# A SURVEY AND COMPARISON OF THE HELMINTH PARASITES OF THE RED-EARED TURTLE, *Pseudemys scripta elegans* (Wied, 1838) Carr, 1938, IN TEXAS AND OKLAHOMA

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TABLE OF CONTENTS


| Chapter | | Page |
|---|---|---|
| I. | ACKNOWLEDGEMENTS | iii |
| II. | INTRODUCTION | 1 |
| III. | THE TAXONOMY OF *Pseudemys scripta elegans* | 3 |
| IV. | THE HABITAT OF *Pseudemys scripta elegans* AND ITS RELATION TO PARASITISM | 6 |
| V. | METHODS AND MATERIALS | 11 |
| VI. | DATA CONCERNING PARASITES | 21 |
| | An Unusual Case of Extreme Parasitism | 25 |
| VII. | DESCRIPTIONS OF MONOGENETIC TREMATODES | 28 |
| | *Polystomoides coronatum* (Leidy, 1888) Price, 1939 | 29 |
| | *Neopolystoma orbiculare* (Stunkard, 1916) Price, 1939 | 32 |
| VIII. | DESCRIPTIONS OF DIGENETIC TREMATODES | 35 |
| | *Telorchis corti* Stunkard, 1915 | 36 |
| | *Telorchis singularis* (Bennett, 1935) Wharton, 1940 | 39 |
| | *Proparorchis artericola* Ward, 1921 | 41 |
| IX. | DESCRIPTIONS OF NEMATODES | 46 |
| | *Camallanus microcephalus* (Dujardin, 1845) Railliet and Henry, 1915 | 47 |
| | *Spironoura concinnae* Mackin, 1936 | 50 |
| | *Spiroxys contortus* (Rudolphi, 1819) Schneider, 1866 | 53 |
| X. | DESCRIPTIONS OF ACANTHOCEPHALANS | 58 |
| | *Neoechinorhynchus emydis* (Leidy, 1851) Hamann, Stiles and Hassal, 1905 | 59 |
| | *Neoechinorhynchus headachis* new species | 64 |

# INTRODUCTION

Applied scientific investigation is of necessity based upon the foundation of pure science. An investigation which involves pure science was undertaken to determine the helminth fauna of the red-eared turtle, Pseudemys scripta elegans (Wied), in two diverse ecological areas. This problem was chosen because: (1) both the habits and habitat of the host were favorable for parasitism; (2) the hosts were plentiful and relatively easy to obtain; (3) the literature did not reveal a similar report in either aspect; (4) red-eared turtles were presently thought to be of limited economic importance; (5) new parasites would possibly be found; and (6) the writer would gain a broader knowledge of parasites and of methods of parasitological investigations for future work.

Collecting of the turtles for the survey began in April 1953, in the Stillwater, Oklahoma area and in June 1953, in two Texas localities. All of the turtles obtained in Texas were collected during June, July, and August 1953, while those in the Stillwater area were obtained in April and May 1953, and during the period September 1953 through December 1954.

The data for this survey are based on parasites collected from a total of seventy-nine turtles of which fifty-six

were obtained from Texas localities and twenty-three from the Stillwater area. A review of the literature concerned with the host and its ecology and the parasites of the host is included in the report.

## THE TAXONOMY OF THE RED-EARED TURTLE, *Pseudemys scripta elegans*

There has been much controversy concerning the valid scientific name of the red-eared turtle. This past controversy and the present confusion have made it extremely difficult to determine whether the parasites found in this survey have been previously reported from this host. It therefore seems advisable to recount briefly the history involving the taxonomy of this turtle, but it is not the intent of the writer to discuss the validity of the scientific name in present use.

The red-eared turtle, one of the slider turtles, was originally described by Wied in 1838 as *Emys elegans*, but it was not generally known until 1857 when Agassiz introduced it into North American herpetological literature as *Trachemys elegans*. In 1844, Gray described a shell from Louisiana as *Emys holbrooki* and according to Stejneger (as cited by Carr, 1952) this shell was later identified as that of *Pseudemys elegans*. Gray described another turtle in 1873 as *Trachemys lineata* but again according to Stejneger (as cited by Carr, 1952) this specimen was later identified as *P. elegans*. Until 1933, there were two "sliders" recognized in the Mississippi drainage, *P. elegans*, described by Wied in 1838 from Indiana and *P. troosti*, described by Holbrook in 1836 from the Cumberland River in Tennessee. At this time the dun-

colored, long-nailed, long-tailed form was considered to be P. troosti and the red-eared one, P. elegans. But in 1933, Viosca showed that the dun-colored turtles were nothing but "old" melanistic (blackened) males of the red-eared species, P. elegans. Consequently, one of the names had to go into synonomy. This established P. troosti as the name since it had priority. Just as this situation was interpreted, Carr in 1938 showed that P. troosti intergraded with the yellow-bellied turtle, Pseudemys scripta, which name had priority, and hence the "sliders" would accordingly have to be called P. scripta troosti. Stejneger and Hartweg (as cited by Carr, 1952) believed that the "sliders" of the eastern edge of the Appalachian Plateau in Tennessee and Kentucky, named Pseudemys cumberlandensis by Holbrook in 1840, constituted a recognizable subspecies and that the specific name P. troosti had been applied by Holbrook in 1836, not to melanistic males of the wide-ranging Mississippi Valley form (the red-eared species) but to the males of P. cumberlandensis. Since P. troosti was described four years prior to P. cumberlandensis the former name had to be used for the highland subspecies, and this left the red-eared race to take the next available name, which was P. elegans. Therefore, at present the red-eared race is known as Pseudemys scripta elegans and the highland race (the Cumberland turtle) is known as Pseudemys scripta troosti.

In reviewing the literature one cannot be certain to which species the name P. troosti and P. elegans refer.

Currently it is necessary to have the geographic location and a description of the turtle to make a positive identification. In view of this situation with regard to species, a brief description of the red-eared turtle used in this survey is related, listing only the distinguishing characteristics.

Distinguishing Characteristics:

Shell: Low, nearly or quite unkeeled, plastron and bridge extensively marked with black in the older specimens.

Head: Thin, light lines on the beak and several thin longitudinal stripes extending backward from the hind border of the orbit and a long, oval expansion of the broad supratemporal stripe, which is usually bright red in color.

The oval expansion of the supratemporal stripe is so obvious in this species that Stejneger (as cited by Carr, 1952) commented on it by stating that the red-eared species was the easiest and most unmistakable identified turtle from infancy to old age of all our freshwater forms, because of the unique and insistently conspicuous red patch above the ear. It is, however, very difficult in practice to separate the old melanistic males of the subspecies P. s. elegans, P. s. troosti, and in some cases it is impossible.

## THE HABITAT OF *Pseudemys scripta elegans* AND ITS RELATION TO PARASITISM

The turtles collected for this survey were obtained from two principal localities in Texas and from six in the vicinity of Stillwater, Oklahoma. The ecological aspects of the two ponds in South Texas were quite different in spite of the fact that both had been subjected to a severe three-year drouth. The ponds in Oklahoma were quite diverse ecologically but both Texas type ponds were represented. The drouth did not affect the ponds and turtle populations as severely in Oklahoma as it did in the Texas localities. With few exceptions, however, the parasite fauna was similar for the ponds in Texas and Oklahoma, but the average number of parasites per host varied greatly in some cases, depending on the specific parasite involved.

The pond in Nueces County (Figure 1) was located five miles southwest of Corpus Christi, Texas, and was a stock pond surrounded on two sides by plowed fields and on two sides by roads. The immediate shore area of the pond was barren and grass was not evident for approximately twelve yards from the pond on any side. All vegetation, with the exception of a few trees at the south end of the pond, was dead as a result of the intense heat and lack of water over the long period of time. The water level was extremely low

Figure 1. A stock pond five miles southwest of Corpus Christi, Texas (Nueces County) from which thirteen hosts were obtained. Note lack of vegetation which was caused primarily by a three-year drought. (Arrow denotes funnel-type trap.)

and the pond was approximately one-eighth of its maximum size. During the three months that the turtles were trapped the water level fell approximately four feet. Through the month of June there was an abundance of turtles in this pond, both the red-eared turtle, Pseudemys scripta elegans, and the yellow mud turtle, Kinosternon flavescens flavescens. During July the number of red-eared turtles decreased slowly and by August only a few were observed in the pond and the surrounding area. It was interesting to note that the population of the yellow mud turtle appeared to remain relatively constant throughout the summer. There were no empty shells of either species in the area surrounding the pond. The decrease in the turtle population was interpreted as the result of migration and not of starvation, since all of the turtles collected from this pond appeared to be in good physical condition. Some even nested in the area as evidenced by the finding of one nest and one hatchling turtle which still retained its "egg tooth".

The pond in Kleberg County was in reality the spillway depression from a small dam located on the Santa Gertrudis division of the King Ranch, which is approximately three miles west of Kingsville, Texas. The stream above the dam was dry and had not flowed for approximately a year. The pond was surrounded by high banks on three sides and the fourth side was a long slope covered with large rocks.

The water level in this pond was considerably below normal but it remained relatively constant throughout the summer.

The vegetation in the area consisted of several small palm trees and thick, lush, green grass. The turtle population was exceptionally dense and a count at any one time of seventy to eighty protruding heads of the red-eared species was not uncommon. There was also a dense population of Emory's soft shelled turtles, Amyda ferox emoryi. The food supply in the pond appeared to be insufficient for the vast turtle population in spite of the flora surrounding the pond. This was evidenced by the large number of empty shells of Pseudemys scripta elegans surrounding the immediate pond area. At the time of the first count in early summer there were eighty-three red-eared turtle shells, and by the end of the summer the number had increased to one hundred and twenty-three. No attempt was made to estimate or calculate the number of skeletons of the soft shelled turtle in the same area, but they were numerous. The turtles had tried apparently to migrate in search of food, but were prevented from leaving the area because of their inability to negotiate the high banks and large rocks surrounding the pond. There was no observable decrease, on the basis of casual observation, in the turtle population in this pond during the collecting period in spite of the increase in the number of skeletons.

All of the turtles collected from this pond were in poor physical condition and many were very sluggish. The sluggish ones were very anemic, the blood having about the same consistency of water. The reproductive organs in many of these turtles had degenerated and were very inconspicuous.

There were no turtle nests in the area surrounding this pond and there was no evidence that normal reproductive activity had occurred for a considerable period.

The parasite fauna, however, in the turtles of the two ponds was approximately the same as to the number of species recovered and the average number per host. The only parasites collected from turtles taken from the Kleberg County pond and not found in the turtles taken from the Nueces County pond were blood flukes in the genus Proparorchis.

## METHODS AND MATERIALS

The turtles for this survey were obtained from three principal areas. Thirteen turtles were taken from a large stock pond approximately five miles southwest of Corpus Christi, Nueces County, Texas and forty-three specimens were trapped in and taken from a pond on the Santa Gertrudis Division of the King Ranch which is located approximately three miles west of Kingsville, Kleberg County, Texas. Twenty-three turtles were recovered from six ponds in the vicinity of Stillwater, Payne County, Oklahoma.

Most of the turtles used in this survey were captured by the writer and the others were contributed by interested individuals. Various methods were used for capturing the turtles. All of those obtained in the two Texas localities (with the exception of one large female which was collected by hand) were taken by using cylindrical, wire-mesh fish traps. In one instance a total of fifty-one turtles was taken in two traps at one time, which gives an idea of their abundance. All of the turtles were released, the traps were baited subsequently and then checked at twenty minute intervals until suitable numbers for the day were obtained. This method proved to be quite successful and by using two traps with different-sized openings all sizes of turtles were secured. The smallest turtle taken by using this method was a

hatchling which still possessed its "egg tooth", and the largest specimen was 10 3/4 inches in length (carapace length), which is unusually large for this species. Specimens in Oklahoma were collected by trapping, by seining and by hand.

It is commonly known by parasitologists that if hosts are kept in captivity for a period of time some species tend to lose their parasites. An effort was made for this reason to examine the turtles as soon as possible after their capture and all those that could not be examined in three or four days were released. Those that were kept for several days before examination were placed in a large container (wash-tub) with a little water and fed on lettuce and other leafy green vegetables, since the adults have been reported to be herbivorous.

All of the turtles were examined for ectoparasites at the time they were removed from the traps and again when they were sacrificed and dissected. At this time the turtles were measured and the length and width of both the carapace and plastron were recorded. The turtles were sexed using the length of the claws and position of the anal opening in relation to the carapace as the criteria, and this was verified when they were dissected. This method was quite accurate for mature turtles but the immature ones could be sexed only by dissection.

The hosts were decapitated and five blood smears were made from each turtle. The body surface and external openings were carefully examined for ectoparasites such as

leeches and monogenetic trematodes which may be found not only on the surface, but in the rectum, mouth, and urinary bladder.

In preparation for dissection the turtle was placed on its carapace, thereby exposing the plastron which was removed by cutting the bridges with a hacksaw and severing the muscles attached to it. The visceral organs were exposed by removing the peritoneum. To prevent postmortem migration and abnormal movements of the parasites, resulting from manipulations, ligatures were placed at the following places prior to the removal of the viscera. Blood vessels were ligated at the heart and lungs. The gall bladder duct was ligated at the liver. The urinary bladder as well as the accessory bladders were ligated at the cloaca. Ligatures were placed at the following levels along the digestive tract; (1) junction of the esophagus and stomach, (2) between the stomach and small intestine, (3) at the middle of the small intestine, (4) between the small and large intestine and (5) between the large intestine and rectum. The visceral organs were removed subsequently and placed separately in dishes containing physiological saline solution. The body cavity was rinsed with physiological saline solution after the removal of the organs and both the body cavity and washings were examined for parasites, with the aid of a dissecting microscope. The hollow organs were slit from end to end, washed thoroughly, and the contents and organs examined for parasites according to routine

procedures. Solid organs such as the liver, spleen, and kidneys were teased with needles in order to free the parasites. All organs were thoroughly rewashed several times and the washings were examined for parasites each time after organs were removed to new containers of physiological saline solution. These containers were refrigerated at 38°F. two to four hours during the intervening periods. These examinations were continued as long as parasites were recovered in washings. All parasites that were collected were kept in a physiological saline solution and refrigerated at 38°F. until they were fixed.

All nematodes and acanthocephalans were fixed in 10 per cent formalin solution. Most of the trematodes were fixed in the same manner but some of the very delicate specimens, such as Proparorchis sp., were fixed in alcohol-formalin-acetic acid solution. All specimens were stored in the solution used for their fixation.

A host record card (Figure 2) was made for each turtle examined. All pertinent information was recorded on the card and a duplicate record was kept in a spiral notebook. All specimens were labeled by writing the host number and letter, indicating the position in the host, on a small piece of bond paper with India ink. These small tags were placed in the containers with the respective specimens.

Parasitologists have found it extremely difficult to stain nematodes for study except by elaborate and time consuming methods. Consequently almost all workers in the field

| | | |
|---|---|---|
| Host - | Host No. - | |
| Locality - | Date Collected - | |
| Collector - | Date Killed - | |
| Parasites Found - | Date Examined - | |
| | | |
| Fixation - | Carapace - | Length |
| Stain - | | Width |
| Mount - | Plastron - | Length |
| Remarks - | | Width |

Figure 2. Sample Host Record Card

have depended upon semi-permanent, unstained mounts using either lacto-phenol or glycerine jelly preparations for study. The lacto-phenol solution will destroy parasites if they are left in it too long and the glycerine jelly mounts are tedious to prepare. Both media, however, are serviceable and are used because they clear the specimens so that the internal anatomy may be seen. Nevertheless, when this survey was started, an attempt was made to stain some of the nematodes and the acanthocephalans, with poor results. As a consequence of this, a mounting medium, Hoyer's, used by entomologists, was recalled and tried for mounting these worms. Excellent results were secured and later several stains were added to the medium which gave still better definition.

Hoyer's mounting medium (a modification of Berlese's gum-arabic mounting medium) is an aqueous solution of gum arabic, chloral hydrate and glycerine. According to Baker and Wharton (1952) the medium is prepared by mixing the following ingredients at room temperature in the order listed:

Distilled water . . . . . 50 gms.
Gum arabic (clear crystals)*. . . . . 30 gms.
Chloral hydrate . . . . . 200 gms.
Glycerine . . . . . 20 gms.
(*It was found that powdered gum arabic also gives excellent results, but some entomology workers have found it to be useless.)

These writers recommended that the cover glasses of finished slides be ringed to prevent the absorption of moist-

ure by the medium. Moisture absorption is especially apt to take place when slides are kept in more humid areas, such as the Gulf States.

The clear medium alone was used initially but it was observed that some of the smaller nematode specimens, such as Spiroxys contortus, overcleared. Goldberg (1954) reported that the addition of Giemsa or Aceto-carmine stain to PVA mounting medium enhanced greatly its value for small nematodes. On the basis of this report these two stains were added separately to the Hoyer's solution and excellent staining results were obtained not only with nematodes but with all groups of helminth parasites.

With Hoyer's medium, nematodes were mounted from the living condition or from any aqueous preserving solution. They were mounted directly in the medium without any dehydration procedure because this medium relaxes, fixes, stains and produces perfect mounts of the parasites in one operation. Nematodes mounted in the Hoyer's medium containing Giemsa stain (one part stock stain to nineteen parts of the clear mounting medium) took up the eosin and the specimens were red in a blue field. This proved to be a very useful feature in that the blue field acted as a light filter and prevented a great deal of eye strain. Specimens mounted in this medium were easy to study since all structures, including the internal anatomy, could be seen distinctly. The length of time required for the processes of staining and clearing specimens mounted in the Giemsa stain

medium varied from a few minutes to several hours, and depended apparently on the size of the specimen.

It was possible to reclaim and stain nematodes that had been mounted in clear Hoyer's medium. In April 1954 approximately twelve specimens of Spironoura concinna were mounted in the clear medium. These nematodes were examined in October 1954 for purposes of identification. At that time it was observed that overclearing of the specimens had rendered them useless. The slides were placed in containers with water and left for 12 to 14 hours. This loosened the cover glasses, diluted the medium and allowed the specimens to absorb water which caused them to regain their original opaque appearance. Then the worms were mounted in the Giemsa-stained Hoyer's medium and they were very satisfactory specimens for study.

Acanthocephalans, like the nematodes, have been relaxed, fixed, stained, and permanently mounted in one operation. The Giemsa medium gave excellent results. The hooks on the proboscis and the internal structures, such as the nuclei, lemnisci, reproductive organs and the eggs within a gravid female, were easily seen. Even the characteristics of the eggs, such as the three shell membranes, were easily observed in the gravid female and according to Hopp (1954) these characteristics are extremely difficult to see except in living eggs. If the live worms were mounted immediately after they were removed from the host, the proboscis was withdrawn into the body and the inverted position of the

hooks was readily observable. If the specimens were relaxed partially, prior to mounting, the proboscis remained extruded and the hooks and proboscis could be measured. Some acanthocephalan worms were stained, using borax carmine and various hematoxylin stains, destained, rinsed in a basic solution and mounted in the clear Hoyer's medium with results equally as good.

The majority of the trematodes were stained and mounted for study by using basic parasitological technique procedures as follows; (1) removal of storage solution by washing, (2) staining, (3) destaining, (4) dehydrating, (5) clearing, and (6) mounting. Several stains were used including various hematoxylin stains, Semichon's Acid Carmine, Borax Carmine, and Cochineal. The best results were obtained with cochineal and hematoxylin stains.

Hoyer's mounting medium containing Aceto-carmine stain was used satisfactorily for mounting small, delicate trematodes, Telorchis sp. The best results were obtained by using one part Aceto-carmine stain (stock solution) to ten parts of the clear medium. The flukes were taken from the preserving fluid, either 10 per cent formalin or Alcohol-Formalin-Acetic Acid, and mounted, omitting the dehydration process.

There are a few general observations that should be mentioned concerning the use of Hoyer's mounting medium and they apply to all groups of helminths. When specimens are mounted in any of these variations of Hoyer's medium they

seem to collapse and appear worthless, but as soon as the medium is dispersed throughout the worm, its original shape returns and there is no apparent internal distortion. Very little shrinkage, if any, was observed in any of the specimens mounted. It was found that specimens mounted in the Giemsa stained medium tended to fade if placed in direct sunlight for any length of time; however, satisfactory results were obtained by drying the slides in a dark place such as an oven, and then storing them in ordinary slide boxes. Hoyer's mounting medium and the variations presented in this thesis have proved to be satisfactory and fast as compared with older methods, and they were a great help in doing the taxonomic work concerned with this survey.

## DATA CONCERNING PARASITES

The red-eared turtles examined in this survey showed varying degrees of parasitism, but no specimen was negative for all species. The number of mature parasites in a host varied from fifteen to two-hundred forty-seven. A total of thirty-nine immature nematodes, which could not be classified, was found either free in the coelom or embedded in the mesenteries. No attempt was made to count the numerous encysted nematodes of Spiroxys sp. The number of encysted trematodes in a host ranged from three to fifteen, and no attempt was made to identify them. The data concerning the incidence of infection in turtles from Texas and Oklahoma are presented in Tables I and II respectively.

The tables show the incidence of infection of the various groups of parasites (i.e. acanthocephalans, nematodes and trematodes) according to their location within the host. The data presented in Table I are based on a total of 56 hosts obtained in Texas and gives the groups of parasites by location within the host, number of hosts infected, per cent of hosts infected, average number of worms or cysts per host, and the total number of parasites collected. The same data for 23 hosts from Oklahoma are presented in Table II.

The incidence of infection as shown in Table I, varies from 1.8 per cent for the mouth trematodes to 85.7 per cent

for intestinal nematodes while in Table II the incidence ranges from 8.7 per cent for nematodes encysted in the liver to 87 per cent for acanthocephalans in the intestine. By comparing the two tables it will be noted that the incidence of infection for the different worms varied considerably in some instances with the geographic location.

Acanthocephalans were the most numerous parasites encountered and presented the highest incidence of infection. There were no cestodes and none have been reported from this turtle. Ten species of helminth parasites are reported in this survey and each is described.

Table 1

INCIDENCE OF INFECTION IN TURTLES COLLECTED

IN THE TWO TEXAS LOCALITIES

| Groups of Parasites by Location | No. of Turtles Infected | Percent of Turtles Infected(1) | Average No. of Worms or cysts per Host | Total No. of Parasites Collected |
|---|---|---|---|---|
| Mouth: | | | | |
| Trematodes | 1 | 1.8 | 2 | 2 |
| Esophagus: | | | | |
| Trematodes (Encysted) | 3 | 5.4 | 1 | 3 |
| Stomach: | | | | |
| Nematodes | 16 | 30 | 6 | 94 |
| Trematodes (Encysted) | 9 | 16 | 19(3) | 153 |
| Nematodes (Encysted)(2) | 39 | 70 | --(3) | --- |
| Small Intestine: | | | | |
| Acanthocephalans | 36 | 64.3 | 26 | 934 |
| Nematodes | 48 | 85.7 | 18.6 | 843 |
| Trematodes | 15 | 26.8 | 29 | 430 |
| Nematodes (Encysted)(2) | 12 | 21.4 | --(3) | --- |
| Large Intestine: | | | | |
| Nematodes | 8 | 14.3 | 3 | 24 |
| Urinary Bladder: | | | | |
| Accessory bladder Trematodes: | 11 | 20 | 2 | 18 |
| Bladder proper Trematodes: | 2 | 3.6 | 3 | 5 |
| Liver: | | | | |
| Trematodes | 1 | 1.8 | 15 | 15 |
| Trematodes (Encysted) | 4 | 7.1 | 5 | 21 |
| Nematodes (Encysted)(2) | 21 | 37.5 | --(3) | --- |
| Mesenteries: | | | | |
| Nematodes (Immature) | 10 | 18 | 2 | 17 |
| Coelom: | | | | |
| Nematodes (Immature) | 3 | 5.4 | 1 | 4 |
| Heart: | | | | |
| Trematodes | 2 | 3.6 | 1 | 2 |

(1) The percentages are based on a total of 56 turtles.
(2) These were larval forms of Spiroxys sp.
(3) Dash indicates that the cysts were too numerous to count.

Table 2

INCIDENCE OF INFECTION IN TURTLES COLLECTED

FROM VARIOUS LOCALITIES IN OKLAHOMA

| Groups of Parasites by Location | No. of Turtles Infected | Percent of Turtles Infected (1) | Average No. of Worms or Cysts per Host | Total No. of Parasites Collected |
|---|---|---|---|---|
| Mouth: | | | | |
| Trematodes | 19 | 82.6 | 4 | 66 |
| Esophagus: | | | | |
| Trematodes (Encysted) | 0 | 0 | 0 | 0 |
| Stomach: | | | | |
| Nematodes (Encysted) | 11 | 47.8 | 9 | 97 |
| Trematodes | 0 | 0 | 0 | 0 |
| Nematodes (Encysted) (2) | 14 | 60.9 | --(3) | --- |
| Small Intestine: | | | | |
| Acanthocephalans | 20 | 87 | 36 | 719 |
| Nematodes | 17 | 74 | 38 | 643 |
| Trematodes | 6 | 27 | 62 | 372 |
| Nematodes (Encysted) (2) | 5 | 21.7 | --(3) | --- |
| Large Intestine: | | | | |
| Nematodes | 0 | 0 | 0 | 0 |
| Urinary Bladder: | | | | |
| Accessory bladder Trematodes | 17 | 74 | 3 | 45 |
| Bladder proper Trematodes | 5 | 21.7 | 4 | 18 |
| Liver: | | | | |
| Trematodes | 0 | 0 | 0 | 0 |
| Trematodes (Encysted) | 0 | 0 | 0 | 0 |
| Nematodes (Encysted) (2) | 14 | 60.9 | --(3) | --- |
| Mesenteries: | | | | |
| Nematodes (Immature) | 4 | 17.4 | 2 | 9 |
| Coelom: | | | | |
| Nematodes (Immature) | 4 | 17.4 | 2 | 9 |
| Heart: | | | | |
| Trematodes | 0 | 0 | 0 | 0 |

(1) These percentages are based on a total of 23 turtles.
(2) These were larval forms of Spiroxys sp.
(3) Dash indicates that the cysts were too numerous to count.

## An Unusual Case of Extreme Parasitism

All of the turtles examined in this survey were infected with helminth parasites. One specimen, however, proved to be unusually interesting because of the extreme number and variety of parasites recovered from a turtle of unusual size, and merits special mention.

A small red-eared turtle was captured in the vicinity of Yost Lake, located near Stillwater, Oklahoma, on September 15, 1954. It was kept in captivity for 44 days until it died. While in captivity it was kept in a small aquarium and fed on commercial turtle food. The turtle had been dead approximately an hour before it was examined, hence it is quite unlikely that much postmortem migration of parasites occurred. The age of the turtle was estimated to be one year using the number of rings on the plastron as the criterion. In all probability the egg hatched in the fall of 1953, the turtle overwintered in the nest, and emerged in the spring of 1954.

A total of 247 helminth parasites was removed from this turtle. The most abundant parasite was a nematode, Camallanus microcephalus, with a total of 231 specimens. The normal habitat of this nematode is the anterior part of the small intestine and the pyloric region of the stomach. In this host, however, 31 of these nematodes were taken from the

cardiac region of the stomach, and such an extensive distribution was not observed in any other host examined in this survey, which included 79 turtles.

A total of 15 monogenetic trematodes was collected from this turtle with the following distribution: five from the mouth, five from the urinary bladder and five from the accessory bladders. A total of only 25 monogenetic trematodes was taken from 56 turtles collected in Texas of which 23 per cent were infected, with an average of only 2 per host. A total of 129 monogenetic trematodes was taken from 23 turtles collected in Oklahoma of which 96 per cent were infected, with an average of between 4 and 5. Nine monogenetic flukes was the largest number taken from any turtle, with the exception of the one under discussion.

One specimen of Proparorchis arterícola was recovered from the spleen. This was an interesting specimen because it was the largest one collected and much larger than the maximum recorded for the species. These parasites in all the other hosts were taken from the heart, lungs, and liver, but they have been reported also from the blood vessels.

Numerous minute organisms were removed from the urinary bladder of this turtle. These organisms were identified as rotifers and annelid worms. These normally, free-living organisms were alive and apparently had become adapted to this unusual environment. They seemed normal in every respect and moved about quite rapidly. The rotifer and annelid worm populations apparently had reached tremendous

proportions in the small container in which the turtle was kept and for lack of space and food they were probably forced into this environment. This observation seems to give some support to the modern theory of the origin of parasitism, that of preadaptation (Baer, 1952).

# DESCRIPTIONS OF

# MONOGENETIC TREMATODES

1. Polystomoides coronatum (Leidy, 1888) Price, 1939
2. Neopolystoma orbiculare (Stunkard, 1916) Price, 1939

Polystomoides coronatum (Leidy, 1888) Price, 1939

Polystomatidae Gamble, 1896

Synonyms according to Price (1939):

Polystoma coronatum Leidy, 1888

P. (Polystomoides) coronatum (Leidy, 1888) Ward, 1917
P. opacum Stunkard, 1916
P. (Polystomoides) opacum (Stunkard, 1916) Ward, 1918
P. megacotyle Stunkard, 1916
P. (Polystomoides) megacotyle (Stunkard, 1916) Ward, 1918
P. microcotyle Stunkard, 1916
P. (Polystomoides) microcotyle (Stunkard, 1916) Ward, 1918
P. albicolis MacCallum, 1919
P. digitatum MacCallum, 1919

Description: Body elongate oval, 3 to 6.4 mm. long by 0.765 to 1.6 mm. wide at level of vaginal apertures. Oral sucker 0.133 to 0.306 mm. long by 0.323 to 0.765 mm. wide. Pharynx subglobular, 0.274 to 0.46 mm. long by 0.304 to 0.595 mm. wide; esophagus very short. Intestinal ceca extending to near posterior end of body proper. Haptor more or less cordate (sometimes digitate) 0.970 to 1.8 mm. wide, bearing three pairs of cuplike suckers each 0.34 to 0.51 mm. in diameter. Haptor armed with two pairs of large hooks between posterior pair of suckers and 16 larval hooklets distributed as follows: one in each sucker, six between anterior pair of suckers, four between posterior pair of suckers. Outer pair of large hooks 0.095 to 0.197 mm. long, inner pair 0.045 to 0.095 mm. long, and larval hooklets 0.020 to 0.025 mm. long. Genital aperture median, immediately posterior to intestinal bifurcation; genital coronet with 14 to 40 hooks, 0.020 to 0.026 mm. long.

Cirrus 0.133 to 0.22 mm. wide; testis circular or bluntly oval, 0.285 to 0.680 mm. long by 0.19 to 0.525 mm. wide, median and pre-equatorial. Ovary comma-shaped 0.133 to 0.435 mm. long by 0.064 to 0.114 mm. wide, pretesticular to right or left of median line. Vitellaria extending from level of base of pharynx to posterior end of body proper with some follicles forming band across body at intestinal bifurcation and filling completely postesticular portion of body. Vaginal paired apertures ventral, slightly posterior to level of distal pole of ovary near margins of body on either side. Genito-intestinal canal opening into intestine on ovarial side. Eggs oval, 0.228 to 0.25 mm. long by 0.153 to 0.178 mm. wide.

This description is modified from Price (1939).

Hosts: Amyda ferox (Schneider), A. spinifera (LeSeur), Pseudemys scripta elegans (Wied), P. scripta (Schoepff), Chelydra serpentina (Linn) Malacoelemmys leseuri.

Habitat: Mouth, nostrils and urinary bladder.

Distribution: United States (New York, Massachusetts, North Carolina, Texas, Oklahoma) and (?) Canada.

Discussion: A total of 68 specimens of this species was collected. Only two of these were from turtles in Texas and both specimens were taken from one host. This gives an incidence of infection in turtles from Texas of 1.8 per cent compared with 82.6 per cent in Oklahoma. This was the greatest percentage differential observed in any species.

The representative specimens, except for one, examined agreed closely with the redescription of Polystomoides coronatum by Price (1939). As noted in the description, this species possesses an opistohaptor with 6 suckers. The odd specimen, collected in Oklahoma, had only 5 suckers on the opistohaptor, but it was perfectly formed and there was no evidence that another sucker had been present. This specimen was considered to be an anomaly since all other characters agreed with the species description.

Neopolystoma orbiculare (Stunkard, 1916) Price, 1939

Polystomatidae Gamble, 1896

Synonyms according to Price (1939):

Polystoma orbiculare Stunkard, 1916
P. (Polystomoides) orbiculare (Stunkard, 1916) Ward, 1918
P. oblongum Wright, of Leidy, 1888
P. troosti MacCallum, 1919
P. spinulosum MacCallum, 1919
P. inerme MacCallum, 1919
P. elegans MacCallum, 1919
P. aspidonectis MacCallum, 1919
P. floridanum Stunkard, 1924
Polystomoides orbiculare (Stunkard, 1916) Ozaki, 1935

Description: Body elongate oval, 2.4 to 5.8 mm. long by 0.318 to 1.6 mm. wide. Oral sucker 0.17 to 0.34 mm. long by 0.272 to 0.588 mm. wide, opening sub-terminal. Pharynx 0.187 to 0.30 mm. long by 0.204 to 0.39 mm. wide. Esophagus short, intestinal ceca extending to near posterior end of body proper. Haptor circular 0.70 to 1.6 mm. wide with six suckers and sixteen larval hooklets. Suckers each 0.17 to 0.425 mm. wide, usually equidistant; larval hooklets 0.020 mm. long, distributed as follows: one in each sucker, six between anterior pair of suckers, four between posterior pair of suckers. Genital aperture median, near intestinal bifurcation. Genital coronet with 16 hooks, blades about 0.020 mm. long. Cirrus pouch 0.076 to 0.148 mm. in diameter; testis oval 0.425 to 1.0 mm. long by 0.34 to 0.68 mm. wide, equatorial or slightly pre-equatorial. Ovary comma-shaped 0.12 to 0.375 mm. long by 0.965 to 0.17 mm. wide, to right or left of median line. Vaginal apertures paired, ventrolateral, at level of posterior pole of ovary on either side.

Vitellaria extending from level of posterior margin of pharynx to posterior end of body proper with some follicles forming band across median field of intestinal bifurcation and filling post-testicular area. Genito-intestinal canal opening into intestine on ovarial side. Eggs oval 0.228 to 0.272 mm. long by 0.153 to 0.17 mm. wide.

This description was modified from Price (1939).

Hosts: Pseudemys scripta elegans (Wied), P. alabamensis, Chrysemys belli marginata, C. picta, Trionyx ferox, Malaclemys centrata concertrica, Chelydra serpentina, Pseudemys scripta, P. elegans, P. troosti (The exact identity of the last three turtles is unknown because of the controversy in the past involving the names of the turtles in the Pseudemys "complex.")

Habitat: Urinary bladder

Distribution: United States (North Carolina, Illinois, Iowa Minnesota, Oklahoma, Florida, Texas).

Discussion: A total of 86 trematodes of this species was collected from 28 red-eared turtles of which 23 specimens were obtained from 11 turtles collected in Texas and 63 from 17 turtles captured in Oklahoma. The incidence of infection was 20.0 per cent in Texas with an average of 2 worms per host while in Oklahoma it was 74.0 per cent with an average of 4 worms per host. Representative specimens of this species agreed closely with the redescription of Neopolystoma orbiculare by Price (1939). On the basis of the 20 representative specimens examined, the range of the number of hooks of

the genital coronet was 31 to 36, which is quite narrow as compared with the range of 14 to 40 given by Price (1939).

There are two types of bladders in turtles: the large bilobed urinary bladder which joins the cloaca midway between the two oviducts and a pair of accessory urinary bladders which are attached to the cloaca posterior to the oviducts. The accessory urinary bladders are elongated sac-like structures and their function is uncertain but it is thought that in females they carry water, used in softening the soil while digging a nest. The bladder habitat of N. orbiculare is usually given as the "urinary bladder." The majority of the flukes in both Texas and Oklahoma turtles were found in the accessory bladders instead of the urinary bladder "proper."

# DESCRIPTIONS OF

# DIGENETIC TREMATODES

1. *Telorchis corti* Stunkard, 1915
2. *Telorchis singularis* (Bennett, 1935) Wharton, 1940
3. *Proparorchis artericola* Ward, 1921

Telorchis corti Stunkard, 1915

Reniferidae Baer, 1924

Synonyms according to Wharton (1940):

Telorchis linstowi Goldberger, 1911 (nec Stossich, 1890)
Telorchis lobosus Stunkard, 1915
Telorchis medius Stunkard, 1915
Telorchis insculpti MacCallum, 1918
Telorchis guttati MacCallum, 1918
Telorchis chelopi MacCallum, 1918
Telorchis pallidus MacCallum, 1918
Telorchis angustus MacCallum, 1921 (nec Stafford, 1900)
Cercorchis corti (Stunkard, 1915) Perkins, 1928
Telorchis stenenoura Ingles, 1930
Cercorchis texanus Harwood, 1932
Cercorchis medius McMullen, 1934 (nec Stunkard, 1915)

Description: Body elongate, 3.6 to 7.15 mm. long by 0.32 to 0.5 mm. wide, with greatest width at level of acetabulum. Oral sucker, 0.14 mm. in diameter, surrounded by cuticular spines, 0.003 to 0.004 mm. long; pharynx, very short if present, 0.07 to 0.08 mm. in diameter. Esophagus, one and one-half to two and one-half times length of pharynx. Intestinal ceca extend beyond testes. Acetabulum either slightly smaller than or equal to oral sucker, one-sixth to one-seventh of body length from anterior end. Genital pore slightly anterior and usually to right of acetabulum. Testes spherical to oval, approximately equal in size, 0.2 to 0.29 mm. long by 0.16 to 0.24 mm. wide; distance between testes 0.05 to 0.1 mm. Cirrus sac extends posteriorly from genital pore three-fourths of distance to ovary, 1.12 to 1.18 mm. long by 0.088 mm. wide. Vas deferens greatly coiled. Ovary, spherical to slightly oval, 0.117 to 0.147 mm. long by 0.147 to 0.176 mm. wide, on median line or slightly to left, about three-eighths of body length from anterior end, long axis parallel to that

of body. Seminal vesicle present, Laurer's canal opening just posterior to ovary. Uterus descends on left side, returning on right side of metraterm, rarely descending and ascending limbs cross about one-third of distance from ovary to cephalic testis, forming a figure 8. Metraterm almost straight, extending posteriorly from genital pore one-fourth to one-third of distance to ovary. Genital sinus absent. Vitellaria arranged in indistinct follicular groups, lateral, external to intestinal ceca, beginning one-third of distance from ovary to acetabulum, anterior to posterior end of cirrus sac, and extends five-sixths of distance from ovary to anterior testis. Eggs, 0.030 to 0.031 mm. long by 0.015 to 0.019 mm. wide. Excretory pore at posterior tip of body, large median bladder extending anteriorly to level of ovary where it receives a pair of collecting tubules.

This description is modified from Stunkard, 1915 and Wharton, 1940.

Hosts: Chelydra serpentina, Chrysemys marginata, C. picta, Clemmys guttata, C. insculpta, C. marmorata, Deirochelys reticularia, Graptemys geographica, Malacelmys macrospilota, Pseudemys scripta elegans, P. elegans. (The exact identity of the last named turtle is unknown due to the past controversy involving the names of the turtles in the Pseudemys "complex.")

Habitat: Small intestine

Distribution: North America

Discussion: A total of 521 flukes of this species was removed

from 14 red-eared turtles of which 287 specimens were obtained from 10 turtles collected in Texas and 234 from 4 turtles captured in Oklahoma. The incidence of infection was 17.9 per cent in Texas with an average of 29 worms per host while it was 17.4 per cent in Oklahoma, with an average of 59 worms per host. Representative specimens of Telorchis corti agreed closely with the descriptions by Stunkard (1915) and Wharton (1940).

Telorchis singularis (Bennett, 1935) Wharton, 1940

Reniferidae Baer, 1924

Synonyms according to Wharton (1940):

Telorchis robustus Stunkard, 1915 (nec Goldberger, 1911)
Cercorchis singularis Bennett, 1935

Description: Body elongate, 7.68 to 14.1 mm. long by 0.63 to 0.84 mm. wide, both extremities bluntly rounded. Cuticula shows decreasing spination from anterior end to posterior third of body after which spines are wanting. Oral sucker subterminal, 0.12 mm. long by 0.14 mm. wide; prepharynx short, muscular; pharynx 0.14 mm. long by 0.11 mm. wide; esophagus variable in length, averaging 0.21 mm.; intestinal ceca extend to posterior end of body. Acetabulum 0.14 mm. in diameter. Genital pore slightly anterior and usually to right of acetabulum. Testes tandem, each 0.25 to 0.31 mm. in diameter, between ends of intestinal ceca. Cirrus sac, 3.91 mm. long by 0.1 mm. wide, extending from ovary to near acetabulum where it opens into large genital sinus. Seminal vesicle occupies posterior fourth of cirrus sac; prostate gland well developed, 1.03 mm. long; ejaculatory duct 2.06 mm. long. Ovary 0.21 mm. in diameter, located immediately posterior to middle of body slightly right. Mehlis' gland, Laurer's canal and vitelline reservoir present; seminal receptacle absent. Uterus largely intercrural, transversely coiled, overlapping slightly in center with descending portion on right side of body. Metraterm, 2.1 mm. long by 0.06 mm. wide, opening into genital sinus anterior to opening of cirrus sac, surrounded by large

muscular bulb, 0.13 mm. in diameter, near its distal end. Genital sinus passes left of acetabulum to genital pore which is located slightly to left of median line immediately anterior to acetabulum. Vitellaria arranged in indistinct follicular groups, lateral to intestinal ceca, extending from level one-fourth distance from acetabulum to ovary to anterior margin of anterior testis. Excretory vesicle extends from Mehlis' gland to posterior end of body, receives pair of collecting tubules anteriorly which extend short distance anterior to acetabulum. Eggs oval, 0.018 to 0.025 mm. long by 0.012 to 0.015 mm. wide.

This description is modified from Bennett, 1935.

Hosts: Chelydra serpentina, Pseudemys scripta elegans, P. elegans, P. scripta, P. troosti. (The exact identity of the last three species is unknown because of the past controversy involving the names of the turtles in the Pseudemys "complex.")

Habitat: Small intestine

Distribution: North America

Discussion: A total of 281 specimens of this species was removed from 10 red-eared turtles of which 143 were obtained from 7 hosts from Texas and 138 were taken from 3 collected in Oklahoma. The incidence of infection was 12.5 per cent in Texas, with an average of 21 worms per host, while it was 13.2 per cent in Oklahoma, with an average of 46 worms per host. Representative specimens of Telorchis singularis agreed closely with the description by Bennett (1935).

Proparorchis artericola Ward, 1921

Spirorchidae Stunkard, 1921

Synonyms:

Spirorchis innominata Ward, 1921
Spirorchis eustreptos MacCallum, 1921
Spirorchis emydis MacCallum, 1921
Spirorchis pictae MacCallum, 1926

Description: Monostomate blood fluke, oval or spindle-shaped, 1.62 to 3.0 mm. long by 0.28 to 0.80 mm. wide; no body spines. Oral opening terminal or subterminal, surrounded by elongated oval, oral sucker, 0.32 to 0.70 mm. long by 0.17 to 0.38 mm. wide. Esophagus slightly sinuous, increasing progressively in external diameter posteriorly. Extreme posterior end of esophagus surrounded by prominent esophageal gland cells. Intestinal ceca markedly sinuous, extending beyond reproductive organs. A median diverticulum is located opposite the esophagus at its junction with ceca. Testes, six to ten irregularly-shaped bodies, median and in linear series, extend from approximately 0.80 mm. behind median intestinal diverticulum posteriorly for distance of 0.54 to 0.97 mm. Seminal vesicle, elongated pyriform in shape, immediately behind posterior testis. Prostate not distinct. Cirrus and cirrus sac delicate, not easily seen. Genital pore located posteriorly on ventral side, to left of median line at level of ovary. Ovary lobed, located between ceca immediately posterior to testes. Vitellaria voluminous, paired, lateral, extending from level of posterior end of esophagus to beyond ends of intestinal ceca. Paired vitelline ducts join behind ovary. Seminal receptacle, Laurer's canal, ootype present.

Ootype apparently functions as uterus. Two small lateral bladders join to form excretory duct which opens at terminal pore. Eggs, spherical to oval, 0.075 to 0.084 mm. long by 0.041 to 0.045 mm. wide.

This description is modified from MacCallum (1921) and Ward (1921).

Hosts: Pseudemys troosti, P. hieroglyphica, Chrysemys picta dorsalis; Graptemys pseudogeographica pseudogeographica, P. elegans, Malacoclemmys leseueri, P. scripta, Chrysemys marginata, Chelopus insculptus, Pseudemys scripta elegans.

Habitat: Liver, lungs, heart, spleen, and major arteries.

Distribution: United States (Illinois, Iowa, Texas, North Carolina, Oklahoma, New York, "Southeastern section of the United States").

Discussion: In 1918, MacCallum published a brief description of an unusual trematode found in the intestine of a wood turtle, Chelopus insculpta. To this form he gave the generic name, Spirorchis, but omitted the specific designation. In the description he stated that the color of the intestinal contents of the worm was indicative of a hematophagic trematode. In 1921, Ward described a similar worm from four species of turtles and named it Proparorchis arterícola. In the same publication Ward assigned the specific name "innominata" to MacCallum's previously described trematode. Ward called attention to the similarity of the two worms and also pointed out several discrepancies in both MacCallum's description and figures. The cardinal differences between these two flukes

were size of the worms, presence or absence of a pharynx, position of the genital pore, size of the eggs, and location in the host. Due to the brevity of MacCallum's inadequate description, Ward was unable to establish the taxonomic relationship between the two forms. Stunkard (1921), however, secured MacCallum's specimens to compare with his material and concluded that both flukes, Proparorchis artericola and Spirorchis innominata, should be in the same genus. In the examination of MacCallum's specimens, Stunkard determined that the esophageal gland cells had been mistaken for the pharynx. He determined also that MacCallum was in error as to the position of the genital pore. Stunkard expressed the opinion that the specimens described by MacCallum came from the mesenteric blood vessels which had been ruptured during the dissection of the turtle. He corrected MacCallum's description of Spirorchis and the corrected description agreed with that of Proparorchis. After communicating with Dr. Stiles, a member of the International Commission on Nomenclature, Stunkard accepted the generic name Spirorchis MacCallum as having priority over Proparorchis Ward.

In 1921, MacCallum published an objection to the use of Ward's specific name, "innominata", and stated that the specific name, "eustreptos", which was intended in his original publication in 1918 had been omitted erroneously. He claimed that Ward suggested the specific name, "innominata", without studying the original specimens and without consulting him, and that, therefore, "eustreptos", was the valid name. It

is unfortunate that the specific name was omitted in MacCallum's original publication in 1918, but it is not feasible to accept the omitted name "eustreptos", as valid. Therefore, the names for these two species are Spirorchis artericola (Ward, 1921) and Spirorchis innominata Ward, 1921.

The basis for the validity of the two species appears to be based on the testicular follicles, as to whether or not they are distinctly separated (Byrd, 1939). There is also a slight difference in size. The testicular follicles in the specimens from this survey varied from distinct to indistinct units, with all intermediate gradations. On the basis of these observations the two species were considered to be synonymous. An attempt was made to determine the valid scientific name, but because of the confusion existing in the literature it is still questionable. The writer is of the opinion that Proparorchis artericola Ward, 1921 is preferable to the other names on the basis of Opinion No. 46 in Schenk and McMasters (1948) which states: ".... if (as in Aclastus Foerster, 1868) it is not evident from the original publication of the genus how many or what species are involved, the genus contains all of the species of the world which would come under the generic description as originally published, and the first species published in connection with the genus (as Aclastus rufipes Ashmead, 1902) becomes ipso facto the type." Because of the errors and brevity in MacCallum's description, it is questionable whether his genus could be considered to be valid. In this report Spirorchis is assumed

to be a *nomen dubium*.

The size of specimens collected in this survey appeared to be influenced by the location in the host. Those removed from the liver were the smallest specimens, those from the lungs and heart were intermediate in size and a single fluke from the spleen was the largest.

DESCRIPTIONS OF

NEMATODES

1. Camallanus microcephalus (Dujardin, 1845) Railliet and Henry, 1915

2. Spironoura concinnae Mackin, 1939

3. Spiroxys contortus (Rudolphi, 1819) Schneider, 1866

Camallanus microcephalus (Dujardin, 1845) Railliet and Henry, 1915

Camallanidae Railliet and Henry, 1915

Synonyms according to Chitwood (1932):

Camallanus trispinosus (Leidy, 1851)
Camallanus cyathocephalus MacCallum, 1918
Camallanus scabrae MacCallum, 1918
Camallanus troosti MacCallum, 1918
Camallanus chelydrae MacCallum, 1918
Camallanus floridianae MacCallum, 1918
Camallanus elegans MacCallum, 1918
Camallanus testudinis MacCallum, 1918
Camallanus seurati Magath, 1919
Camallanus americanus Magath, 1919

Description: Body reddish-brown in color, slender, cylindrical, and finely striated. Mouth consisting of large corneous capsule golden brown in color, forming two valves united at posterior end. Each valve with five to eight ridges on either side of unstriated median band. Two sets of three spines, pointed posteriorly, lying dorsally and ventrally at posterior end of buccal capsule. Esophagus divided into two parts; anterior cone-shaped or elongated pyriform, gradually thickening at posterior end; posterior cylindrical and slightly thickened terminally. Single pair of minute cervical papillae located dorso-laterally at level of thickest part of second portion of esophagus. Nerve ring 0.20 mm. and excretory pore 0.35 mm. from anterior end.

Male: Body 4.5 to 11.3 mm. long by 0.15 to 0.27 mm. wide, tail recurved ventrally, 0.084 mm. long from anal opening to tip. Caudal alae 0.439 to 0.793 mm. long by 0.031 mm. wide joined anteriorly on ventral surface, extend laterally to tip of tail, bearing seven pairs of caudal papillae or

ribs. Spicules unequal; right one 0.84 to 0.92 mm. long, with acute angle at anterior end, slightly curved, acuminate, with small process curved anteriorly, 0.005 mm. long and 0.075 mm. from distal end; left spicule 0.31 mm. long slender, acuminate, slightly curved, without accessory process.

Female: Body 7.4 to 19.4 mm. long by 0.16 to 0.46 mm. wide. Single ovary 1.9 to 3.5 mm. long pyriform shaped. Uterus consists of large sac, usually containing developing eggs and embryos. Vulva slightly posterior to middle of body, provided with a vulvar flap, 0.3 mm. long and protruding 0.12 mm. ventrally from body. Vagina directed dorsally and posteriorly to join uterus. Larvae in uterus, 0.20 to 0.36 mm. long. Tail straight, long, tapering to point, with three minute terminal papillae, 0.14 to 0.31 mm. long.

This description was modified from Leidy (1851) and Magath (1919).

Hosts: Pseudemys scripta elegans, Chelydra serpentina, Sternotherus odoratus, Chrysemys picta, C. marginata, Pseudemys scripta, P. elegans, P. troosti. (The exact identity of the last three species is unknown because of the past controversy involving the names of the turtles in the Pseudemys "complex.")

Habitat: Small intestine, and pyloric region of stomach.

Distribution: North America.

Discussion: A total of 1,486 specimens of the species was removed from 65 red-eared turtles of which 843 were obtained from 48 turtles collected in Texas and 643 from 17 turtles

captured in Oklahoma. The percent of hosts infected in Texas was 85.7, with an average number of 18 worms per host, while in Oklahoma hosts only 74.0 per cent harbored this parasite, with an average number of 38 worms per host.

Representative specimens of Camallanus microcephalus agreed closely with the descriptions by Leidy (1851) and Magath (1919).

The habitat of this nematode is usually considered to be the stomach and small intestine. Only one host was found to have these parasites in the cardiac region of the stomach and all others had a few in the pyloric region, but most of them were found in the anterior end of the small intestine.

Spironoura concinnae Mackin, 1936

Kathlaniidae (Travassos, 1918) Yorke and Maplestone, 1926

Description: Slender, white nematodes with finely striated cuticula. Head truncate with three lips, each bearing two bifurcate papillae. Cervical papillae paired, each consisting of a projecting spherical knob located laterally and anterior to level of excretory pore. Esophagus divided into three parts: pharynx, cylindrical midportion and terminal hourglass-shaped bulb. Posterior end of pseudo-bladder and excretory bridge at level of anterior esophageal bulb. Tail in both sexes sharply pointed, usually straight in female and curved ventrally in male.

Male: Body 8.69 to 13.4 mm. long by 0.34 to 0.38 mm. wide. Pharynx 0.07 to 0.08 mm. long by 0.07 mm. wide. Esophagus: anterior bulb 0.12 to 0.13 mm. long by 0.11 to 0.12 mm. wide; cylindrical midportion 1.30 to 1.42 mm. long by 0.11 mm. wide; posterior bulb 0.18 to 0.19 mm. long by 0.17 to 0.18 mm. wide. Distance from anterior end to excretory pore 1.15 to 1.22 mm. to nerve ring 0.33 to 0.36. Cloaca 0.26 to 0.28 mm. long. Precloacal region occupied by 45 to 52 oblique muscles. Pseudo-sucker, 3.00 to 3.33 mm. anterior to anal opening, composed of 25 to 32 pairs oblique muscles. Ten pairs of caudal papillae present with the following distribution: 2 pairs subventral post anal papillae at level two-thirds to three-fourth tail length posterior to anal opening, lateral pair at same level, second lateral pair slightly posterior to level of anal opening; 3 pairs circumanal papillae. First pair preanals between level of

middle and anterior end of cloaca, second pair usually slightly anterior to middle of spicules, third pair anterior to end of spicules. All papillae exceptionally small. Spicules paired, alate, 1.07 to 1.15 mm. long. Gubernaculum present, 0.15 to 0.16 mm. long. Tail curved ventrally, 0.46 to 0.52 mm. long.

Female: Body 14.6 to 15.8 mm. long by 0.47 to 0.54 mm. wide. Pharynx 0.07 mm. long by 0.07 to 0.08 mm. wide. Esophagus: anterior bulb 0.14 to 0.16 mm. long by 0.13 to 0.14 mm. wide; cylindrical midportion 1.47 to 1.60 mm. long by 0.12 to 0.14 mm. wide; posterior bulb 0.18 to 0.21 mm. long by 0.18 to 0.19 mm. wide. Distance from anterior end to excretory pore 1.36 to 1.42 mm., to nerve ring 0.33 to 0.36 mm. Rectum 0.23 to 0.24 mm. long, vagina 0.99 to 1.06 mm. long, tail 1.02 to 1.25 mm. long. Distance from anterior end to vulva 8.93 to 9.40 mm. Eggs 0.086 to 0.099 mm. long by 0.059 to 0.066 mm. wide.

This description was modified from Mackin, 1936.

Hosts: Pseudemys concinnae, P. scripta elegans.

Habitat: Large intestine and rectum.

Distribution: Oklahoma, Illinois and Texas

Discussion: Only 24 specimens of Spironoura concinnae were collected and all agreed with the description given for this species by Mackin (1939). This parasite was collected only in Texas and 14 per cent of the 56 hosts were infected, with an average of 3 worms per host.

This parasite has been reported from Oklahoma by Mackin

(1939) from Pseudemys concinnae. This is the first report in turtles from Texas and constitutes a new distribution record. Pseudemys scripta elegans is also a new host record.

Spiroxys contortus (Rudolphi, 1819) Schneider, 1866

Spiruridae Oerley, 1885

Synonyms:

Spiroptera contorta Rudolphi, 1819
Spiroxys contorta (Rudolphi, 1819) Schneider, 1866

Description: Body slender, semi-transparent, transversely striated, 2 to 4 cm. long. Oral opening surrounded by two tri-lobed lips, each bearing one lateral and two submedian papillae. Vestibule having distinct cuticular prominences and indentations. Posterior margin of "head" bounded by a definite cuticular collar. Tri-lobed cuticular support for each of two lips arising from each arch of collar. Two prominent cervical spines and one small inconspicuous lateral spine on each side of collar. Small single, one dorsal and one ventral, cervical papilla located 0.8 to 0.9 mm. from anterior end of worm. Nerve ring 0.47 to 0.67 mm. from anterior end; excretory pore 0.52 to 0.75 mm. from anterior end. Esophagus in whole mount appears to be undivided, gradually widening posteriorly. Opening of esophagus into tessellated intestine guarded by three small valves. Rectum of female and cloaca of male, each have two large ventral and one large dorsal unicellular glands. Tail in both sexes rather short, ending in an abrupt, sharp, conical tip.

Male: Caudal alae well developed, meet ventrally, anterior to anus, forming a vesicular swelling. Eleven pairs of caudal papillae present, of which four are pre-anal and seven post-anal; single median genital papilla 0.108 to 0.196 mm. anterior to anus. Spicules, paired equal or subequal, 1.85

to 3.5 mm. long, slender, cylindrical, without a keel, transversely striated, each ending in a sharp point. Gubernaculum present; 0.140 to 0.164 mm. long and 0.049 to 0.063 mm. wide. Testis long, tortuous, joining the seminal vesicle 10 to 15.2 mm. anterior to level of anus. Seminal vesicle straight, thin-walled sac, 4.6 to 6.2 mm. long, emptying into thick-walled ejaculatory apparatus 2.3 to 3.4 mm. long. Ejaculatory tube slender, 3.4 to 5.4 mm. long, emptying into cloaca.

Female: Vulvar opening located slightly posterior to middle of body and guarded by two cuticular prominences. Vagina thick-walled, muscular, annulated, 0.72 to 1.66 mm. long, directed anteriorly to join two uteri. Each uterus has two separate thin-walled expansions connected by a slender, thick-walled, slightly coiled, intra-uterine tube. Uterine measurements as follows: first anterior expansion 1.36 to 1.51 mm. long, 0.20 to 0.21 mm. wide; anterior intra-uterine tube, 0.75 mm. long, 0.075 mm. wide; second anterior expansion, 5.2 to 6.1 mm. long, 0.272 mm. wide; first posterior expansion 1.29 to 1.51 mm.; posterior intra-uterine tube 0.76 mm. long, and second posterior expansion 5.53 to 6.3 mm. long, 0.30 mm. wide. Two dorso-lateral caudal papillae located about mid-way between anus and caudal tip. Distance from most anterior caudal papillae to tip of tail, 0.22 to 0.27 mm. Eggs, 0.055 to 0.073 mm. long and 0.039 to 0.05 mm. wide.

This description was modified from Hedrick (1935).

Hosts: Chrysemys belli marginata, Terrapene ornata, Chelydra

*serpentina*, *Emys blandingi*, *E. orbicularis*, *Graptemys geographica*, *Sternotherus odoratus*, *S. carinatus*, *Kinosternon subrubrum*, *Pseudemys texana*, *P. scripta elegans*, *P. hieroglyphica*, *Deirochelys reticularia*, *P. elegans*. (The exact identity of this turtle is unknown because of the past controversy involving the names of the turtles in the *Pseudemys* "complex.")

*Habitat*: Stomach

*Distribution*: Europe and North America (United States: Ohio Texas, Oklahoma, Michigan, Washington, Louisiana, Wisconsin.)

*Discussion*: Specimens collected in the survey followed closely the description of *Spiroxys contortus* by Hedrick (1935). Some of the minute anatomical details in Hedrick's description could not be discerned, however, in preserved specimens.

A total of 12 mature specimens was recovered in 4 of 56 turtles examined from South Texas, and no mature specimens were observed in any of 20 turtles examined from Oklahoma. All of the turtles collected in Oklahoma contained only encysted larvae of *Spiroxys contortus* and 39 of 56 turtles collected in South Texas harbored encysted larvae in addition to the mature specimens. The fact that both immature encysted and mature specimens have been reported from many hosts is interesting and, apparently, not well understood as to the cause. Hedrick (1935) stated that *Pseudemys elegans* is a "natural host" of *Spiroxys contortus*. According to Monnig

(1949) a "natural host" of a parasite is an animal in which the parasite can develop, live normally, and establish itself in large numbers. In this survey of 76 turtles, 4 harbored a total of only 12 mature Spiroxys contortus as already indicated, while 59 contained only encysted larvae. On the basis of these findings, the writer is not in agreement with Hedrick's statement that Pseudemys elegans is a "natural host" of this parasite. The large number of encysted larvae and the extremely small number of mature specimens indicate that the parasite is not well adapted in the host and, therefore, this turtle could not be considered as its "natural host." This peculiar condition could possibly be explained on the assumption that the ponds from which these turtles were obtained were recently contaminated areas. However, this would be doubtful (even though the turtles taken in South Texas were all obtained in a three month period) since the two ponds in South Texas from which the turtles were obtained were 40 miles apart and it is scarcely feasible that these two ponds, as well as those in Payne County, Oklahoma, would become infected simultaneously and only recently. Another possibility is that this turtle may be a transfer host in which Spiroxys contortus is unable to reach maturity except in a few aberrant cases. This is indicated by the tremendous number of encysted larvae found in the turtles examined in this survey and the relatively few mature worms. It is also known that other species of the Family Spiruridae are able to utilize a transfer host (Chandler, 1949). This theory of a transfer

host is in agreement with Chitwood (1941) who stated that "turtles" may be used as a transfer host of Spiroxys contortus.

Hedrick stated that the life cycle of Spiroxys contortus involved three hosts, but in spite of this he described feeding experiments in which "cyclops" (the first intermediate host) was fed to turtles (the definitive host), and adult specimens were obtained. Hedrick stated that "these data prove conclusively that larvae from the infected cyclops undergo direct development into adults in the final host." By his own work Hedrick proved that a second intermediate host was not necessary for the completion of the life cycle. Furthermore, the turtles used in his experimental work, for determining this cycle, were obtained from various sources and were treated with carbon tetrachloride in an attempt to obtain "parasite free" hosts. It is common knowledge among parasitologists that this treatment would eliminate only some or all of the parasites in the digestive tract and would not destroy the larvae encysted in the tissues. Therefore, this life cycle as determined by Hedrick is not considered to be valid, due to the contradictions and questionable techniques. More work should be done on the life cycle of this nematode parasite and the elucidation of the life cycle should reveal the effects of certain biological conditions concerned with this cycle and the reason for the peculiar distribution of encysted larvae and mature worms.

# DESCRIPTIONS OF

# ACANTHOCEPHALANS

1. *Neoechinorhynchus emydis* (Leidy, 1851) Hamann, Stiles and Hassall, 1905

2. *Neoechinorhynchus headachis* new species

Neoechinorhynchus emydis (Leidy, 1851) Hamann, Stiles and Hassall, 1905

Neoechinorhynchidae Hamann, 1892

Synonyms according to Van Cleave (1924):

Echinorhynchus emydis Leidy, 1851
Echinorhynchus hamulatus Leidy, 1856
Neorhynchus emydis (Leidy, 1851) Van Cleave, 1913
Eorhynchus emydis (Leidy, 1851) Van Cleave, 1914

Description: Body long, slender and curved ventrally. Males 6 to 15 mm. long by 0.48 to 1.04 mm. wide; females 10 to 32 mm. long by 0.75 to 1.25 mm. wide. Proboscis globular and slightly wider than long, measuring 0.12 to 0.21 mm. long by 0.18 to 0.23 mm. wide, with three circlets of 6 hooks each. First circlet has two types of hooks of which lateral ones are larger and set on lower level than other four; lateral hooks of circlet 0.085 to 0.106 mm. long, paired laterodorsal and lateroventral hooks of circlet 0.067 to 0.096 mm. long; points of hooks of this circlet usually reaching beyond bases of hooks of middle circlet. Hooks of middle circlet 0.042 to 0.059 mm. long; those of basal circlet 0.035 to 0.052 mm. long.

Male: Anterior testis 0.90 to 1.04 mm. long by 0.29 to 0.30 mm. wide; posterior testis 0.88 to 0.93 mm. long by 0.31 to 0.36 mm. wide.

Female: Uterus 0.46 to 0.91 mm. wide. Eggs, 0.018 to 0.030 mm. long, have three membranes of which the middle one is most distinctive and occupies only part of the space between other two, and resembles a vacuole (see fig. 3).

This description is modified from Van Cleave (1924), Hopp (1954), and Cable and Hopp (1954).

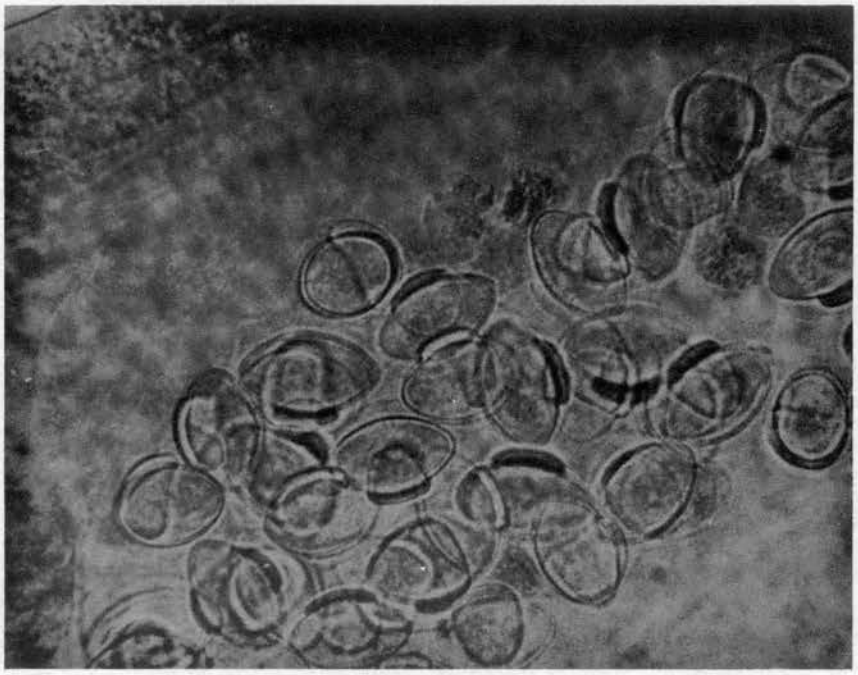

Figure 3. Photomicrograph of the eggs of Neoechinorhynchus emydis.

Hosts: Graptemys geographica, Pseudemys scripta elegans

Habitat: Small intestine

Distribution: Indiana, Oklahoma, Texas

Discussion: The first valid record of an acanthocephalan from a turtle was reported by Leidy (1851) when he described Echinorhynchus emydis from the geographic turtle, Graptemys geographica, and until 1954 this was the only species described from North American turtles. In 1856 Leidy for no apparent reason renamed this species Echinorhynchus hamulatus and listed four species of turtles as hosts. The lengths he recorded for Echinorhynchus hamulatus were significantly larger than those recorded for Echinorhynchus emydis originally. On the basis of recent findings by Hopp (1954), and Cable and Hopp (1954), which will be discussed subsequently, it appears that Leidy's revised description and host list were based on a confusion of two or more species of acanthocephalans inhabiting turtles.

In 1913 Van Cleave called attention to Leidy's obvious renaming of the same species when he placed it in the genus Neorhynchus, and emphasized the necessity of accepting by reason of priority the name "emydis" as valid for the species. This species was redescribed in 1924 by Van Cleave and transferred to the genus Neoechinorhynchus as N. emydis. His redescription added little to Leidy's meager description and only the praesoma was considered in detail. The egg measurements given in this redescription do not coincide with any of those of the known species and no structural description of

the egg was given. In 1950 Van Cleave and Bullock reported a detailed study of the praesoma and increased the maximum length of the worms from 30 to 40 mm. They concluded from this work that Neoechinorhynchus emydis was the only species of acanthocephalan occurring in North American turtles. On the basis of the findings of Cable and Hopp (1954). It appears, however, that Van Cleave and Bullock were dealing with more than one species.

Until 1954 the only information concerning the morphology and internal anatomy of these worms consisted of a detailed study of a praesoma, including egg measurements. In 1954 Hopp redescribed this species and worked out the life cycle. This was the first adequate description of the species including the egg. In 1954 Cable and Hopp described two new species and in these the praesoma is almost identical with N. emydis. The criteria, used by Cable and Hopp, for separating the three species included differences in size of the reproductive organs, general morphology of the posterior end, and size and structure of the eggs.

The specimens obtained in this survey followed closely the descriptions given by Van Cleave (1924), Hopp (1954), and Cable and Hopp (1954) for Neoechinorhynchus emydis except for the length of the egg. According to Hopp, who adequately described and figured the egg for the first time, the eggs in a living condition measured 0.023 to 0.025 mm. in length. Most of them in this survey measured 0.029 to 0.030 mm. in length and 0.030 mm. in the preserved state. On the basis

of these findings, the range in length was extended in the description.

The following hosts have been reported for this species: Chelydra serpentina, Chrysemys emydis, Clemmys insculpta, C. guttata, Emys serrata, Graptemys geographica, Graptemys pseudogeographica, Pseudemys concinna, P. scripta, P. elegans, P. troosti. On the basis of Hopp (1954) and Cable and Hopp (1954) it appears that this host list is based on a confusion of three or more acanthocephalan species and is therefore invalid. According to Hopp, Graptemys geographica was the only host and on the basis of the findings of this survey, Pseudemys scripta elegans, is another host.

Cable and Hopp have started a new trend in acanthocephalan taxonomy, at least inasfar as the species that inhabit North American turtles are concerned. In the past, the taxonomy of this group has been based primarily on one structure, namely, the praesoma, with little emphasis on the rest of the organism. They are considering the differences in the organism as a whole as the criteria for speciation and on the basis of the specimens collected in this survey, this appears to be necessary.

Neoechinorhynchus headachis new species.

Neoechinorhynchidae Hamann, 1892

Description: Characters of the genus Neoechinorhynchus. Body long, slender, curved ventrally. Males 8.78 to 26.92 mm. long by 0.752 to 1.09 mm. wide; females 9.92 to 39.32 mm. long by 0.782 to 1.29 mm. wide. Proboscis globular, somewhat wider than long, 0.163 to 0.193 mm. long by 0.218 to 0.25 mm. wide, with three circlets of 6 hooks each. Anterior circlet has two types of hooks of which lateral ones are larger and set on lower level than other four; lateral hooks of circlet 0.080 to 0.085 mm. long, paired laterodorsal and latero-ventral hooks of circlet 0.065 to 0.072 mm. long; points of hooks of this circlet usually reaching beyond bases of hooks of middle circlet. Hooks of middle circlet 0.044 to 0.049 mm. long; those of basal circlet 0.033 to 0.039 mm. long.

Male: Anterior testis 1.69 to 2.48 mm. long by 0.40 to 0.59 mm. wide; posterior testis 1.32 to 2.25 mm. long by 0.34 to 0.49 mm. wide.

Female: Uterus 0.09 to 0.16 mm. wide, straight, tubular, variable in length, bilobed posteriorly. Eggs, 0.020 to 0.022 mm. long by 0.009 to 0.010 mm. wide, parallel sided with truncated ends; shell consisting of three membranes of which the middle one is the most distinct and is incomplete and occupying only part of the space between the other two, forming four "papilla-like" knobs (see Plate I).

Host: Pseudemys scripta elegans

Habitat: Small intestine

## EXPLANATION OF PLATE 1

Abbreviations: em, embryo; im, inner membrane; mm, middle membrane; om, outer membrane; sa, selector apparatus; ub, uterine bell; ut, uterus; va, vagina; vs, vaginal sphincter.

Figure 1. *Neoechinorhynchus headachis*, shelled embryos in "frontal" and "lateral" views.

Figure 2. *Neoechinorhynchus headachis*, praesoma in lateral view.

Figure 3. *Neoechinorhynchus headachis*, posterior end of female in semi-lateral view.

All drawings made with the aid of a camera lucida.

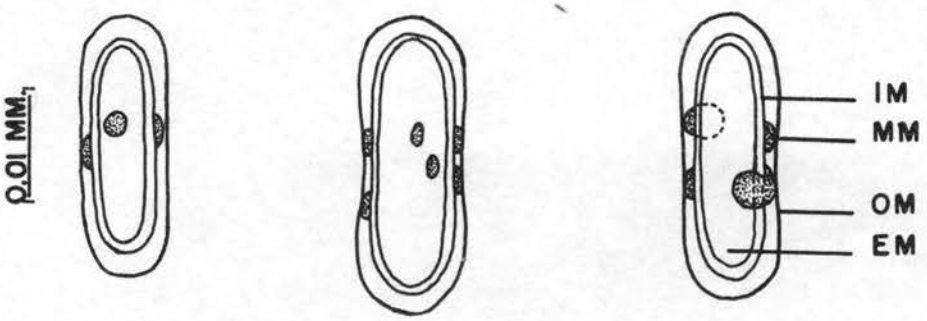


FIGURE 1

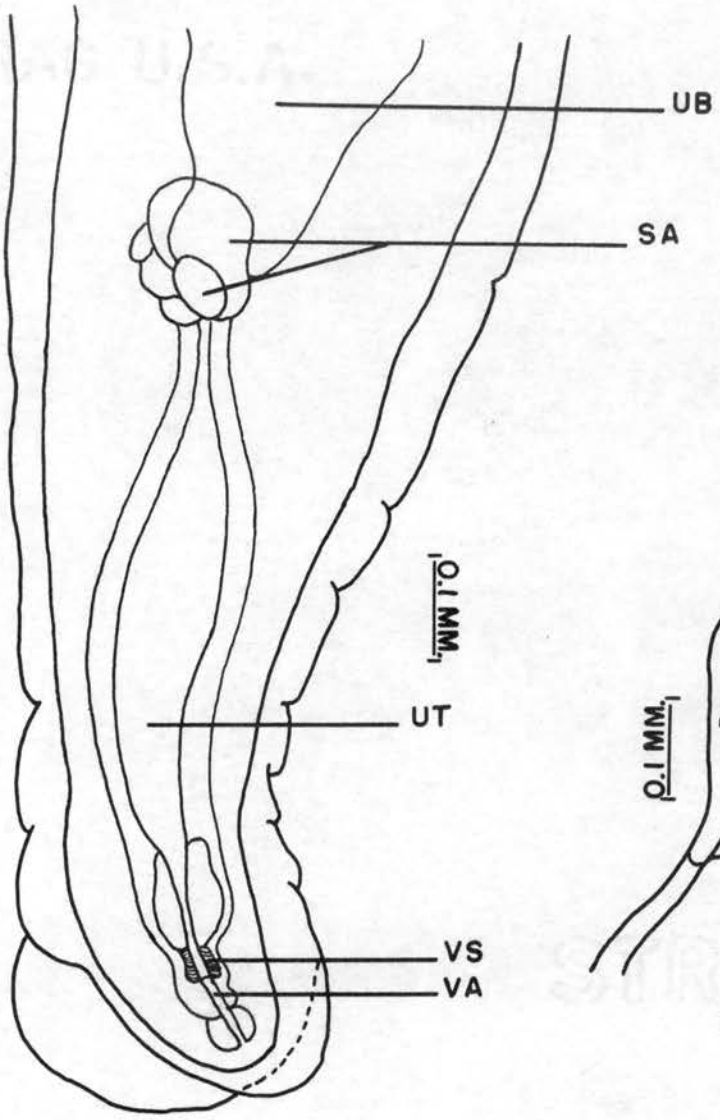


FIGURE 3

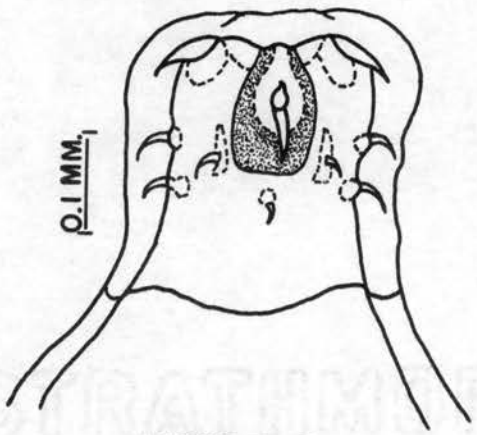


FIGURE 2

PLATE 1

Distribution: Oklahoma and Texas

Discussion: A total of 1,276 specimens of this species was removed from 45 red-eared turtles of which 934 were obtained from 36 hosts from Texas and 342 were taken from 9 hosts from Oklahoma. The incidence of infection was 64 per cent in Texas, with an average of 26 worms per host, while in Oklahoma it was 39 per cent with an average of 38 worms per host. No mixed infections were observed and no more than one species of Acanthocephala was taken from turtles removed from a specific pond.

The taxonomy of this genus of thornyheaded worms has been considered in detail under the discussion of Neoechinorhynchus emydis, consequently, only the characteristics that distinguish this from other species will be discussed.

For many years the taxonomic characters used to distinguish species have been limited to the characteristics of the proboscis, even though size measurements of the worms were given. In 1954 Cable and Hopp described two new species of Neoechinorhynchus, from North American turtles, in which they used the measurements of the reproductive organs and the structure of the eggs as differential characters. Such data are necessary in differentiating species and they have been included in the description of Neoechinorhynchus headachis. Heretofore, three species of acanthocephalans were known from turtles of North America and this new one is the fourth to be described. The species are: Neoechinorhynchus emydis from Pseudemys scripta elegans and Graptemys geographica;

N. pseudemydis from Pseudemys scripta elegans; N. chrysemydis from Chrysemys picta marginata and now N. headachis from Pseudemys scripta elegans. The characteristics used as a basis for differentiating the species of Neoechinorhynchus from turtles are presented in Table 3. The measurements which usually have been included in descriptions of species of Neoechinorhynchus from turtles are presented in Table 4. It is shown in this table that there is overlapping of measurements which have been used previously as the basis for species determination.

The new species, Neoechinorhynchus headachis, is very similar to N. pseudemydis, as shown in Table 3, but there are several valid differences. In the male N. headachis the testes are nearly equal in size with the anterior one slightly larger than the posterior one, while in N. pseudemydis the posterior testis is decidedly larger than the anterior testis. Furthermore, the egg sizes are very different in the two species and the descriptions show that they differ markedly in structure.

N. headachis differs from N. emydis in the size of the testes. The anterior testis is slightly larger than the posterior one in both species, but in N. headachis the testes are approximately twice as large as in N. emydis. The uterus of N. headachis is approximately one-fourth as wide as that of N. emydis. The descriptions of the eggs show that they differ markedly in size and structure. The only similarity between N. headachis and N. chrysemydis is the width of the

Table 3.

COMPARISON OF DIFFERENTIAL CHARACTERISTICS OF SPECIES OF *Neoechinorhynchus* FROM TURTLES

| Characters | *N. emydis* | *N. pseudemydis* | *N. chrysemydis* | *N. headachis* |
|---|---|---|---|---|
| **Male** | | | | |
| percentage of body cavity occupied by reprod. system | 42-50% | 35-42% | 48% | 47-55% |
| anterior testis - length | 0.90-1.04 | 1.85-2.14 | 0.98 | 1.69-2.48 |
| width | 0.29-0.30 | 0.40-0.44 | 0.19 | 0.40-0.59 |
| posterior testis - length | 0.88-0.93 | 2.60-2.90 | 0.81 | 1.32-2.25 |
| width | 0.31-0.36 | 0.43-0.45 | 0.19 | 0.34-0.49 |
| **Female** | | | | |
| uterus width | 0.46-0.91 | 0.10-0.15 | 0.096 | 0.09-0.16 |
| posterior end | irregular | bilobed | rounded | bilobed |
| caudal papilla | absent | absent | present | absent |
| **Eggs** | | | | |
| length | 0.023-0.030 | 0.042-0.051 | 0.055-0.060 | 0.020-0.022 |
| width | 0.015-0.019 | 0.018-0.022 | 0.019-0.022 | 0.009-0.010 |
| **Host** | *Graptemys geographica* & *Pseudemys scripta elegans* | *Pseudemys scripta elegans* | *Chrysemys picta marginata* | *Pseudemys scripta elegans* |

All measurements in millimeters.

Table 4. COMPARISON OF MEASUREMENTS USUALLY INCLUDED IN DESCRIPTIONS OF SPECIES OF *Neoechinorhynchus* IN TURTLES

| Characters | *N. emydis* | *N. pseudemydis* | *N. chrysemydis* | *N. headachis* |
|---|---|---|---|---|
| Proboscis - Length | 0.120-0.210 | 0.194-0.180 | 0.123-0.170 | 0.163-0.193 |
| Width | 0.180-0.230 | 0.198-2.240 | 0.200-0.207 | 0.218-0.250 |
| Proboscis Hooks | | | | |
| Anterior Circlet | 0.065-0.107 | | | |
| Laterals | | 0.085-0.106 | 0.080-0.140 | 0.080-0.085 |
| Others | | 0.067-0.096 | 0.048-0.082 | 0.065-0.072 |
| Middle Circlet | 0.042-0.059 | 0.050-0.060 | 0.044-0.061 | 0.044-0.049 |
| Basal Circlet | 0.035-0.052 | | | |
| Laterals | | 0.028-0.034 | 0.021-0.026 | |
| Others | | 0.042-0.050 | 0.038-0.048 | |
| Male - | | | | |
| Trunk - Length | up to 14.5 | up to 26.4 | 12.9 | up to 26.92 |
| Width | up to 1.04 | up to 0.83 | 0.68 | up to 1.09 |
| Female - | | | | |
| Trunk - Length | up to 22.2 | up to 38.5 | 13.7 | up to 39.32 |
| Width | up to 1.25 | up to 1.25 | 0.73 | up to 1.29 |

All measurements in millimeters.

uterus, and N. headachis falls within the range of N. chrysemydis. There are marked differences in all other characters, as shown by Table 3.

Cable and Hopp (1954) believed that there is greater host specificity in the thornyheads of turtles than has been believed in the past. On the basis of the findings in this survey, it would seem that certain species of turtles are more susceptible than others to the various species of thornyhead infections. This is supported by the fact that of the species of acanthocephalans in turtles, three of the four have been reported from Pseudemys scripta elegans.

## SUMMARY


1. A comparison is made of the parasite fauna in two diverse ecological areas.
2. Seventy-nine specimens of the red-eared turtle, Pseudemys scripta elegans, were examined for helminth parasites; fifty-six were collected from two localities in Texas and twenty-three were taken from ponds in the vicinity of Stillwater, Oklahoma.
3. One new species of Acanthocephala was named, Neoechinorhynchus headachis, and described.
4. Pseudemys scripta elegans is reported as a new host for Spironoura concinnae and Neoechinorhynchus emydis.
5. New distribution records are reported for Proparorchis artericola (Texas and Oklahoma) and Spironoura concinnae (Texas).
6. Species of helminths reported from the turtle, Pseudemys scripta elegans, in this survey are as follows: trematodes, Proparorchis artericola Ward, 1921; Telorchis corti Stunkard, 1915; Telorchis singularis (Bennett, 1935) Wharton, 1940; Polystomoides coronatum (Leidy, 1888) Price, 1939; Neopolystoma orbiculare (Stunkard, 1916) Price, 1939; nematodes, Spiroxys contortus (Rudolphi, 1819) Schneider, 1866; Camallanus microcephalus (Dujardin, 1845) Railliet and Henry, 1915; Spironoura

concinnae Mackin, 1936; acanthocephalans, Neoechinorhynchus emydis (Leidy, 1851) Hamann, Stiles and Hassall, 1905; Neoechinorhynchus headachis, new species.

7. A new technique was described for staining and mounting nematodes and acanthocephalans, which is much more efficient, less time consuming, and nearly free from failures.
8. An unusual case of extreme parasitism in a very young turtle is reported.
9. Many immature nematodes and flukes were encountered in this survey but no attempt was made to identify them.
10. No cestodes were found in Pseudemys scripta elegans and none has been reported from this turtle.

# CONCLUSIONS

The results of the survey show that the red-eared turtle, Pseudemys scripta elegans, is very heavily parasitized in parts of Oklahoma and Texas. The incidence of infection is shown to vary greatly with the different parasite species and with the geographical location of the host. For instance, the mouth trematode, Polystomoides coronatum, was found in only 1.8 per cent of the hosts obtained in Texas while 73.1 per cent of the turtles were infected in Oklahoma. Concentration and near starvation of hosts due indirectly to drouth conditions did not appear to affect the parasite burden of the turtles as one might expect.

The various species of parasites inhabiting the red-eared turtle were common to the Oklahoma and Texas areas, except for one species each of an acanthocephalan and a nematode. Oklahoma apparently represents the southern boundary for the geographic range of Neoechinorhynchus emydis since this species was not recovered from hosts obtained in Texas. It is known to have a wide, more northerly distribution.

This survey has brought to light many interesting problems concerned with various phases of parasitology such as taxonomy, host-parasite relationships, life history studies, and ecological aspects. This constitutes one of the main values of a survey problem and makes an individual with a

research mind and trained in parasitology realize how little is actually known concerning the parasite-host relations and the relationship of both to the environment.

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Master of Science

Thesis: A SURVEY AND COMPARISON OF THE HELMINTH PARASITE OF THE RED-EARED TURTLE, Pseudemys scripta elegans (Wied, 1838) Carr, 1938, IN TEXAS AND OKLAHOMA.

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