasmiorchis to contain P. orientalis as type and three additional species P. pellucidus, P. hardellii and P. obscurum. In this same year, Mehra (1934) called attention to the identity of Tremarhynchus Thapar with Coeuritrema Mehra, and proposed the reduction of Henotosoma Stunkard and Haematotrema to synonomy with Spirorchis. Senha (1934) erected the genus Gomotrema for the reception of G. sanguina from some of the turtles of India. In 1935 Luhman added the species H. synorchis to the genus Hapalotrema. Stunkard (1943) described Dictyangium chelydrae from the snapping turtle, and Byrd (1943) revised the family Spirorchiidae and described nine new species; S. blandingoides, from Pseudemys troostii and P. hieroglyphica; S. pseudemyae, from Pseudemys troostii; S. minutum and S. magnitestis from Chelydra serpentina; Hapalorhynchus stunkardi, from Kinosternon carinatum, H. reelfooti, and H. evaginatus from Amyda spinifera; Unicaecum dissimilis, from Pseudemys troosti; and Vasotrema longitestis, from Amyda spinifera. Williams (1952) reported four species of trematodes, Allossostoma parvum, Polystomoides oblongatum, Polystomoides coronatum, and Neopolystoma orbiculare as a part of the results of his survey of the helminth parasites of Chelydra serpentina.

The extensive investigations of the parasites of the turtles have revealed only two species of Cestoidea from the freshwater host turtles included in this study. The first of these, Tetrabothrium trionyechinum, was described from Trionyx ferox by Lonnenberg in 1894, and the other, Ophiotaenia testudo, was described by Magath (1924) from Amyda spinifera. Both of these tapeworms were recovered from soft-shelled turtles in this country.

The only species of Acanthocephala known from the turtles is Echinorhynchus emydis described by Leidy in 1851.

METHODS AND MATERIALS

Parasites involved in this study were obtained through autopsy of 20 specimens of Chelydra serpentina, 98 of Graptemys pseudogeographica, 70 of Kinosternon subrubrum, 97 of Pseudemys scripta elegans, 161 of Trionyx ferox emoryi and 124 of Trionyx spinifera, collected from the fish ponds of the Tishomingo Federal Fish Hatchery; Rock Creek, near Sulphur, Oklahoma; and Lake Texoma.

In addition to personal collections, discussed in the preceding paragraph, Dr. J. T. Self made available to me a considerable number of helminth parasites recovered from C. serpentina, G. pseudogeographica, P. scripta elegans, K. subrubrum, T. spinifera and T. ferox emoryi taken from Lake Texoma by him and his students at the University of Oklahoma Biological Station during the years 1951 through 1954. A majority of the hosts in both collections were captured in nets or in surface traps. The remainder were recovered by hand from fish hatchery ponds following draining. It was found that baited floating traps provided an effective means for trapping all of the hard-shelled species, except Kinosternon subrubrum. This species must be taken in a dip net or by hand since it will not enter either a submerged or surface-set trap. Submerged traps baited with dead rabbits proved to be the most effective method for capturing the two soft-shelled species. However, a considerable number of these were caught in fly nets. The latter method is effective except during the very cold months. During January and February the number of specimens recovered by any of these methods dropped to a very low level. Most of both hard and soft-shelled species taken during this period were captured in submerged traps baited with dead rabbits. These traps were set near the mouths of creeks flowing into the lake and at various locations on Rock Creek.

Preliminary studies of the gross morphology of the helminths recovered were made before they were killed. All hosts were killed by breaking their necks and were immediately autopsied. This method was used to prevent possible damage to endoparasites, particularly in the lungs and stomach.

All specimens were stored in 70% alcohol containing 1% glycerine. Delafield's hematoxylin, Mayer's paracarmine and picrocarmine were used to stain all "in toto mounts". Of these, Mayer's paracarmine proved to be generally the most satisfactory. All sections were stained with Delafield's hematoxylin and Mayer's paracarmine.

Standard procedures were used in the preparation of the paraffin sections. Nematodes and acanthocephalans were not stained, but instead were cleared with lacto-alochol for study.

OBSERVATIONS

Cestoidea

Three species of cestodes were recovered from the intestines of Trionyx ferox emoryi, Trionyx spinifera, Pseudemys elegans, and Graptemys pseudogeographica. These cestodes were Cylindrotaenia americana, from Trionyx ferox emoryi; Proteocephalus trionyechinum, from both Trionyx ferox emoryi and Trionyx spinifera; Proteocephalus testudo, from Pseudemys scripta elegans and Graptemys pseudogeographica respectively. Although Cylindrotaenia americana has been previously reported from lizards, this is the first time it has been reported in turtles. Proteocephalus trionyechinum and P. testudo were reported by Lonnenberg (1894) and by Magath (1924) from Trionyx ferox and T. spinifera respectively, but neither of these forms has been previously reported from either of the hard-shelled species. The host distribution and incidence of these cestodes are tabulated in Tables II and VI.

Data in the aforementioned tables reveal a relatively low incidence of cestode infection in all host species. Cylindrotaenia americana, which was recovered from only two specimens of Trionyx ferox emoryi and eight specimens of Trionyx spinifera, had the lowest incidence. As shown in Tables II and VI specimens of Proteocephalus testudo were found only in Graptemys and Pseudemys, and P. trionyechinum and C. americana occurred only in the two soft-shelled species. No cestodes were recovered from Kinosternon subrubrum and Chelydra serpentina examined, and these parasites seem to be very rare or absent in these turtles.

The first cestode described from a turtle, Tetrarhynchus macrobothrium, was from Testudo mydas, reported by Rudolphi (1819). Leukart (1879) recorded Tetrarhynchus spp. from Tethys fimbriata, and Tetrarhynchobothrium bicolor from Holichelys atra. Lonnenberg (1894) described Tetrabothrium trionyechinum from Trionyx ferox. Stiles and Hassell (1894) recorded Taenia spp. from Trionyx spp., but did not give a description of this form. La Rue (1914) failed to mention Lonnenberg's T. trionyechinum in his monograph; but Rudin (1917) did list this form. Magath (1924) described Ophiotaenia testudo from Amyda spinifera. Hughes, Baker and Dawson (1941) transferred both T. trionyechinum and Ophiotaenia testudo to the genus Proteocephalus. However, Hughes, et al., did not provide the taxonomic evidence used to justify these redesignations. It must be assumed that these changes were based upon studies of the original descriptions of the forms in question, since the type specimens were not available for examination. The rather generalized description of T. trionyechinum justified placing this worm in the genus Proteocephalus, since the original description indicates that the testes are arranged in a continuous field, and that no fifth sucker is present. If we assume that Magath's description of Ophiotaenia testudo is correct, no question can be raised as to the proper generic designation of this species. However, I have recovered a number of tapeworms from the hard-shelled species of turtles, which seem to be identical to the specimens used by Magath in describing O. testudo, except that the testes lie in a continuous median field between the two osmo-regulatory ducts as in the genus Proteocephalus, rather than in two lateral bands as in Ophiotaenia. Since the arrangement of the testicular field is the principal distinguishing characteristic of these genera I have called the worms examined in this study *Proteocephalus testudo*, in conformance with the designation proposed by Hughes, *et*. *al*., (1941). The characteristics of *Ophiotaenia testudo* are recorded in Table I. Since the only difference between the form described by Magath and my specimens is in the arrangement of the testicular field, the tabulation of the characteristics of these separately has been omitted.

Proteocephalus trionyechinum:

In examing a large number of cestodes recovered from *Trionyx ferox emoryi* and *Trionyx spinifera*, and in comparing them with Lonnenberg's description of *Tetrabothrium trionyechinum*, I have concluded that my specimens are identical to *T*. *trionyechinum*. As stated previously, the description of this cestode by Lonnenberg is very general and does not provide adequate information to separate this form from other species of the genus *Proteocephalus*. Therefore, it is necessary to redescribe *T*. *trionyechinum* for the purpose of firmly establishing it as a valid species of the genus *Proteocephalus*.

Proteocephalus trionyechinum is relatively small and slender, measuring from 20 to 23 cm. in length, and 2.2 mm. at its widest point. The segmentation is fairly distinct but the scolex is not set off sharply from the rest of the worm. The latter is sub-globose, flattened anteriorly, and 0.55 mm. wide by 0.57 mm. long (Plate II, fig. 3). There are four well developed circular suckers averaging 0.48 mm. in diameter. The suckers are directed anterio-laterad. The number and arrangement of suckers, presence or absence of the rostellum and spines conform to the characteristics of this genus. The breadth of the first proglottids is greater than the length, 0.065 long x 0.464 mm. wide, but the length breadth ratio increases as they mature, the largest ones being 3.0 mm. long x 2.2 mm. wide.

The musculature is not well developed and the parenchyma is relatively fine meshed (Plate II, fig. 5). The arrangement of the genital organs is typical of the genus. There is a well defined genital papilla. The genital pores, which are situated in the anterior sixth of the proglottid alternate irregularly. The genital atrium communicates with the exterior by means of the genital pore; both the vagina and the cirrus organ open into the latter.

From where the vagina opens into the anterior surface of the genital atrium it courses along an almost straight line to approximately the midline of the proglottid, never crossing the cirrus pouch. At this point the vagina curves sharply caudad and dorsal to the uterus forming a few loose loops to join the oviduct just dorsal to the common vitelline duct. No receptaculum seminis is present. The distal end of the vagina is loosely coiled in the inner ovarian space. Near the junction of the vagina with the oviduct the musculature of the vaginal wall gradually thickens to form the seminal canal, which joins the oviduct to form the fertilization canal (Plate I, fig. 2).

The ovaries are composed of loose tubules which form two, more or less, distinct butterfly shaped lobes. They occupy the middle half of the posterior end of the proglottid.

From the ventro-posterior margin of the ovary an ovate muscular oöcapt forms the proximal end of the oviduct which courses ventroposteriorad. The oviduct forms several loops at right angles with the longitudinal axis of the proglottid, and receives the vagina in the proximal third of its length to form the fertilization canal. The oötype is heavily muscular, relatively straight, and is surrounded by the cells of the Mehlis organ. The cells of the Mehlis organ discharge their contents into the lumen of the oötype through structures which appear to be individual ducts. After several coils the uterus runs anteriorly along the mid-line of the proglottid to a point anterior to the cirrus and about 1/6 of the length of the proglottid from the anterior end. From 15 to 20 lateral pouches are present in fully mature proglottids. The vitellaria are arranged in two compact lateral bands which surround the excretory canals. The paired vitelline ducts course mediad and join to form a common duct just posterior to the isthmus of the ovary. From this point the common vitelline duct forms a few loose loops and joins the fertilization canal just before it enters the oötype (Plate I, fig. 2). The genital pore is lateral and opens in the anterior one-sixth of the proglottid. The cirrus organ is attenuated near its junction with the genital atrium being 0.25 mm. in diameter at this point, and it increases in diameter medially to a maximum of 0.38 mm. This organ is pyriform in shape, heavily muscular, and covered with short spines. Prostate gland cells are present. The cirrus organ is 0.033 x 0.099 mm. long when withdrawn into the cirrus pouch. The wall of this organ has a fimbriated appearance which may be due to the contracted state of its musculature in fixed specimens. The ejaculatory duct is enlarged in the region adjacent to its junction with the cirrus, and seems to serve as a seminal vesicle. This duct coils several times in the posterior portion of the cirrus pouch before merging with the vas deferens. The vas deferens forms a tightly coiled mass near the median terminus of the cirrus pouch, and courses posteriorly where it is formed by convergence of the vasa efferentia (Plate II, fig. 4). There are from 100 to 120 large ovate testes arranged generally in a single continuous median field, except where the stem of the uterus interrupts. Testes average 0.0774 x 0.0645 mm. in diameter, and are located just inside the longitudinal musculature near the dorsal surface of the proglottid (Plate II, figs. 4, 5).

The eggs of this species are enveloped in three membranes; a heavy outer one (the shell) and two relatively thin inner ones.

The comparative data in Table I indicate that the species to which *P. trionyechinum* is most closely related is *P. testudo*. However, *P. trionyechinum* differs from *P. testudo* with respect to shape and size of both the mature and ripe proglottids. The proglottids of *P. trionyechinum* are both wider and longer than those of *P. testudo*. There is also a considerable difference in the lengths of the strobila of these worms. The maximum length of the strobila of *P. trionyechinum* is 23 cm. while the length of that of *P. testudo* is 30 cm. to 50 cm. The diameter of the cirrus pouch of *P. trionyechinum* is not so great as that of *P. testudo* but it is considerably longer than that of the latter. The number of testes in *P. trionyechinum* ranges from 100 to 120, while in *P. testudo* the range is from 125 to 200. There is also a considerable variation in the size of the suckers. Since these characteristics are considered to be specific, I have designated these cestodes as separate species and have placed them in the genus *Proteocephalus*.

Species: *Proteocephalus trionyechinum*
Hosts: *Trionyx ferox emoryi* and *T. spinifera*
Habitat: Small Intestine
Locality: Lake Texoma (Marshall County, Oklahoma)

Type specimen: U. S. Natl. Mus. Hel. Col. No. 56238

Paratype: Stovall Museum of Science and History
Division of Zoology.

Proteocephalus testudo Magath (1924), (Hughes et al, 1941): This worm was described by Magath (1924) from Amyda spinifera as Ophiotaenia testudo. If one assumes that Magath's description is valid, the generic designation is undoubtedly correct. However, without giving any indication as to the data used, Hughes, et al, (1941) changed the generic designation of this parasite to Proteocephalus.

Unfortunately Magath's specimens have been lost. After studying a number of tapeworms recovered from the intestines of the hard-shelled species of turtles, I have concluded that my materials are, with the exception of the arrangement of the testes, specifically identical to those described by Magath as O. testudo. Magath stated that the testes of the worms he studied were arranged in two lateral fields, while the testes in my specimens are arranged in a continuous median field. Since the continuous arrangement is typical of Proteocephalus and not Ophiotaenia, I designate this worm Proteocephalus testudo in conformity with the generic redesignation of this species by Hughes et al, (1941).

Cylindrotaenia americana Jewell: This cestode was described by Jewell (1916) from Acris gryllus. Harwood (1932) recovered it from Hyla squirella, Pseudacris triseriata, Rana pipiens, and from the lizard Leiolopisoma laterale. Harwood also recorded it in Argentina and Brazil from Leptodactylus ocellatus; in Mozambique from Arthroleptes ogoensis and Rana acquiplicalata. Walton (1941) recorded it from Acris gryllus, Bufo terrestris and B. canorus. Although it was reported from a reptile by Harwood, this is the first time this cestode has been reported from turtles. The ten specimens in my collection were recovered from the small intestines of 2 individuals of *Trionyx ferox emoryi* and 8 of *T. spinifera* taken from Lake Texoma just south of the University of Oklahoma Biological Station, in Marshall County, Oklahoma.

Although I autopsied more than 285 specimens of these two species of turtles during the course of this study, these were the only hosts found to be infected with this cestode. This low incidence of infection in my hosts, and the fact that this tapeworm has not previously been reported from turtles, indicates that it rarely infects this order of reptiles.

Trematoda

Sixteen species of trematodes have been recovered from the heart, lungs, bladder and intestines of the six host species of turtles studied in this work. Except for *Cephalogonomus vescaudus* and *Aorchis extensus*, the intensity of infection was very light in all of the hosts examined. Some of the ecological factors which may account, in part, for the lack of heavier trematode burdens in these reptiles will be discussed in the ecological section of this paper. The host incidence of infection and host distribution of these parasites has been compiled in Tables III and VII.

The following data include the names of the parasites, the hosts, and information concerning new host records.

Aorchis extensus Barker and Parsons, 1914: A large number was recovered from the lungs of *K. subrubrum*.

Cephalogonomus vescaudus Poirier, 1902: Recovered in large numbers from *T. ferox emoryi*, and *T. spinifera* taken from Rock Creek, and also in smaller numbers from hosts of these species taken from Lake Texoma. Small numbers were also collected from P. elegans, G. pseudogeographica, and K. subrubrum.

Crepidostomum cooperi Hopkins, 1931: This worm was recovered from Chelydra serpentina. Insofar as I can determine this constitutes a new host record for it, the only other report being that of Hopkins who recovered it from T. ferox emoryi.

Cotylaspis cokeri Barker and Parsons, 1914: All specimens were collected from T. ferox emoryi.

Polystomoides orbiculare Stunkard. 1916: A number of specimens was recovered from P. scripta elegans and K. subrubrum.

Spirorchis artericola Ward, 1921: This fluke was recovered only from P. scripta elegans.

Spirorchis scripta Stunkard, 1923: All specimens were recovered from G. pseudogeographica.

Telorchis aculeatus Linstow, 1879: Several specimens were recovered from C. serpentina.

Telorchis arrectus Dujardin, 1859: One individual was collected from T. ferox emoryi.

Telorchis attenuatus Goldberger, 1911: A number of specimens of this trematode was recovered from C. serpentina.

Telorchis clava Diesing, 1850: Several specimens were collected from C. serpentina.

Telorchis corti Stunkard, 1915: This trematode was collected from both T. spinifera and P. scripta elegans.

Telorchis diminutus Stunkard, 1915: All specimens were collected from K. subrubrum.

Telorchis lobosus Stunkard, 1915: This trematode was recovered from both C. serpentina and G. pseudogeographica.

Telorchis medius Stunkard, 1915: This fluke was taken from both K. subrubrum and P. scripta elegans.

Vasotrema longitestis Byrd, 1938: This fluke was recovered from T. ferox emoryi and T. spinifera.

Nematoda

In spite of the fact that the nematodes of aquatic turtles have been investigated in many geographical areas of the world, only three very limited studies have been reported for Oklahoma forms. Mackin (1927) reported Dracunculus globicephalus from C. serpentina, and in 1936 he reported the results of a study on the morphology and life history of the nematodes of the genus Spironoura, including the description of two new species, S. wardi and S. concinnae from C. serpentina and P. concinna respectively captured in southeastern Oklahoma. In his paper on the parasites of C. serpentina Williams (1952) described the male of Capillaria serpentina, and identified four previously described species.

I have identified nine species of nematodes recovered in this study. My data indicate that there is very little seasonal variation in either the incidence or intensity of roundworm infection in these forms. The host distribution and incidence are shown in Table IV.

With one exception, all of the species recovered have been previously reported from turtles. Oxysomatium variabilis has not previously been reported from aquatic turtles but is known to occur in terrestrial species.

The following list includes the names, host, and other pertinent data concerning the nine species of nematodes recovered from the six species of turtles included in this study.

Camallanus trispinosus Leidy, 1957: This worm was recovered from P. scripta elegans, G. pseudogeographica, C. serpentina, T. spinifera, and T. ferox emoryi. It showed little host specifically, but was more common in P. scripta elegans than in other hosts studied.

Cucullanus cirratus Muller, 1777: P. scripta elegans and K. subrubrum were the only hosts species found to harbor this parasite.

Cucullanus emydis Seibold, 1843: Recovered from several specimens of T. ferox emoryi.

Oxysomatium variabilis Harwood, 1930: Recovered from P. scripta elegans and G. pseudogeographica. As noted previously, this is the first time that this form has been reported from aquatic turtles.

Oswaldocruzia leidyi Travassos, 1907: Collected from G. pseudogeographica and T. ferox emoryi.

Spironoura chelydrae (Harwood, 1932), Mackin, 1936: Recovered from C. serpentina.

Spironoura wardi Mackin, 1936: Collected from P. scripta elegans, and G. pseudogeographica.

Spiroxys contorta (Rudolphi, 1819), Schnieder, 1866: Taken from P. scripta elegans, G. pseudogeographica, K. subrubrum, T. ferox emoryi, and T. spinifera.

Acanthocephala

Neoechinorhynchus emydis Leidy, 1851, was recovered from P. scripta elegans, and from C. serpentina. Since approximately the same number of specimens was recovered from each host, both forms apparently serve equally well as definitive hosts for this worm.

The intestinal wall showed considerable evidence of damage in areas from which these worms were removed. These areas were reddened and the sub-mucosa was thickened, indicating considerable scar tissue formation. In some areas a tumor-like condition existed. The cavities of these areas were filled with a yellowish material, closely resembling pus.

Ecology

In addition to the taxonomic aspects of this study I have concerned myself with the ecological factors which seem to affect the incidence and intensity of helminth infection as well as the methods used in capturing these reptiles.

Most of the turtles used in this study were collected from Lake Texoma since I was interested in acquiring a representative sampling of the helminth parasites of turtles taken from this habitat. The distribution and intensities of infection of these six host species are compiled in Tables IV through VII.

The six species of turtles included in this study are almost exclusively aquatic in habitat. Despite this fact, a number of specimens of both Graptemys and Pseudemys have been collected on roads and in fields near the lake. Some of these specimens were females which may have been searching for a suitable place to lay their eggs. This conclusion is influenced by two factors; namely, all were gravid with well developed eggs, and the dates of capture were coincident with the normal egg depositing season of the species concerned. Several male Pseudemys were captured on a highway near Madill, Oklahoma. Since there were ponds located on both sides of the road where they were taken, I assumed they were migrating from one pond to the other. These short migrations, of course, account for the establishment of these turtles in new habitats.

The habit of basking on the surface of partially submerged objects accounts for the relative ease of capturing, in surface traps, both G. pseudogeographica and P. scripta elegans. The two soft-shelled species are not so prone to bask, and are rarely taken in surface set traps. The specimens of these species were captured in partially submerged traps which were baited with dead rabbits. Many of the soft-shells were also taken in fly nets which were set in four or five feet of water. Some were also taken in bottom set nets, in the deep waters of the Buncombe Creek arm of the lake. Most of those captured in deep water were taken during the months of March and April. During the period from May to November both the soft and hard-shelled species seem to remain for the most part in shallow water. This assumption is based upon the relatively small number captured in nets and traps set in deep water, as against the relatively large numbers taken from the same trapping devices, when set in the waters of inlets with a depth of five feet or less. There is no particular mystery about this variation in the distribution of the population of these reptiles if one takes into consideration the types of food consumed by them and the ecological situations where the food exists in the greatest abundance.

I found that all six species of turtles studied fed upon a wide variety of both plant and animal materials. The predominance of any type of food varied to some extent with the season. From May through November, snails, fish, crayfish and various kinds of insect larvae were predominant, but from November through March the contents of the gut were greatly reduced in volume and contained more algae than animal material. Although some snail opercula were found, the remains of crustacea and fish fragments were most predominant. Since some molluskan remains have been found to be common in the stomach and intestinal contents of these turtles by other workers, it should be safe to assume that such would be the case in Lake Texoma if a normal population of these mollusks were present. However, since mollusks and especially snails are usually scarce in this lake they could not form an important part of the food of these particular turtles. The reasons for the reduced size of the existent populations of mollusks are related to the drastic fluctuation of the water level and the heavy siltation of the shallow waters of the entire shoreline area.

The annual vertical fluctuation of the water in this lake may be as much as 40 feet and frequently is as much as 20 feet. This rather extreme variation in water level would not be quite so drastic in its effects on mollusks, if it were not for the fact that this impoundment is used for both flood control and for generating hydroelectric power. The effect of the withdrawal of water for the aforementioned purposes often causes the water level to fluctuate several feet; in some instances within a week's time. Such rapid changes in the level of the water inhibit the growth of aquatic plants so that the lake has no permanent floral growth. Siltation is also a factor in this situation and this, along with the paucity of vegetation for food, keep snail populations at a very low level.

The small populations of snails and crustaceans in the lake undoubtedly have a direct bearing on the size and specific nature of the digenetic trematode populations of the turtles, since these parasites utilize both the crustaceans and snails as intermediate hosts. With the exception of Cephalogonomus vescaudus, both the intensity and incidence of these helminths in these reptiles is low. So long as the lake itself is so unbalanced that aquatic plants cannot attain a stable flora it should be expected that digenetic trematode populations will be low.

The incidence of cestode infection among these six species of turtles, is low. The percentages of infection are shown in Table II. The low incidence is undoubtedly a reflection of the scarcity of intermediate hosts in the lake. In addition to the generally low incidence of cestodes during the period from March through November, none were taken during the months of December through February. This condition seems to be consistent with the findings of Magath (1924) and others who also examined a considerable number of these species of turtles during the winter months.

However, the temperature of the water from which Magath collected his specimens was considerably lower than any of those recorded for Lake Texoma during the winter months involved in this study. In fact, studies dealing with these species indicate that they go into complete hibernation during the winter in areas where the water temperature drops below 25°C. This condition does not prevail in Lake Texoma, since specimens of all species studied were captured in small numbers during the months of December through February. However, specimens taken during the winter months were captured only during prolonged warm periods. It is, therefore, probable that these turtles go into a state of inactivity during extremely cold weather and become active during prolonged periods of relatively high temperatures. Although there are no accurate Army Engineer's records available which record the seasonal variation of bottom temperature in the lake, it is doubtful that a thermocline more than two to four degrees centigrade would exist at any time. This conclusion is based upon the effect of convection, wind action, and the fact that the Red river currents tend to mix the water to some degree through rolling action. Dr. Virgil Dowell and I did take a number of both surface and bottom temperature readings in various areas of the lake which showed a variation of from two to four degrees. According to engineers' records the lowest surface temperature which has been recorded for the lake is 45°F. The water surface temperature ranges from 47°F. to 48°F. for the months of January and February, then begins to rise toward the maximum of 76°F. during July and August. It is doubtful if temperature variation accounts directly for the loss of helminths during these months. It would be interesting to know what physiological changes occur in the intestinal mucosa during this period and if such factors as dietary deficiencies produce conditions which result in the complete disappearance of cestodes from the intestinal tract of these turtles.

The incidence of infection of P. trionyechinum in T. ferox emoryi of 11.1% is the highest for the three species of cestodes studied. It occurred in only 3.1% of T. spinifera. However, the incidence of C. americana is six times as high in T. spinifera as in T. ferox emoryi. These variations are interesting since these turtles are so closely related, both taxonomically and in general habits. The occurrence of

P. testudo in the hard-shelled species shows a three per cent higher incidence in Graptemys than in Pseudemys. Neither the incidence nor the intensity of infection could be considered high, since the largest number of worms recovered from a single host was 6. In most cases the number recovered ranged from 1 to 4.

The low incidence and intensity of trematode infections in these turtles is undoubtedly related to the low molluskan population. The data pertaining to the incidence and host distribution of these parasites are compiled in Tables III and VII. These data reveal that Cephalogonomus vescaudus occurred in a greater percentage of the hosts than any other species, having been recovered from 7.1% of G. pseudogeographica; from 4.1% of P. scripta elegans; from 2.8% of K. subrubrum; 34.8% of T. ferox emoryi and from 52.4% of T. spinifera examined. This trematode not only occurred in a higher percentage of specimens of three of the six species of turtles, but it also was recovered from five of the six species of turtles studied. The broad spectrum of distribution of this form may reflect the fact that all of these turtles have some foods in common. Telorchis corti, T. lobosus and T. medius were recovered from two hosts in each species. There is no significant difference in the intensity or incidence of host infection for T. corti and T. lobosus, (Table III). T. medius was recovered from both P. scripta elegans and K. subrubrum, but the incidence of infection in the latter host was approximately six times that of the former. Polystomoides orbiculare was the only other trematode recovered from more than one species of turtle. It was collected, in small numbers, from K. subrubrum and P. scripta elegans. Its incidence in P. scripta elegans was twice as high as that of K. subrubrum,

Table III. Vasotrema longitestis was collected from both T. ferox emoryi and T. spinifera. It was in no case collected in large numbers. The largest number collected from a single host was 4. As indicated by the data in Table III, the incidence of infection was identical in the two host species. All of the remaining species of trematodes were collected from single host species, and only Aorchus extensus infected more than ten per cent of the hosts examined.

Although the incidence of nematode infection was high in these turtles, the number of species and intensity of infection was low. As shown in Table IV, Spironoura wardi was recovered from 22.0% of G. pseudogeographica examined and Spiroxys contorta was recovered from 18.3% of this host. Camallanus trispinosus and S. contorta were recovered from 22.0% and 38.0% respectively of the specimens of P. scripta elegans examined, and from five of the six species of turtles studied. C. trispinosus was not recovered from K. subrubrum, and S. contorta was not found in C. serpentina. C. trispinosus seems to have the highest overall frequency of any species of nematode recovered (Tables IV and VII). S. contorta shows the second highest incidence (Table VII). The incidence of nematode infection greatly exceeds that of the other three helminths recovered from these reptiles.

The one species of Acanthocephala recovered, Neoechinorhynchus emydis, occurred in small numbers in both C. serpentina and P. scripta elegans. It has been recorded by other workers from T. spinifera, T. ferox emoryi, and P. scripta elegans (Table V).

My observations agree with those of Magath and other workers who have found that immature turtles are rarely infected with helminth parasites. With the exception of *Kinosternon*, none of the specimens included in this study with a carapace measurement of less than 5 inches was infected. In the case of *K. subrubrum*, which rarely exceeds 4 inches in carapace length at maturity, specimens whose carapaces were less than 2.5 inches were free of helminths.

SUMMARY

A taxonomic study of the helminth fauna of six species of aquatic turtles common to Lake Texoma and its Washita river tributaries was made. These turtles were *Trionyx spinifera*, *T. ferox emoryi*, *Pseudemys scripta elegans*, *Graptemys pseudogeographica*, *Kinosternon subrubrum*, and *Chelydra serpentina*.

From these hosts, 3 species of Cestoda, 16 of Trematoda, 9 of Nematoda, and 1 of Acanthocephala were taken. These parasites were recovered from the lungs, heart, stomach, urinary bladder, and the intestines of their hosts.

Cylindrotaenia americana is reported for the first time from turtles. *Proteocephalus testudo* is reported for the first time from *Pseudemys scripta elegans*, and *Graptemys pseudogeographica*. *Crepidostomum cooperi* is reported for the first time from *Chelydra serpentina*, this species being originally collected from *Trionyx mutica*. *Oxysomatium variabilis* is reported for the first time from aquatic turtles, it being previously known as a parasite of terrestrial turtles and lizards.

A complete redescription of *Proteocephalus trionyechinum* is given for the purpose of clarifying both the generic and specific position of this form.

The ecological conditions existent in Lake Texoma which influence the incidence and intensity of endoparasitic infection, and methods used

in capturing the six host species, are discussed in the ecology section of this study.

TABLE I

Comparison of Selected Characteristics of Species of Ophiotaenia and Proteocephalus Trionyechinum Lonnenberg

Characters	Ophiotaenia filaroides La Rue	Ophiotaenia perspicua La Rue	Ophiotaenia grandis La Rue	Ophiotaenia testudo Magath	Proteocephalus trionyechinum Lonnenberg
Strobilae	8.0 to 11.0cm. x 0.8 to 0.9	36cm x 2.0mm. at wdst. pt.	Frag. 2.75 to 4.25mm. 20cm.	30 to 50 cm. x 1.6mm. wd.	23 cm. x 1.5 mm. at wdst. pt.
1st Proglottid	0.1 to 0.17mm. x 0.3 to 0.36mm.	Much broader than long	Much broader than long	Much broader than long	0.65 x 0.464 mm.
Mature Proglottid	Longer than broad	2.0 mm. sq. or longer than	Usually longer than broad	Broader than long	Slightly longer than broad
Ripe Proglottid	1.6 x 0.8 mm. to 4.0 x 0.75mm	3.8 x 1.2 mm.	3 to 5 mm. x 2 to 3 mm.	2.1 x 1.6 mm.	3.0 x 2.2 mm.
Scolex	0.36 x 0.46mm. apex conical	0.355 x 0.408 mm. wd.	1.2 x 0.6 mm. conical apex	0.42 x 0.63 mm. Globose	0.55 x 0.57mm. wd.
Suckers	Oval deep 0.165 x 0.84	Circular 0.10 x 0.17 mm.	Circular 0.35 x 0.36 mm.	Circular 0.12 x 0.10 mm.	Circular 0.48 mm. diam.
Fifth Sucker	Vestigial Deep set	Vestigial Deep set	Not present Vestigial	Not present	Not present
Cirrus Pouch	0.22 x 0.11mm.	0.32 x 0.8mm.	0.64 x 0.36mm.	0.56 x 0.27mm.	0.33 x 0.99mm.
Genital Pore	Anterior 1/5 of Proglottid	1st 1/3 of Proglottid	Near middle of Proglottid	Anterior 1/6 of Proglottid	Anterior 1/6 of Proglottid

TABLE I
Page 2

Characters	*Ophiotaenia filaroides* La Rue	*Ophiotaenia perspicua* La Rue	*Ophiotaenia grandis* La Rue	*Ophiotaenia testudo* Magath	*Proteocephalus trionyechinum* Lonnenberg
Cirrus pouch Wdth. Segment	3 to 4 times	3 to 4 times	3 to 5 times	3 to 4 times	2 times
Ductus Ejaculatorius	Few coils	Several coils	Nearly straight	Many coils	Many coils
No Testes	70 to 114	150 to 215	200 to 250	125 to 200	100 to 120
Testes Diameter	.05 to .06mm	.053 to .106mm	.04 to .125mm	.050 x .063 mm	.0774 x .0645mm
Testes Arrangement	2 lateral fields	2 lateral fields	2 lateral fields	2 lateral fields	1 median field
Vagina in relation to Cirrus Pouch	Anterior to cirrus pouch	Anterior to cirrus pouch	Ant. or post. to cirrus pouch	Anterior to cirrus pouch	Anterior to cirrus pouch
Uterus, No. Pouches	20 to 35	20 to 30	40 to 60	15 to 25	15 to 20
Egg Diameter	0.21 mm.	.018 to .021mm	0.015 to 0.016 mm.	0.019 to 0.0 21mm.	0.22
Egg membranes No. & Size	3 membranes outer .035mm	3 membranes outer .045 mm	3 membranes outer .085mm	3 membranes outer .029mm	3 membranes outer .026mm
Hosts	*Ambystoma tigrinum*	*Natrix rhombifera*	*Ancistrodon piscivorus*	*Amyda spinifera*	*Amyda spinifera* & *A. mutica*

TABLE II

Percentage of Host Infection - *Cestoidea*

Species	No. Hosts Examined	Name of Parasite	No. of Hosts Infected	Percentage of Hosts Infected
Chelydra serpentina	20	*Cylindrotaenia americana*	0	0
		Proteocephalus testudo	0	0
		Proteocephalus trionyechinum	0	0
Graptemys pseudo-geographica	98	*Cylindrotaenia americana*	0	0
		Proteocephalus testudo	8	8.1
		Proteocephalus trionyechinum	0	0
Kinosternon subrubrum	70	*Cylindrotaenia americana*	0	0
		Proteocephalus testudo	0	0
		Proteocephalus trionyechinum	0	0
Pseudemys scripta	97	*Cylindrotaenia americana*	0	0
		Proteocephalus testudo	5	5.1
		Proteocephalus trionyechinum	0	0
Trionyx ferox emoryi	161	*Cylindrotaenia americana*	2	1.2
		Proteocephalus testudo	0	0
		Proteocephalus trionyechinum	18	11.2
Trionyx spinifera	124	*Cylindrotaenia americana*	8	6.5
		Proteocephalus trionyechinum	4	3.2

TABLE III

Percentage of Host Infection - Trematoda

Name of Host	No. Hosts Examined	Name of Parasite	No. of Hosts Infected	Percentage of Hosts Infected
Chelydra serpentina	20	Crepidistomum cooperi	1	1
		Telorchis aculeatus	4	20
		Telorchis attenuatus	3	1
		Telorchis clava	2	1
		Telorchis lobosus	3	1.5
		Dictyangium chelydrae	1	0.5
Graptemys pseudo-geographica	98	Cephalogonomus vescaudus	7	7.1
		Spirorchis scripta	1	1
		Telorchis lobosus	2	2
Kinosternon subrubrum	70	Aorchus extensus	28	40
		Cephalogonomus vescaudus	2	2.8
		Polystomoides orbiculare	2	2.8
		Telorchis diminutus	7	10
		Telorchis medius	6	8.5
Pseudemys scripta	97	Cephalogonomus vescaudus	4	4.1
		Polystomoides orbiculare	4	4.1
		Spirorchis artericola	1	1.3
		Telorchis corti	4	4.1
		Telorchis medius	1	1.3
Trionyx ferox emoryi	161	Cephalogonomus vescaudus	56	34.8
		Cotylaspis cokeri	1	0.6
		Telorchis erectus	1	0.6
		Vasotrema longitestis	7	4.3
Trionyx spinifera	124	Cephalogonomus vescaudus	65	52.4
		Telorchis corti	4	3.2
		Vasotrema Longitestis	7	5.6

TABLE IV

Percentage of Host Infection - Nematoda

Name of Host	No. Hosts Examined	Name of Parasite	No. of Hosts Infected	Percentage of Hosts Infected
Chelydra serpentina	20	Camallanus trispinosus	5	25
		Spironoura chelydrae	4	20
Graptemys pseudo-geographica	98	Camallanus trispinosus	11	11.2
		Oxysomatium variabilis	1	1.0
		Oswaldocruzia leidyi	1	1.0
		Spironoura wardi	22	22.4
		Spiroxys contorta	18	18.3
Kinosternon subrubrum	70	Cucullanus cirratus	4	5.7
		Spiroxys contorta	20	28.5
Pseudemys scripta elegans	97	Camallanus trispinosus	22	22.6
		Cucullanus cirratus	2	2.0
		Spiroxys contorta	38	39.1
Trionyx ferox emoryi	161	Camallanus trispinosus	15	9.2
		Cucullanus emydis	3	1.8
		Oswaldocruzia leidyi	6	3.3
		Spiroxys contorta	32	20.0
Trionyx spinifera	124	Camallanus trispinosus	17	13.7
		Oxysomatium variabilis	3	2.4
		Spiroxys contorta	17	13.7

TABLE V

Percentage of Host Infection - Acanthocephala

Name of Host	No Hosts Examined	Name of Parasite	No. of Hosts Infected	Percentage of Hosts Infected
Chelydra serpentina	20	*Neoechinorhynchus emydis*	2	10
Pseudemys scripta elegans	97	*Neoechinorhynchus emydis*	4	4.2

TABLE VI

Specific Distribution of Cestodes

	Chelydra serpentina	Graptemys pseudogeographica	Kinosternon subrubrum	Pseudemys scripta elegans	Trionyx ferox emoryi	Trionyx spinifera
Cylindrotaenia americana	O	O	O	O	x	O
Proteocephalus testudo	O	x	O	x	O	O
Proteocephalus trionyechinum	O	O	O	O	x	x

X = Presence of Cestodes

TABLE VII

Specific Distribution of Trematodes

	Chelydra Serpentina	Graptemys pseudo-geographica	Kinosternon subrubrum	Pseudemys scripta elegans	Trionyx ferox emoryi	Trionyx spinifera
Aorchus extensus	0	0	x	0	0	0
Crepidistomum cooperi	x	0	0	0	0	0
Cephalogonomus vescaudus	0	x	x	x	x	x
Cotylaspis cokeri	0	0	0	0	x	0
Dictyangium chelydrae	x	0	0	0	0	0
Polystomoides orbiculare	0	0	x	x	0	0
Spirorchis artericola	0	0	0	x	0	0
Spirorchis elegans	0	x	0	0	0	0
Telorchis aculeatus	x	0	0	0	0	0
Telorchis attenuatus	x	0	0	0	0	0
Telorchis lobosus	x	x	0	0	0	0
Telorchis corti	0	0	0	x	x	x
Telorchis medius	0	0	x	x	0	0
Telorchis diminutus	0	0	0	0	0	x
Telorchis arrectus	0	0	0	0	x	0
Vasotrema longitestis	0	0	0	0	x	x

X = Presence of Trematodes

TABLE VIII

Specific Distribution of Nematodes

	Chelydra Serpentina	*Graptemys pseudo-geographica*	*Kinosternon subrubrum*	*Pseudemys scripta elegans*	*Trionyx ferox emoryi*	*Trionyx spinifera*
Camallanus trispinosus	x	x	0	x	x	x
Cucullanus cirratus	0	0	x	x	0	0
Cucullanus emydis	0	0	0	0	x	0
Oxysomatium variabilis	0	x	0	x	0	0
Oswaldocruzia leidyi	0	x	0	0	x	0
Spironoura chelydrae	x	0	0	0	0	0
Spironoura wardi	0	x	0	x	0	0
Spiroxys contorta	0	0	x	x	x	x

X = Presence of nematodes

Proteocephalus trionyechinum Lonnenberg

EXPLANATION OF PLATE I

Fig. 1. Mature proglottid showing general organization of genital complex, arrangement of testicular field, lateral arrangement of vitellaria, and bilobate nature of ovary. Magnification, 36x.

Fig. 2. Female genital complex reconstructed from serial sections, 234x.

ABBREVIATIONS USED

c.	Cirrus	od.	Oviduct
ed.	Excretory duct	ot.	Oötype
ga.	Genital atrium	t.	Testes
mg.	Mehlis gland	u.	Uterus
o.	Ovary	vd.	Vas deferens
oc.	Oöcapt	vg.	Vagina
fc.	Fertilization canal	vd.	Vitelline duct
cs.	Cirrus sac	vt.	Vitelline gland
Ex.d.	Excretory ducts	pg.	Prostate gland
		cut.	Cuticle

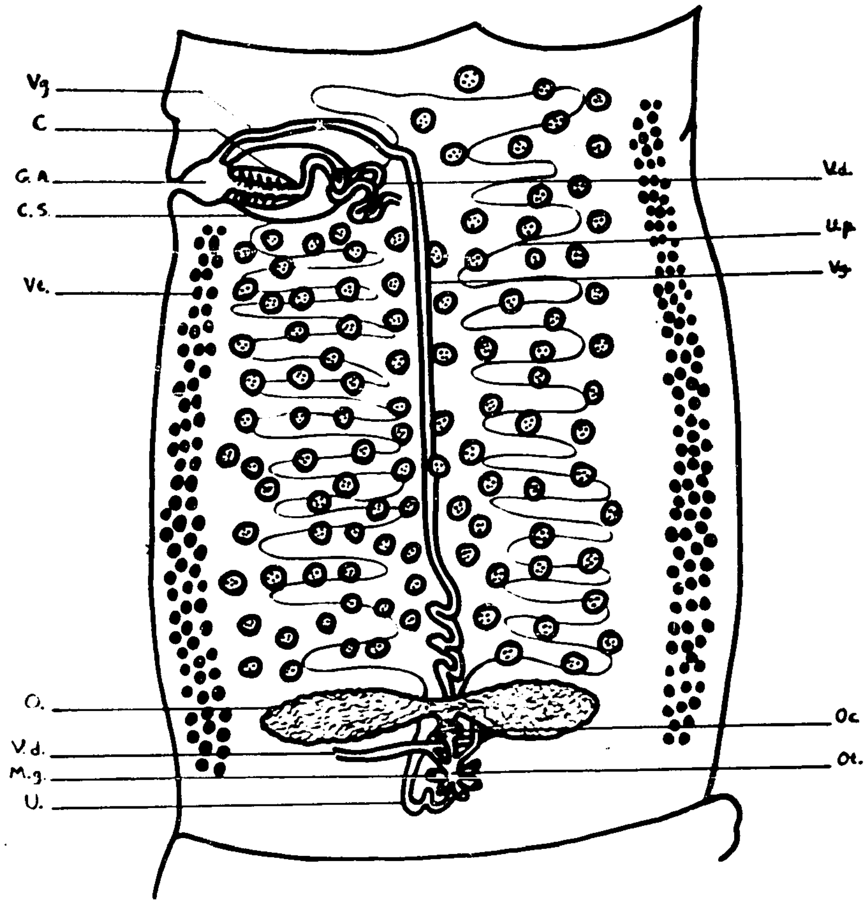

Fig. 1.

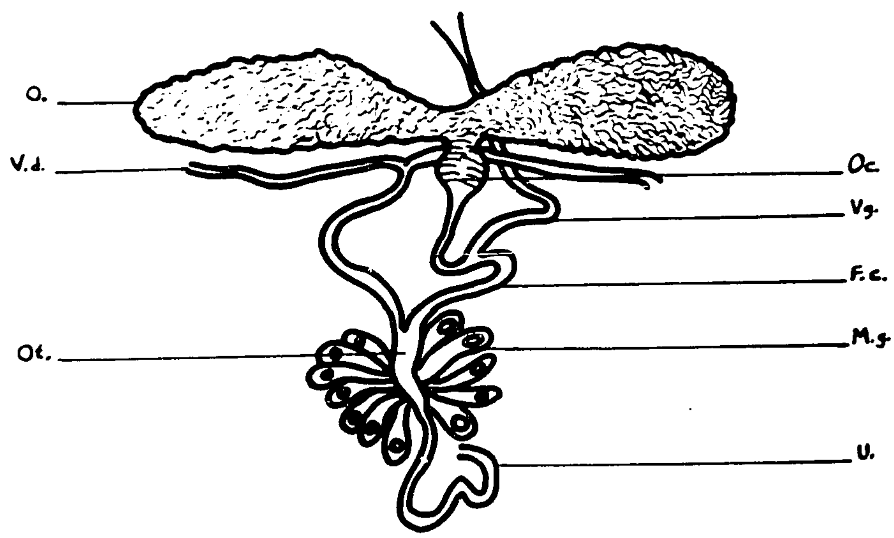

Fig. 2

PLATE I

Proteocephalus trionyechinum Lonnenberg

EXPLANATION OF PLATE II

Fig. 3. Scolex of adult showing ovate shape, absence of a fifth sucker, anteriorly directed suckers, very short neck, and immature proglottids. Magnification, 73x.

Fig. 4. Cross-section through cirrus sac of a mature proglottid showing the coiled nature of vas deference, the arrangement of the testes inside the muscular sheath and in a continuous field, the follicular nature of the vitellaria, and the muscular cirrus organ. Magnification, 52x.

Fig. 5. Cross-section through mature proglottid just posterior to the cirrus pouch, 60x.

ABBREVIATIONS USED

c.	Cirrus	od.	Oviduct
ed.	Excretory duct	ot.	Oötype
ga.	Genital atrium	t.	Testes
mg.	Mehlis gland	u.	Uterus
o.	Ovary	vd.	Vas deferens
oc.	Oöcapt	vg.	Vagina
fc.	Fertilization canal	vd.	Vitelline duct
cs.	Cirrus sac	vt.	Vitelline gland
Ex.d.	Excretory ducts	pg.	Prostate gland
		cut.	Cuticle

Fig. 3

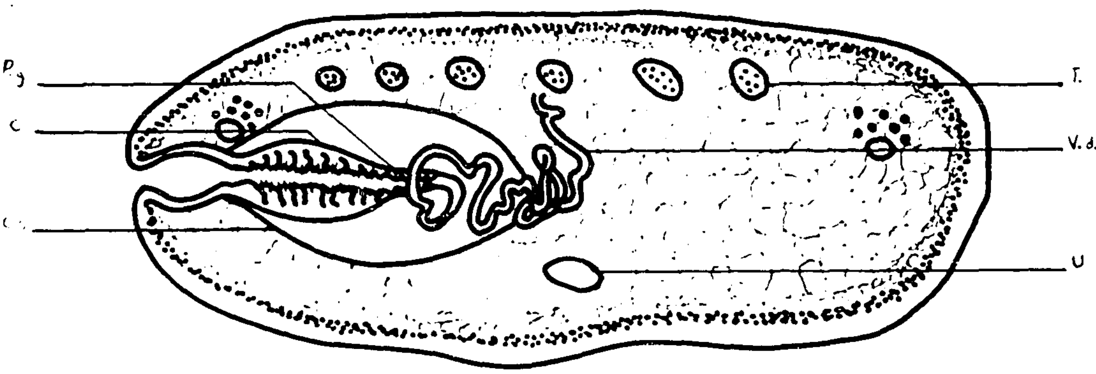

Fig. 4

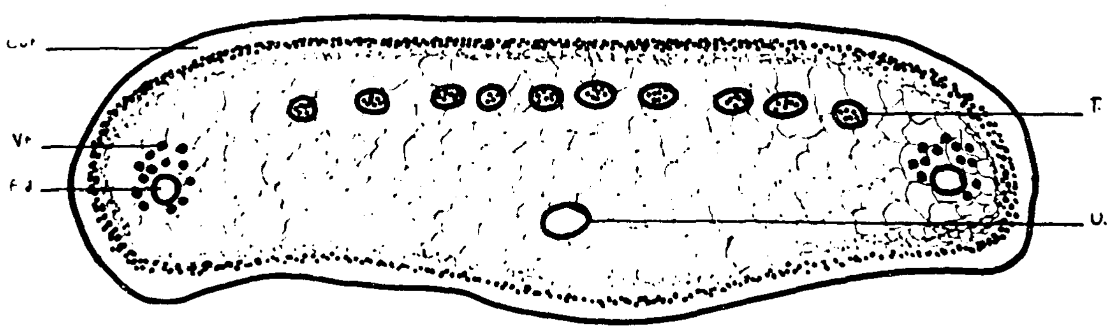

Fig. 5

PLATE II

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