SOME WELMINTH PARASITES FROM BATS WITH DESCRIPTIONS
OF TWO NEW SPECIES OF ACANTHATRIUM FAUST, 1919
(TREMATODA: LECTHODENDRIIDAE)

A Thesis
Presented in Partial Fulfillment of the Requirements
for the Degree Master of Science

by

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The Ohio State University
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Approved by:

[Signature]

Joseph N. Miller
Adviser

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And to my wife, whose patience and understanding contributed to the completion of this study.
INTRODUCTION

Up to 1931 very little was known about the helminth parasites from bats of the United States. In 1931 Stiles and Nolan published the booklet, *A Key Catalogue of Parasites Reported for Chiroptera (Bats) with Their Possible Public Health Importance*, listing in it the known world species of both ecto- and endoparasites. Of the helminth parasites reported by Stiles and Nolan, only two out of fifty-three trematodes, one out of six cestodes, and one out of forty-seven species of nematodes had been described from bats of the United States.

In the twenty-six years that followed, numerous helminths were discovered, but the bats of the United States have by no means been thoroughly covered. The author failed to uncover any truly complete survey, one in which a large number of bats from a given area were examined primarily for the purpose of recording the helminths found and making the results available through publication. Too often, the only material available on a parasite was the information given at the time of its description as a new species. General parasite surveys of mammals failed, in almost every case, to include the Chiroptera; therefore, very little was found out about the geographical distribution of many of the parasites reported herein.

This report was an outgrowth of a paper on the helminth
parasites of the hibernating big brown bat, which was presented before the Zoology section at the sixty-third annual meeting of the Ohio Academy of Science in April, 1954. In the present report the author has attempted to make available descriptions of the helminth parasites encountered in a survey of eighty-eight bats. Four species of bats were examined. These consisted of thirty-five big brown bats, *Eptesicus fuscus fuscus* (Beauvois), thirty-one Georgian bats, *Pipistrellus subflavus subflavus* (F. Cuvier), one little brown bat, *Myotis lucifugus lucifugus* (LeConte), and twenty-one Indiana bats, *Myotis sodalis* Miller and Allen. These bats were taken from localities in both Ohio and Kentucky as indicated by the following chart.

<table>
<thead>
<tr>
<th>Location</th>
<th><em>Eptesicus</em></th>
<th><em>Pipistrellus</em></th>
<th><em>Myotis</em></th>
<th><em>Myotis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>fuscus</em></td>
<td><em>subflavus</em></td>
<td><em>lucifugus</em></td>
<td><em>sodalis</em></td>
</tr>
<tr>
<td>Columbus (Franklin County) Ohio</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dublin (Franklin County) Ohio</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clear Creek Cave (Hocking County) Ohio</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bat Cave (Hocking County) Ohio</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bat Cave (Carter County) Kentucky</td>
<td>2</td>
<td>17</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>
Helminth parasites, representing two phyla, were harbored by the four species of bats used in this research. A total of twelve species and one subspecies of helminths, including two new species, are reported. Also, several new host-parasite combinations are given.

The Platyhelminthes were represented by one cestode and nine trematodes as follows:

Cestoda:

_Hymenolepis roudabushi_ Macy and Rausch, 1946

Trematoda:

_Prosthodendrium (P.) transversum_ Byrd and Macy, 1942
_Prosthodendrium (P.) ascidia navicula_ Macy, 1936
_Acanthatrium microcanthus_ Macy, 1940
_Acanthatrium eptesici_ Alicata, 1932
_Acanthatrium lunatum_ n. sp.
_Acanthatrium obovatum_ n. sp.
_Acanthatrium sp.
_Limatulum gastroides_ Macy, 1935
_Plagiorchis (P.) micracanthos_ Macy, 1931

The Nematohelminthes were represented by three species as follows:

Nematoda:

_Physocophalus sexalatus_ (Molin, 1860)
_Ascarops strongylina_ (Rudolphi, 1819)
_Capillaria sp._
Of the eighty-eight bats examined, eighty-five, representing 96.6 per cent, were infected with at least one species of helminth. The percentages of infection of each host for the thirteen helminths recovered are indicated by the following chart.

<table>
<thead>
<tr>
<th>Helminth Parasites</th>
<th>Host</th>
<th>Eptesicus Tuscus</th>
<th>Pipistrellus subflavus</th>
<th>Nyctis lucifugus</th>
<th>Nyctis socailis</th>
<th>All four species combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hymenolepis roudabushi</td>
<td></td>
<td>8.57</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3.41</td>
</tr>
<tr>
<td>Prosthodendrium (P.) transversum</td>
<td></td>
<td>8.57</td>
<td>0</td>
<td>0</td>
<td>38.1</td>
<td>12.5</td>
</tr>
<tr>
<td>Pros. (P.) ascidia navicula</td>
<td></td>
<td>57.2</td>
<td>0</td>
<td>100</td>
<td>95.3</td>
<td>46.6</td>
</tr>
<tr>
<td>Acanthatrium microcanthum</td>
<td></td>
<td>5.72</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.27</td>
</tr>
<tr>
<td>Acanthatrium eptesici</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4.77</td>
<td>1.14</td>
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<tr>
<td>Acanthatrium lunatum n. sp.</td>
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<td>14.3</td>
<td>80.7</td>
<td>0</td>
<td>0</td>
<td>34.1</td>
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<tr>
<td>Acanthatrium obovatum n. sp.</td>
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<td>0</td>
<td>0</td>
<td>3.41</td>
<td>3.41</td>
</tr>
<tr>
<td>Acanthatrium sp.</td>
<td></td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>1.14</td>
</tr>
<tr>
<td>Limatulum gastroides</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9.53</td>
<td>2.27</td>
</tr>
<tr>
<td>Plagiorchis (P.) micruncanthis</td>
<td></td>
<td>11.4</td>
<td>16.1</td>
<td>0</td>
<td>42.8</td>
<td>20.4</td>
</tr>
<tr>
<td>Physocephalus sexalatus</td>
<td></td>
<td>28.6</td>
<td>16.1</td>
<td>0</td>
<td>9.53</td>
<td>19.3</td>
</tr>
<tr>
<td>Ascarops strongylina</td>
<td></td>
<td>2.86</td>
<td>12.9</td>
<td>0</td>
<td>0</td>
<td>5.68</td>
</tr>
<tr>
<td>Capillaria sp.</td>
<td></td>
<td>5.72</td>
<td>0</td>
<td>0</td>
<td>28.6</td>
<td>9.10</td>
</tr>
</tbody>
</table>
While only helminth parasites have been reported in this study, it should be pointed out that other types also were obtained. Bats are known to harbor numerous ectoparasites; fleas, mites, and ticks were commonly encountered.
MATERIALS AND METHODS

The majority of the bats used in this study were collected by hand from their places of hibernation, and brought back to the laboratory for examination. Since it took several minutes of handling before the hibernating bats became very active, it was found that they could be removed with little or no difficulty from the ceilings of caves, attics, and other such places. Other specimens were either removed from their day time roosting places or were brought to the author by neighbors or students who found them at night in their homes. With the exception of a few, all bats were kept in a refrigerator at forty degrees Fahrenheit in suitable aerated containers until the time of autopsy. A number of big brown bats were kept in a small cage at room temperature, and fed meal worms every two or three days. Although both male and female bats were kept in the same cage, no young were ever produced. One female was kept alive for eighteen months before finally being sacrificed.

After a bat was chloroformed it was opened on the ventral surface, and the lungs, liver, heart, kidneys, gall bladder, urinary bladder, stomach, and intestines were removed and placed in Ringer's warm solution. A careful examination of each of the above parts was then made under a binocular dissecting microscope. Any helminth parasites
encountered were removed to a separate dish containing Ringer's warm solution and examined further. For closer examination of living helminths, a drop of this physiological solution, containing a specimen, was placed on a microscope slide over which a cover glass ringed with vaseline was lowered, and the preparation then was examined under a monocular compound microscope.

Fixation of the cestodes and trematodes was accomplished under the pressure of a cover glass. The living specimens, along with Ringer's solution, were placed on a slide over which a cover glass was lowered. The fixing agent was introduced under the edge of one side of the cover glass and drawn under it by using a piece of absorbent paper towel at the opposite side. This procedure was carried on under a dissecting microscope so that the specimens could be carefully observed while being fixed. By this means the specimens were also flattened, thus making the internal structures more visible when stained and cleared. The fixing reagents used were either Ladvowsky's formula of A.F.A. fixing solution or 10 per cent formalin. Ten percent formalin was used in the majority of cases, especially with smaller forms, since it was found that A.F.A., because of its surface tension, tended to flow freely from under the cover glass, causing it to press down excessively on the specimen. Care was taken
to prevent the displacement of the organs in these worms while they were being fixed.

The nematodes, with the exception of some of the encysted forms, were fixed in warm 70 per cent alcohol. When numerous cysts were encountered, many of them were often placed directly into 10 per cent formalin.

Both the cestodes and trematodes, after being stained with either Ehrlich's hematoxilin, Mayer's paracarmine, or Semichon's carmine, were dehydrated in ethyl alcohol, cleared in xylene, and mounted in piccolyte. Since Semichon's stain seemed to give the best staining results, it was employed most often. The nematodes were temporarily mounted in glycerine and examined without staining.

The drawings prepared for this report were made either with the aid of a camera lucida or with an arc-light-type projection apparatus.
PLATYHELMINTHES

Cestoda

Although a number of genera of cestodes, including Taenia, Hymenolepis, and Oöchoristica, have been reported from bats, the author found only tapeworms belonging to the genus Hymenolepis. Of the eighty-eight bats which were examined, twenty-eight, representing 31.8 per cent, were infected with either immature or adult tapeworms.

The Genus Hymenolepis

Class - Cestoda

Order - Cyclophyllidea

Family - Hymenolepididae Railliet & Henry, 1909

Subfamily - Hymenolepidinae Perrier, 1897

Genus - Hymenolepis Weinland, 1858

Discussion:

The genus Hymenolepis was established by Weinland in 1858 for a form now known as Hymenolepis diminuta (Rudolphi, 1819). The characters of the family were founded upon this species. A brief description of members of this genus is as follows: Small to medium-sized tapeworms with a retractible rostellum armed with a single circle of thorn-like hooks. Three testes, variable in arrangement. Large cirrus pouch with an external and internal seminal vesicle. A large seminal receptacle usually present.
Hughes (1941) recognized some 328 valid species and subspecies, and constructed a workable key. With one exception, according to Hughes, the hymenolepids are very host specific. Hughes based his first principal separation of the species into two groups on the basis of whether they parasitized birds or mammals.

The known world species of *Hymenolepis*, occurring in bats, include the following; *Hymenolepis acuta* (Rudolphi, 1819); *H. balsaci* Joyeux and Baer, 1934; *H. chiropterophila* Vigueras, 1941; *H. christensoni* Macy, 1931; *H. decipiens* (Diesing, 1850); *H. gertschi* Macy, 1947; *H. grisea* (van Beneden, 1873); *H. kervoulae* Hubscher, 1937; *H. moniezi* Parona, 1893; *H. roudabushi* Macy and Rausch, 1946; and *H. sandgroundi* Baer, 1933. Macy (1931) reported the first hymenolepid, *Hymenolepis christensoni*, from bats of the United States. This form was recovered from the intestine of the little brown bat, *Myotis lucifugus* (LeConte).
Hymenolepis roudabushi Macy & Rausch, 1946

Host:

Eptesicus fuscus fuscus (Beauvois).

Site of Infection:

Small intestine.

Locality:

Columbus (Franklin County) Ohio.

Description:

(Plate I, Figs. 1-6) Strobila serrate, 60 to 150 mm long by 1.5 mm wide near the posterior end. Serration definitely not due to amount of contraction. Scolex 330μ wide, with suckers 90 to 100μ in diameter. Hooks 41 to 48 in number, measuring 38 to 43μ in length. Genital pores unilateral, slightly posterior to middle of each proglottid.

Testes three in number, 100 to 150μ long by 150 to 180μ wide, one poral and two antiporal in position, arranged in a transverse field. Internal seminal vesicle just anterior to poral testis, measuring 140 to 170μ long by 66 to 72μ wide. External seminal vesicle 210 to 230μ long by 60μ wide, extending inward past the longitudinal excretory canal. Genital pore aspinose; cirrus present but not seen projecting from genital pore.

Ovary narrow, transverse, length varying in mature proglottids, 300 to 600μ long by 40μ wide, about midway between the longitudinal excretory canals. A single
vitellarium in each proglottid, posterior to the ovary and in field of middle testis, 40 to 60μ long by 70 to 90μ wide. Seminal receptacle large, retort-shaped, extending to near center of proglottid, 490 to 500μ long by 170 to 180μ wide at widest part. Seminal receptacle remaining in gravid proglottids. Eggs 39 to 46μ in diameter.

Discussion:

The big brown bat, *Eptesicus fuscus fuscus*, was the only species that harbored this tapeworm. Of the thirty-five hosts of this species examined, three, representing 8.57 per cent, were infected with adult specimens of *H. roudabushi*. A total of twenty-eight adult worms were recovered from the three bats, numbering sixteen, two, and ten respectively. These three bats were captured in late May and June and in no case did hibernating bats yield adult tapeworms. Numerous immature cestodes, comprised simply of a scolex and short non strobilate neck region, were encountered in 23.9 per cent of all bats examined. Of the total number of big brown bats examined, 45.7 per cent contained these immature forms. Since these immature worms did not possess mature and gravid proglottids, the author was not able to make a truly correct identification, but it was thought, on the basis of the number and size of the hooks, that these worms were young forms of *Hymenolepis roudabushi*.
The species, *Hymenolepis roudabushi*, was first described from *Eptesicus fuscus* (Beauvois), *Nycticeius humeralis* (Rafinesque), and *Lasionycteris noctivagans* (LeConte) in Ames, Iowa and Marysville, Ohio by Macy and Rausch (1946). Although some disagreement existed in the measurements of the worms encountered in the present study and those of the original research, it was believed that enough valid similarities were present to warrant the identification of this material as *Hymenolepis roudabushi*. The size and number of hooks and the arrangement of the various organs were in close agreement. *Hymenolepis roudabushi* differs from other known American species of hymenolepids from bats, *H. christensoni* Macy, 1931 and *H. gertschi* Macy, 1947, mainly in that the strobila is serrate and the number of hooks differ greatly.

**Life History:**

The life histories of the above three species are not known, but it is believed that a coleopteran may be involved as an intermediate host.
Trematoda

Other than, Distoma sp. Stiles and Hassall, 1894, Acanthatrium nycteridis Faust, 1919 was the first trematode described from bats of the United States. During the following years, a number of genera of trematodes, including Acanthatrium, Lecithodendrium, Prosthodendrium, Dicrocoelium, Limatulum, and Plagiorchis, were found occurring in North American bats. In the bats examined for the present study, trematodes occurred more frequently than any other helminth parasite, being present in Seventy-three, representing 82.9 per cent, of the eighty-eight bats. There were nine species of trematodes represented.

The Genus Prosthodendrium

Class - Trematoda
Subclass - Digenea
Order - Prosostomata
Suborder - Distomata
Family - Lecithodendriidae Odhner, 1910
Subfamily - Lecithodendriinae Lühe, 1901
Genus - Prosthodendrium Dollfus, 1931

Discussion:

Dollfus (1931) erected the genus Prosthodendrium for lecithodendriid flukes having the vitelline glands pretesticular. The species Prosthodendrium dinanatum
(Bhalerao, 1926) was considered the type. A general description of the genus is as follows: Small, pyriform, oval, or spherical flukes, with short intestinal ceca not extending beyond testes. Vitellaria anterior to testes, never posttesticular. Testes entire, lateral, on either side of the acetabulum; ovary may or may not be lobed, either anterolateral or posterolateral to acetabulum. Prostate mass containing numerous prostate cells; genital atrium not lined or bordered with spines. Uterus consisting of several transverse loops, posterior to testes; eggs numerous, light brown in color. Parasites of the intestine of bats.

This genus includes two subgenera, Prosthodendrium Dollfus, 1937 and Paralecithodendrium Odhner, 1910. According to Dollfus (1937) the two subgenera are separated on the basis of the lobation of the ovary. In the subgenus, Prosthodendrium, the ovary is not lobed, whereas, in the subgenus, Paralecithodendrium, the ovary is lobed and always situated preacetabular.

In this study, only species belonging to the subgenus Prosthodendrium were encountered. Dubois (1955) revised the subgenus Prosthodendrium, listing the following world species and subspecies: Prosthodendrium (Prosthodendrium) asidia (van Beneden, 1873); P. (P.) asidia navicula Macy, 1936; P. (P.) buongerminii Lent, Freitas and Proenca, 1945;
P. (P.) chilostomum (Mehlis, 1831); P. (P.) cordiforme (Braun, 1900); P. (P.) dinaratum (Bhalerao, 1926); P. (P.) emollidum Caballero, 1943; P. (P.) longiforme (Bhalerao, 1926); P. (P.) macnabi Macy, 1936; P. (P.) mehrai (Pande, 1935); P. (P.) oligolecitum Manter and Debus, 1945; P. (P.) orospinosum (Bhalerao, 1926); P. (P.) orospinosum luzonicum (Tubangui, 1928); P. (P.) parvouterus (Bhalerao, 1926); P. (P.) postacetabulum Yamaguti and Asada, 1942; P. (P.) pyramidum (Looss, 1896); P. (P.) singularium Byrd and Macy, 1942; P. (P.) swansoni Macy, 1936; P. (P.) transversum Byrd and Macy, 1942; P. (P.) travassosi Macy, 1938; P. (P.) urna (Looss, 1907); and P. (P.) urna loossi (Pande, 1935). To this list should be added P. (P.) thomasi Sogandares-Bernal, 1956
**Prosthodendrium (P.) transversum** Byrd & Macy, 1942

**Host:**

*Eptesicus fuscus fuscus* (Beauvois) and *Myotis sodalis*

**Miller and Allen.**

**Site of Infection:**

Small intestine.

**Locality:**

Columbus (Franklin County) Ohio and Bat Cave (Carter County) Kentucky.

**Description:**

(Plate II, Figs. 7-9) Body variable, often wider than long, 0.45 to 1.11 mm long by 0.65 to 0.83 mm wide. Cuticle without spines. Oral sucker subterminal, weak, 59 to 77μ long by 74 to 110μ wide. Prepharynx short; pharynx 33 to 46μ long by 46 to 59μ wide, partly hidden by oral sucker. Esophagus 59 to 267μ long by 13 to 20μ wide. Intestinal ceca extend posteriorly from point of bifurcation then turn anterolateral and skirt edge of each testis. Ceca 166 to 276μ long by 26 to 64μ wide. Acetabulum small, about same size as oral sucker, 61 to 91μ long by 64 to 96μ wide, always posterior to middle of body. When contracted, acetabulum draws into a type of marsupium located just posterior to the prostate mass (Fig. 9). Prostate mass large, 99 to 206μ long by 131 to 180μ wide, situated near center of body between testes and bifurcation of ceca.
Seminal vesicle large, making a conspicuous loop in prostate mass and emptying into pars prostatica at which point it joins metraterm (Fig. 9). Genital pore opens into a muscular type of atrium, referred to as a muscular cloaca by Byrd and Macy (1942), located in posterior portion of prostate mass with opening directed caudad (Fig. 9). Seminal receptacle on right side, just anterolateral to acetabulum. Testes on either side of prostate mass, overlapped posteriorly by uterus; right testis 66 to 193μ long by 107 to 202μ wide; left testis 83 to 225μ long by 107 to 202μ wide. Ovary on right side, in a direct line between right testis and acetabulum, often almost hidden by loops of uterus, 92 to 153μ long by 44 to 184μ wide. Vitellaria medium in size, each group consisting of 30 to 50 follicles, lateral, anterior to testes and ceca but not extending to oral sucker. Uterus with one or two short transverse loops on either side of median plane and with one or two loops that extend all the way across the body behind acetabulum. Eggs numerous, 20 to 22μ long by 11 to 13μ wide.

Discussion:

Twenty-six specimens of P. (P.) transversum were obtained from eleven bats. Three (8.57 per cent) of thirty-five specimens of Eptesicus fuscus fuscus were infected with this trematode, while eight (38.1 per cent) of
twenty-one specimens of *Myotis sodalis* harbored this worm.

The name *Prosthodendrium (P.) transversum* was erected by Byrd and Macy in 1942 for certain lecithodendriid flukes found in the small intestine of the red bat, *Lasiurus borealis borealis* (Müller), taken from the vicinity of Reelfoot Lake in Tennessee. To the author's knowledge, the above report has been the only report of *Prosthodendrium (P.) transversum* until the present study; therefore, *Eptesicus fuscus fuscus* and *Myotis sodalis* constitute new host records for this trematode.

The specimens taken from *Eptesicus fuscus fuscus* were comparatively larger than those obtained from *Myotis sodalis*. The measurements of specimens from the latter host agreed more closely with those of the original material by Byrd and Macy (1942) obtained from *Lasiurus borealis borealis* than did the flukes from *Eptesicus fuscus fuscus*; however, there was no doubt in the mind of the author that the material collected by him and the specimens described by Byrd and Macy were the same species.

**Life History:**

Unknown.
Prosthodendrium (P.) ascidia navicula Macy, 1936

Host:

Eptesicus fuscus fuscus (Beauvois), Myotis lucifugus lucifugus (LeConte), and Myotis sodalis Miller and Allen.

Site of Infection:

Small intestine.

Locality:

Columbus (Franklin County) Ohio, Clear Creek Cave (Hocking County) Ohio, and Bat Cave (Carter County) Kentucky.

Description:

(Plate III, Figs. 10-13) Body aspinose, pyriform, 0.40 to 0.71 mm long by 0.33 to 0.57 mm wide. Oral sucker subterminal, 74 to 96 µm long by 94 to 116 µm wide. Pharynx generally wider than long, 24 to 33 µm long by 29 to 41 µm wide. Esophagus present but often greatly contracted, 13 to 46 µm long. Thick-walled ceca, 92 to 129 µm long by 33 to 46 µm wide, forming bag-like pouches, reaching to testes. Acetabulum smaller than oral sucker, situated about midway in body, 49 to 64 µm long by 52 to 64 µm wide. Prostate mass, 64 to 109 µm long by 83 to 120 µm wide, between bifurcation of intestinal ceca, overlapping anterior portion of ovary but not reaching to acetabulum. Prostate cells in prostate mass numerous; seminal vesicle coiled; genital pore opening on ventral surface, generally centrally located.
Testes large, anterior to equatorial plane of body; right testis 96 to 197μ long by 87 to 202μ wide; left testis 87 to 175μ long by 64 to 193μ wide. Ovary generally oval, 83 to 129μ long by 63 to 92μ wide, situated on the right side between the two testes, slightly overlapped by acetabulum and anterior to it. Vitelline glands bilateral, consisting of numerous, compact follicles, extending from oral sucker to anterior margin of testes. Eggs variable, 22 to 35μ long by 13 to 18μ wide.

Discussion:

A total of 1224 specimens of Prosthodendrium (P.) ascidia navicula were obtained from forty-one bats representing three different species. The largest number harbored by any one host was 269. Of all the parasites obtained, this helminth occurred most frequently. This trematode was found in twenty (57.2 per cent) of thirty-five Eptesicus fuscus fuscus, twenty (95.3 per cent) of twenty-one Myotis sodalis, and in the single specimen of Myotis lucifugus lucifugus.

Macy (1936) described this parasite from the small intestine of the big brown bat, Eptesicus fuscus, taken in St. Paul, Minnesota, and gave it the name Prosthodendrium naviculum. Later (1942), Byrd and Macy encountered this species in the Florida yellow bat, Dasypterus floridanus Miller, taken at State College, Mississippi. The most
noteworthy difference between the two collections of specimens was the size of the eggs. The ova in the Minnesota material measured 19 to 21\(\mu\) long by 12\(\mu\) wide, whereas, those from Mississippi measured 25 to 34\(\mu\) long by 13 to 18\(\mu\) wide. Byrd and Macy maintain that egg size alone is not sufficient reason for establishing a new species. The author found worms in this study having eggs in both ranges, but could not detect any other main differences.

Dubois (1955) revised the subgenus *Prosthodendrium*, describing this trematode as a geographical variety of *Prosthodendrium (P.) ascidia* (van Beneden, 1873) and re-naming it *Prosthodendrium (P.) ascidia navicula* Macy, 1936.

*Myotis lucifugus lucifugus* (LeConte) and *Myotis sodalis* Miller and Allen constitute new host records for this parasite.

**Life History:**

Unknown.
The Genus *Acantharium*

Class - Trematoda

Subclass - Digenea

Order - Prosostomata

Suborder - Distomata

Family - Lecithodendriidae Odhner, 1910

Subfamily - Lecithodendriinae Lühe, 1901

Genus - *Acantharium* Faust, 1919

Discussion:

The genus *Acantharium* was erected by Faust (1919) for all lecithodendriid trematodes having spines in the genital atrium and having pretesticular vitellaria. Other than the type species, *Acantharium nycteridis*, which he described from the bat, *Lasiurus borealis borealis* (Müller), Faust also included *Lecithodendrium sphaerula* Looss, 1896, a bat fluke from Egypt. A general description of members of this genus is as follows: Small, pyriform, oval or spherical flukes, with a genital atrium lined or bordered with numerous integumentary spines; prostate cells numerous; excretory system V-shaped; intestinal ceca short, not extending beyond testes. Vitellaria anterior to testes; testes entire, lateral, on either side of acetabulum; ovary on right side, either slightly anterior or posterior to acetabulum. Uterus consisting of transverse loops, posterior to testes; eggs numerous, light brown in color.
Parasites of the small intestine of bats.

Prior to this research, fourteen species and one variety of *Acanthatrium* have been described. These are: *Acanthatrium sphaerula* (Looss, 1896) Faust, 1919; *A. nycteridis* Faust, 1919; *A. nycteridis plicati* Blalero, 1926; *A. eptesici* Alicata, 1932; *A. mollosidis* Martin, 1934; *A. oregonense* Macy, 1939; *A. ovatum* Yamaguti, 1939; *A. alicatai* Macy, 1940; *A. chosenicum* (Ogata, 1940) Sogandares-Bernal, 1956; *A. microcanthum* Macy, 1940; *A. pipistrelli* Macy, 1940; *A. jonesi* Sogandares-Bernal, 1956; *A. macyi* Sogandares-Bernal, 1956; *A. amphidymum* Cheng, 1957; and *A. oligacanthum* Cheng, 1957. To the above list should be added *A. lunatum* n. sp. and *A. obovatum* n. sp. which are described in this paper.

The taxonomic position of the species, *Lecithodendrium japonicum* Yamaguti, 1939, having spines in the genital atrium, but possessing posttesticular vitellaria, has been a matter of conjecture among taxonomists. According to Sogandares-Bernal (1956), Skarbilovich placed this species in the genus *Acanthatrium*, subgenus *Mesothatrium*. Sogandares-Bernal (1956) raised the subgenus *Mesothatrium* to generic level; however, Cheng (1957) discarded the genus *Mesothatrium* entirely, placing this form in the genus *Acanthatrium* and revising the description of the genus *Acanthatrium* to include those forms having posttesticular
vitellaria. The author has accepted the genus *Mesothatrium* as proposed by Sogandares-Bernal, believing that the position of the vitellaria is of generic significance. The species, *Acanthatrium japonicum* (Yamaguti, 1939) Cheng, 1957 should therefore read *Mesothatrium japonicum* (Yamaguti, 1939) Sogandares-Bernal, 1956.

The main criteria for differentiating species of the genus *Acanthatrium* are the position, size, and arrangement of the atrial spines. The arrangement of the organs is not a good basis for determining species in this genus, since the relative position of internal structures is very similar in most species of *Acanthatrium*.

**Life History:**

The life history of only the species *Acanthatrium oregonense* Macy, 1939 has been worked. Knight and Pratt (1955) found that two intermediate hosts were involved; the snail, *Oxytrema silicula* (Gould), and the larva of the caddis fly, *Limnophilus*. 

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Acanthatrium microcanthum Macy, 1940

Host:
Eptesicus fuscus fuscus (Beauvois).

Site of Infection:
Small intestine.

Locality:
Columbus (Franklin County) Ohio.

Description:
(Plate IV, Figs. 14-16) Ovate body, 1.11 to 1.26 mm long by 0.46 to 0.57 mm wide. Cuticula aspinose. Oral sucker subterminal, 101 to 114μ long by 101 to 110μ wide. Pharynx spherical, 46 to 63μ in diameter. Esophagus long, 110 to 166μ in length by 15 to 26μ wide. Typical lecithodendriid type intestinal ceca, not reaching to testes in relaxed specimens, 166 to 230μ long by 37 to 59μ wide. Acetabulum about same size as oral sucker, situated in posterior part of anterior half of body, 88 to 110μ long by 101 to 118μ wide. Prostate mass large, 147 to 180μ long by 162 to 199μ wide, partly covered by acetabulum, situated between bifurcation of ceca and anterior margins of testes; coiled seminal vesicle; numerous prostate cells and genital atrium present. Genital atrium lined with innumerable spines, 3 to 8μ long, circumferentially arranged. Atrium in anterior part of prostate mass. Testes oval, often irregular, equatorial; right testis
193 to 221μ long by 120 to 156μ wide; left testis 120 to 195μ long by 120 to 175μ wide. Ovary oval to spherical, 110 to 134μ long by 74 to 114μ wide, dorsal, on right side, posterolateral to acetabulum, often hidden from view by uterus. Vitellaria lateral, 10 to 12 large follicles per group, reaching to testes but not forward to oral sucker, dorsal to intestinal ceca. Uterine coils, both longitudinal and transverse, filling posterior half of body; eggs numerous, light brown in color near metraterm, 28 to 31μ long by 15 to 17μ wide.

**Discussion:**

Five specimens of *Acanthatrium microcanthum* were harbored by two out of thirty-five big brown bats, *Eptesicus fuscus fuscus*, representing an infection of 5.72 per cent.

Macy (1940) originally described this species from material of the small intestine of *Eptesicus fuscus* taken in St. Paul, Minnesota. To the author's knowledge, this description by Macy has been the only report of the trematode until the present study. As in other members of this genus, the atrial spines are very characteristic of this species.

**Life History:**

Unknown.
Acanthatrium eptesici Alicata, 1932

Host:

Myotis sodalis Miller and Allen.

Site of Infection:

Small intestine.

Locality:

Bat Cave (Carter County) Kentucky.

Description:

(Plate V, Figs. 17-20) Body rounded, 0.43 mm long by 0.53 mm wide. Cuticle covered with extremely minute spines. Oral sucker subterminal, 59μ long by 79μ wide. Prepharynx absent; pharynx about 37μ in diameter; esophagus short. Intestinal ceca 120μ long, of the typical lecithodendriid type, extending to anterior margins of testes. Acetabulum smaller than oral sucker, 59μ in diameter, located about midway in body near center of prostate mass. Prostate mass large, 138μ long by 166μ wide, between testes and extending anterior to bifurcation of ceca. Genital atrium, containing compact group of long narrow spines, in anterior section of prostate mass and slightly anterior to genital pore. Atrial spines, 18 to 23μ long, more or less parallel in arrangement, directed caudad. Testes ovoid to spherical, located in same transverse plane as acetabulum; right testis 114μ long by 90μ wide; left testis 103μ long by 81μ wide. Ovary ovoid, on right side,
posterolateral to acetabulum at an angle between acetabulum and right testis. Ovary 110μ long by 83μ wide. Vitellaria bilateral, composed of large follicles, about 12 to 15 per group, extending from level of intestinal ceca to level of oral sucker. Uterus consisting mainly of transverse loops filling posterior two thirds of body. Eggs numerous, 25 to 28μ long by 14 to 16μ wide, light brown near metraterm.

Discussion:

A single specimen of Acantharium eptesici was taken from one of twenty-one Myotis sodalis, representing an infection of 4.77 per cent. Although the specimen was contracted more than it should have been, the atrial spines were not changed. This form was identified to species mainly on the basis of the atrial spines. The arrangement of the organs was similar to the type specimen, but their measurements were not in the range given by Alicata (1932) who named the species from material of the intestine of Eptesicus fuscus taken in Washington, D. C. The specimen obtained by the present author differed also in the possession of minute cuticular spines which were not reported for the original material. Macy (1940) reported one specimen of Acantharium eptesici occurring in Eptesicus fuscus in St. Paul, Minnesota, but he reported a difference in the pattern of the atrial spines. According to Macy, the spines in the form he found were arranged in two groups;
one group being directed laterally rather than caudally. Although the author has not had an opportunity to examine the specimen reported by Macy, it seems probable that the form was not A. eptesici.

Since previous specimens have been taken from Eptesicus fuscus fuscus only, Myotis sodalis constitutes a new host record.

**Life History:**

Unknown.
Acanthatrium lunatum n. sp.

Host:

*Eptesicus fuscus fuscus* (Beauvois) and *Pipistrellus subflavus subflavus* (F. Cuvier).

Site of Infection:

Small intestine.

Locality:

Columbus (Franklin County) Ohio, Dublin (Franklin County) Ohio, Bat Cave (Hocking County) Ohio, Clear Creek Cave (Hocking County) Ohio, and Bat Cave (Carter County) Kentucky.

Description:

(Plates VI and VII, Figs. 21-29) Body pyriform to oval, 0.80 to 1.06 mm long by 0.38 to 0.54 mm wide. Minute cuticular spines present. Subterminal oral sucker comparatively large, 120 to 151μ long by 107 to 134μ wide. Pharynx muscular, 28 to 55μ long by 37 to 61μ wide. Esophagus in relaxed specimens attain length of 110 microns. Intestinal ceca of the lecithodendriid type, 190μ long by 50μ wide. Acetabulum large, about same size as oral sucker, 94 to 134μ long by 109 to 151μ wide. Testes lateral, in the same general transverse plane as acetabulum, slightly preacetabular or postacetabular, depending on amount of contraction. Right testis 116 to 169μ long by 96 to 138μ wide; left testis 101 to 147μ long by 94 to 129μ wide.

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Ovary oval, on right side, dorsal, posterolateral to acetabulum and testis, at an angle between right testis and acetabulum. Prostate mass large, 138 to 184μ long by 147 to 230μ wide, containing coiled seminal vesicle, numerous prostate cells and an anterior genital atrium lined with numerous long spines. Spines of genital atrium 20 to 27μ long, 100 or more in number, arranged in a crescentic group in a brush-like fashion (Figs. 24, 28, 29). Genital pore slightly posterior to atrial spines. Seminal receptacle and Laurer's canal present (Fig. 26). Vitellaria bilateral, consisting of medium to large follicles, 10 to 15 per lateral group, anterior to testes but not extending mesad to esophagus. Loops of uterus mainly transverse, bulging with light brown eggs near metraterm end. Eggs numerous, 26 to 28μ long by 13 to 17μ wide.

Discussion:

Two hundred eighty-seven specimens of this species were obtained from twenty-five (80.7 per cent) of thirty-one Georgian bats, *Pipistrellus subflavus subflavus*, and five (14.3 per cent) of thirty-five big brown bats, *Eptesicus fuscus fuscus*. The specific name, from the Latin word "lunatus", refers to the crescent-shaped group of spines in the genital atrium, which character is distinctive of this species.

This species has the arrangement of organs similar to
Acanthatrium pipistrelli Macy, 1940, but differs from it mainly in the character of the atrial spines and the possession of cuticular spines. As indicated by Macy (1940), the long slender spines of A. pipistrelli are arranged in a somewhat compact crescentic group, but are less numerous, being approximately thirty-five in number. The atrial spines of Acanthatrium eptesici Alicata, 1932 are approximately the same size as those of A. lunatum, but are less numerous and are arranged in a parallel group rather than a crescentic one. Neither A. eptesici nor A. pipistrelli have cuticular spines. A. lunatum differs from all other members of this genus in the arrangement and size of the atrial spines, morphological characters upon which the various species of this genus are based.

The specimens of A. lunatum, obtained from Eptesicus fuscus fuscus, had broader groups of atrial spines than those from Pipistrellus subflavus subflavus. It was believed, however, that the specimens from both types of hosts were the same species, Acanthatrium lunatum.

Life History:

Unknown.
Acantharium obovatum n. sp.

Host:
Eptesicus fuscus fuscus (Beauvois).

Site of Infection:
Small intestine.

Locality:
Columbus (Franklin County) Ohio.

Description:
(Plate VIII, Figs. 30-32) Body obovate, 1.19 to 1.68 mm long by 0.59 to 0.82 mm wide. Cuticular spines absent. Oral sucker subterminal, 85 to 107μ long by 110 to 125μ wide. Pharynx 46 to 52μ long by 42 to 64μ wide; esophagus long, 160 to 184μ long by about 37μ wide, curved to one side then contracted just posterior to pharynx. Intestinal ceca 202 to 267μ long by 64 to 74μ wide, forming bag-like pouches, extending to anterior margins of testes. Acetabulum about same size as oral sucker, about one third body distance from anterior end, 101 to 114μ long by 99 to 118μ wide. Acetabulum contracts into a marsupium-like opening just posterior to prostate mass (Fig. 30). Testes irregular, in same transverse plane as acetabulum; right testis 212 to 294μ long by 129 to 184μ wide; left testis 169 to 276μ long by 125 to 147μ wide. Ovary entire, oval, on right side, 127 to 202μ long by 125 to 147μ wide, posterolateral to acetabulum, at an angle

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between acetabulum and right testis. Prostate mass large, 151 to 175μ long by 184 to 258μ wide, containing large coiled seminal vesicle, spinose genital atrium, pars prostatica, genital pore, and numerous prostate cells. Seminal vesicle emptying into a pars prostatica near genital atrium and just anterior to genital pore. Genital atrium, genital pore, and acetabulum open into a common chamber on ventral surface (Fig. 30). Genital atrium, consisting of a fold partly covered on its under surface by numerous spines, 3 to 5μ long, in prostate mass just anterior to acetabulum. Genital pore to left of atrium. Vitellaria bilateral, consisting of large follicles, 6 to 10 per lateral group, extending from level of esophagus to anterior margins of testes. Loops of uterus both transverse and longitudinal. Eggs numerous, light brown, 28 to 33μ long by 16 to 18μ wide.

Discussion:

Twenty-four specimens were harbored by three of thirty-five big brown bats, *Myotis fuscus fuscus*, representing an infection of 8.57 per cent. The specific name, from the Latin root "ob" and the Latin word "ovatus", refers to the reverse egg-shaped body of the trematode.

There are three species, and a possible fourth, in which the size range of the atrial spines (2.6 to 8.0μ) is similar to *Acanthatrium obovatum*. These are:
Acanthatrium mollosidis, A. microcanthum, A. oligocanthum, and Acanthatrium sp.. Acanthatrium sp. is represented by a single specimen obtained from Myotis lucifugus lucifugus by the author, and described in this report. In none of these species is the general body shape obovate as it is in the new species Acanthatrium obovatum.

In Acanthatrium sp. there are twenty-four atrial spines which measure 4 to 5μ in length, arranged only in the anterior region of the genital atrium.

Acanthatrium mollosidis Martin, 1934, a second species, has atrial spines which measure about 5μ long. While this is in the same size range as the atrial spines of A. obovatum, A. mollosidis differs from the latter species in the possession of cuticular spines, the absence of an esophagus, and the arrangement of the atrial spines. The atrial spines of A. mollosidis are arranged in no definite pattern and are directed cephalad rather than caudad.

A third species, A. microcanthum Macy, 1940, having atrial spines 3 to 8μ long, circumferentially arranged around the genital pore, differs from A. obovatum in that in the latter species these spines are not circumferentially arranged, but are mainly in a more compact group on the under surface of the flap-like structure forming the atrium.

A fourth species, A. oligocanthum Cheng, 1957, has
only nine atrial spines measuring 2.6μ in length.

In all known species of the genus Acanthattrium, with the exception of Acanthattrium sp., A. mollosidis, A. microcanthum, A. oligacanthum and A. obovatum, the atrial spines range from 10 to 27μ in length. In these five species the atrial spines range from 2.6 to 8.0μ in length. Acanthattrium obovatum, then, differs from all other species in this genus mainly in the general body shape and the size and arrangement of the atrial spines.

**Life History:**

Unknown.
Acanthatrium sp.

Host:

Myotis lucifugus lucifugus (LeConte).

Site of Infection:

Small intestine.

Locality:

Clear Creek Cave (Hocking County) Ohio.

Description:

(Plate IX, Figs. 33-36) Body pyriform, 0.65 mm long by 0.59 mm wide. Minute spines on cuticle extending entire length of body. Oral sucker subterminal, 94\(\mu\) long by 110\(\mu\) wide. Prepharynx absent. Muscular pharynx 31\(\mu\) long by 52\(\mu\) wide. Esophagus short and twisted, about 55\(\mu\) long in this specimen. Intestinal ceca bifurcate, transverse, just anterior to prostate mass. Acetabulum, 87\(\mu\) long by 103\(\mu\) wide, slightly smaller than oral sucker, situated between testes, overlapping posterior edge of prostate mass. Testes in anterior half of body; right testis 184\(\mu\) long by 193\(\mu\) wide; left testis 206\(\mu\) long by 147\(\mu\) wide. Ovary oval, long axis transverse, 85\(\mu\) long by 129\(\mu\) wide, on right side, dorsal, and posterior to right testis. Slings of uterus noticeably narrow, transverse, and filled with yellowish-brown eggs near metraterm. Eggs 28\(\mu\) long by 15 to 17\(\mu\) wide. Vitelline follicles medium in size, 8 to 10 per group, anterior to testes, but not extending
mesad to esophagus. Prostate mass 179μ long by 105μ wide, possessing numerous prostate cells and a genital atrium containing a group of small spines. Atrial spines about 24 in number, 4 to 5μ in length and in anterior part of atrium. Genital atrium in anterior portion of prostate mass.

Discussion:

A single specimen of this fluke was obtained from the little brown bat, *Myotis lucifugus lucifugus*.

This trematode is somewhat similar to *Acanthatrium mollosidis* Martin, 1934 in that the atrial spines are small and few in number, and that there are cuticular spines present. However, *Acanthatrium* sp. differs in that it has an esophagus; the testes are larger; the atrial spines are located in the anterior part of the prostate mass, with the genital pore opening anterior to the acetabulum; and the cuticular spines cover nearly the entire body rather than only the anterior third. Some similarity exists between this specimen and *A. oligacanthum* Cheng, 1957, in that the atrial spines are small and similarly arranged in the genital atrium. It differs from *A. oligacanthum* in the number of atrial spines, the size of the testes and the acetabulum, and in the possession of cuticular spines. It differs from all other species chiefly by the character of the atrial spines. However, since only one specimen
was found, the author has made no attempt to describe this form as a new species. An effort will be made by him to obtain more little brown bats, *Myotis lucifugus lucifugus*, for examination in the hope that this parasite will be encountered again.

**Life History:**

Unknown.
The Genus *Limatulum*

Class - Trematoda

Subclass - Digenea

Order - Prosostomata

Suborder - Distomata

Family - Lecithodendriidae Odhner, 1910

Subfamily - Pleurogenetinae Looss, 1899

Genus - *Limatulum* Travassos, 1921

Discussion:

The lecithodendriids of the subfamily Pleurogenetinae are characterized by possessing a cirrus pouch and having the genital pore lateral rather than median. The following description of the genus *Limatulum* Travassos, 1921 was given by Stiles and Nolan (1931):

"Genital pore at side of acetabulum. Body ellipsoid, flat, with small cuticular spines. Suckers subequal, acetabulum equatorial. Pharynx present, prepharynx absent; esophagus short; ceca short, ending preequatorial. Cirrus sac well developed, with cirrus and seminal vesicle; testes in acetabular and postacetabular zone or preacetabular; vitellaria in cecal to prececal zone. Excretory vesicle V-shaped."

The following four helminth parasites of this genus are known to occur in bats: *Limatulum limatulum* (Braun, 1900) Travassos, 1921; *L. oklahomensis* Macy, 1931; *L. gastroides* Macy, 1935; and *L. diminutum* Chandler, 1938.
Limatulum gastroides Macy, 1935

Host:

Myotis sodalis Miller and Allen.

Site of Infection:

Small intestine.

Locality:

Bat Cave (Carter County) Kentucky.

Description:

(Plate X, Figs. 37-40) Body oval, flattened slightly dorso-ventrally, 0.45 mm long by 0.37 mm wide. Spinose over anterior three-fourths of body. Oral sucker ventral, 77 to 103μ long by 83 to 110μ wide. Pharynx approximately 46μ in diameter; esophagus, if present, not noticeable. Intestinal ceca forming bag-like pouches, 166μ long by 64μ wide, not quite reaching testes. Acetabulum spherical, centrally located, 74 to 92μ in diameter. Testes oblong, situated mainly in posterior half of body; right testis 83 to 110μ long by 90 to 114μ wide; left testis 97 to 107μ long by 55 to 83μ wide. Ovary entire, pretesticular and preacetabular, situated at right of longitudinal body axis, 74 to 76μ long by 50 to 66μ wide. Seminal receptacle large, 52μ long by 31μ wide, slightly to left of ovary between oral sucker and acetabulum. Cirrus sac, containing coiled seminal vesicle, at left of acetabulum, about 120μ.
long; genital pore opening posterolaterally to acetabulum on left side. Coils of uterus transverse, filling posterior third of body. Eggs 20 to 22\(\mu\) long by 11 to 13\(\mu\) wide, light brown in color.

Discussion:

This species was harbored by two of twenty-one Indiana bats, *Myotis sodalis*, representing an infection of 9.53 per cent. One bat yielded two adults, whereas, the other contained only a single immature specimen.

The first specimens of *Limatulum gastroides* were described by Macy (1935) from several *Myotis lucifugus* taken near Stockholm, Wisconsin and Minneapolis, Minnesota. Later, in a survey on helminth parasites of birds and mammals, Rankin (1946) found *Limatulum gastroides* in *Myotis lucifugus lucifugus* in western Massachusetts. To the author's knowledge, *Myotis lucifugus lucifugus* has been the only host hitherto reported harboring this species. *Myotis sodalis*, therefore, constitutes a new host record.

The forms found by the present author had the cirrus sac to the left of the median plane of the body and the ovary to the right, just the reverse of the species, *L. gastroides*, described by Macy in his original paper. In this genus the ovary is commonly found occurring on the left side while the cirrus pouch and genital pore are found on the right side. However, in one species, *L.*

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diminutum Chandler, 1938, the ovary is in the center between the bifurcation of the intestinal ceca, and the seminal vesicle seemingly lies free in the body in a transverse manner just anterior to the acetabulum; however, it opens into a genital atrium on the left side of the acetabulum. The specimens found in this survey were checked carefully to make certain that the author had interpreted correctly the ventral and dorsal surfaces of the specimens. A request has been made to examine the type specimen of *L. gastroides*.

**Life History:**

Unknown.
The Genus *Plagiochis*

Class - Trematoda

Subclass - Digenea

Order - Prosostomata

Suborder - Distoma

Family - Plagiorchiidae Lühe, 1899

Subfamily - Plagiorchiinae Pratt, 1902

Genus - *Plagiochis* Lühe, 1899

**Discussion:**

Olsen (1937) did a systematic study of the trematode subfamily, Plagiorchiinae, setting up key to the genera, subgenera, and species of members of this group. A general description of the genus *Plagiochis* is as follows: Body elongate, narrowed at both ends. Cuticle spinose. Prepharynx may or may not be present; esophagus either very short or absent. Intestinal ceca extend to posterior or near posterior end of body. Genital pore anterior to acetabulum. Cirrus pouch strongly developed, surrounding acetabulum in a C-shaped manner. Seminal vesicle conspicuous; cirrus elongated; testes oval or spherical, obliquely placed and posterior to ovary. Ovary usually spherical, median or to right of midline of body. Seminal receptacle not present; uterus S-shaped, extending between ovary and anterior testis and anterior testis and posterior testis. Vitellaria numerous, anterior extent between oral sucker
and acetabulum, posterior extent near caudal end of body. Follicles separated anteriorly or united in the form of a broad band.

Included in Olsen's work is a key to the subgenera and species of *Plagiorchis*. The two subgenera, *Plagiorchis* Schulz and Skworzov, 1931 and *Multiglandularis* Schulz and Skworzov, 1931, are differentiated by the character of the vitelline follicles. In *Plagiorchis* the follicles are confined to lateral margins of the body, and only a few extend mesad to median line of body, whereas, in *Multiglandularis* the vitelline follicles, anterior to the acetabulum, extend across the body as a broad, continuous band.

Only a few plagiorchids have been described from bats. The known world species include the following: *Plagiorchis* (P.) *vespertilionis* (Mueller, 1780); *Plagiorchis* (M.) *asperus* Stossich, 1904; *Plagiorchis* (M.) *muris* (Tanabe, 1922); *Plagiorchis* (P.) *micracanthos* Macy, 1931; and *Plagiorchis* (P.) *koreanum* Ogata, 1938.
Plagiorchis micracanthos Macy, 1931

Host:

Eptesicus fuscus fuscus (Beauvois), Pipistrellus subflavus subflavus (F. Cuvier), and Myotis sodalis Miller and Allen.

Site of Infection:

Small intestine.

Locality:

Columbus (Franklin County) Ohio, Bat Cave (Hocking County) Ohio, and Bat Cave (Carter County) Kentucky.

Description:

(Plate XI, Figs. 41-46) Body long, attenuated at both ends, 1.72 to 2.86 mm long by 0.45 to 0.65 mm wide. Cuticular spines variable, covering anterior one-third to three-fourths of body. Oral sucker subterminal, highly muscular, 164 to 237 μ long by 164 to 221 μ wide. Prepharynx present; pharynx muscular, 74 to 110 μ long by 75 to 98 μ wide. Esophagus 46 to 110 μ long by 22 to 41 μ wide, occasionally widening just anterior to bifurcation of ceca. Thick-walled intestinal ceca 1.23 to 1.84 mm long, extending to near end of body, occasionally enlarging in a bulb-like fashion near anterior end. Testes obliquely placed in anterior part of posterior portion of body; anterior testis oval to spherical, 166 to 221 μ long by 120 to 184 μ wide; posterior testis oval to spherical, 153 to 258 μ
long by 138 to 193 μ wide. Ovary oval, 131 to 180 μ long by 109 to 151 μ wide, anterior to anterior testis and to right of median plane, approximately half way between anterior and posterior ends of body. Seminal receptacle not present. Large cirrus sac, 400 to 500 μ long, posterior extent adjacent to left of ovary, passing dorsal to acetabulum on right side, curving to genital pore which is just anterior and to left of acetabulum. Large seminal vesicle; cirrus often protruding from genital pore. Uterus beginning at oötype, just posterior to ovary, extending caudad between anterior testis and posterior testis to caudal end of body, filling area beyond intestinal ceca. At caudal end uterus extends anteriorly, passing once again between posterior testis and anterior testis and continuing on between anterior testis and ovary to genital pore.

Metraterm muscular. Eggs yellowish-brown, 35 to 37 μ long by 18 to 20 μ wide. Vitellaria numerous, bilateral, extending from level of acetabulum in older adults or from level of bifurcation of ceca in younger forms, to near posterior end of body. In younger forms, vitellaria often extend inward, meeting dorsally and ventrally near median plane.

Discussion:

Forty specimens, consisting of both mature and immature forms, were obtained from four (11.4 per cent) of
thirty-five big brown bats, *Eptesicus fuscus fuscus*, five (16.1 per cent) of thirty-one Georgian bats, *Pipistrellus subflavus subflavus*, and nine (42.8 per cent) of twenty-one Indiana bats, *Myotis sodalis*. The greatest number harbored by any one host was ten. This species was invariably found near the posterior end of the ileum rather than in the duodenum where many of the other species of flukes were found.

The original material, consisting of thirty specimens, was described by Macy in 1931 from the intestine of *Myotis lucifugus* and *Eptesicus fuscus* taken near Minneapolis, Minnesota. Later, Manter and Debus (1945) reported the species from a hibernating bat, *Myotis californicus* (Audubon and Bachman), captured near Louisville, Nebraska. This was the first plagiorchid described from bats of the United States, and, to the author's knowledge, the only one. *Pipistrellus subflavus subflavus* and *Myotis sodalis* constitute new host records for this species.

**Life History:**

McMullen (1937) worked the life cycle of *Plagiorchis micracanthos*, finding that the snail, *Stagnicola emarginata angulata* Cort, served as the first intermediate host. Experimentally, McMullen found that the second intermediate host could be one of a number of species of insects, i. e.,
chironomids, mayflies, dragonflies, and mosquitoes. He was able to obtain the adult fluke from mice which he had fed infected dragonfly naiads.
NEMATHELMINTHES

Nematoda

Although not many nematodes have been reported from bats of the United States, three species were obtained from twenty-six, representing 29.5 per cent, of the eighty-eight bats examined for this report. In bats, certain nematodes occur only as encysted larvae, while others occur as adults. The present author found two species encysted as third-stage larvae and one species occurring in the adult form.

Physocophalus sexalatus

Class - Nematoda

Subclass - Phasmidia

Order - Spirurida

Suborder - Spirurina

Superfamily - Spiruroidea Railliet & Henry, 1915

Family - Thelaziidae Railliet, 1916

Subfamily - Ascaropsinae Alicata & McIntosh, 1933

Genus - Physocophalus Deising, 1861

Physocophalus sexalatus (Molin, 1860)

Deising, 1861

Host:

Eptesicus fuscus fuscus (Beauvois), Ripistrellus subflavus subflavus (F. Cuvier), and Myotis sodalis Miller and Allen.

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Site of Infection:

Encysted in stomach wall and on mesenteries.

Locality:

Columbus (Franklin County) Ohio, Clear Creek Cave (Hocking County) Ohio, and Bat Cave (Carter County) Kentucky.

Description:

(Plate XII, Figs. 47-49) Only the third-stage larvae of Physocephaalus sexalatus were encountered in this study. These larvae are found encysted on the mesenteries and occasionally in the stomach wall. Cyst, more or less spherical, 0.45 to 0.53 mm in diameter. Small larvae, coiled within the cysts, 1.20 to 1.60 mm in length by 0.06 to 0.08 mm in width. Buccal cavity, approximately 75μ long; esophagus, composed of both pro- and postesophagus, 450 to 650μ long. Excretory pore, 130 to 180μ from anterior end, opens into a narrow excretory sinus. Nerve ring surrounding esophagus, 90 to 100μ from anterior end, with several ganglia. Tail, 46 to 92μ long, terminating in a knob bearing approximately 20 cuticular processes. Rectum 30μ in length.

Discussion:

Bats serve as aberrant hosts to the encysted third-stage larvae of Physocephaalus sexalatus, and in no case were adult worms obtained. In this study, encysted
larvae were found in ten (28.6 per cent) of thirty-five
big brown bats, *Eptesicus fuscus fuscus*, two (16.1 per
cent) of twenty-one Indiana bats, *Myotis sodalis*, and five
(9.53 per cent) of thirty-one Georgian bats, *Pipistrellus
subflavus subflavus*.

Early workers in Europe found cysts in various species
of bats, but it was not until 1931 that they were reported
from bats in the United States. Alicata (1931) found the
encysted larvae on the mesenteries and in the stomach wall
of the big brown bat, *Eptesicus fuscus fuscus*, captured
in Washington, D. C.. Later, Tromba (1952) reported the
encysted larvae in the little brown bat, *Myotis lucifugus
lucifugus*, from caves in Pendleton County, West Virginia.
Eighteen per cent of the bats examined by Tromba contained
the cysts, which were usually deeply imbedded in the duo-
denum or less frequently on the mesenteries. This species
has never been reported from *Myotis sodalis* and *Pipi-
strellus subflavus subflavus* until the present study.

**Life History:**

According to Alicata (1935) the definitive hosts
include: swine, wild boar, white-lipped peccary, tapir,
horse, cattle, ass, and dromedary. The natural inter-
mediate hosts were found to be various species of dung
beetles. Cram (1930) reported encysted larvae of *P.
sexualatus* naturally occurring in several different species
of birds, mammals, and reptiles, and she was successful in getting the worms to re-encyst in various laboratory animals. She was also successful in obtaining re-encysted larvae from laboratory animals which were fed certain infected dung beetles.
Ascarops strongylina

Class - Nematoda
Subclass - Phasmidia
Order - Spirurida
Suborder - Spirurina
Superfamily - Spiruroidea Railliet & Henry, 1915
Family - Thelaziidae Railliet, 1916
Subfamily - Ascaropsinae Alicata & McIntosh, 1933
Genus - Ascarops Alicata & McIntosh, 1933

Ascarops strongylina (Rudolphi, 1819)
Alicata & McIntosh, 1933

Host:
Eptesicus fuscus fuscus (Beauvois) and Pipistrellus subflavus subflavus (F. Cuvier).

Site of Infection:
Encysted on mesenteries and in stomach wall.

Locality:
Columbus (Franklin County) Ohio, Bat Cave (Carter County) Kentucky.

Description:
(Plate XIII, Figs. 50-52) Only the encysted third-stage larvae were encountered. Cysts more or less spherical, 0.45 to 0.60 mm in diameter. Larvae 1.80 to 2.30 mm long by 0.05 to 0.09 mm wide; cuticle with prominent transverse striations. Buccal cavity 50 to 70μ long; esophagus,
composed of both pro- and postesophagus, 675 to 945μ long. Intestine about two-thirds of body length. Rectum 30 to 40μ long. Excretory pore opening 180 to 230μ from anterior end. Nerve ring surrounding esophagus, 130 to 150μ from anterior end. Tail approximately 60μ long, terminating in a smooth knob, 8 to 10μ long.

Discussion:

The author found encysted larvae on the mesenteries and in the stomach wall of one (2.86 per cent) of thirty-five big brown bats, Eptesicus fuscus fuscus, and four (12.9 per cent) of thirty-one Georgian bats, Pipistrellus subflavus subflavus. Alicata and McIntosh (1933) reported the third-stage larvae of this species encysted on the stomach of the big brown bat, Eptesicus fuscus fuscus, captured in Washington, D. C.. The author found no previous report of these larvae having been taken from Pipistrellus subflavus subflavus; therefore, this host constitutes a new record for Ascarops strongylina.

Life History:

As in Physcephalus sexalatus, bats serve as aberrant hosts to the encysted third-stage larvae of Ascarops strongylina. According to Alicata (1935), the definitive hosts for this nematode include; swine, rabbit, wild boar, cattle, and guinea pig. The intermediate hosts have been
found to be certain species of Coleoptera and also a species of Odonata. Mammals, birds, and reptiles serve as accidental hosts, the worms re-encysting as third-stage larvae in these animals.
Capillaria sp.

Class - Nematoda
Subclass - Aphanidia
Order - Enoplida
Suborder - Dorylaimina
Superfamily - Trichuroidea Railliet, 1916
Family - Trichuridae Railliet, 1916
Subfamily - Capillariinae Railliet, 1915
Genus - Capillaria Zeder, 1800
Capillaria sp.

Host:
Eptesicus fuscus fuscus (Beauvois) and Myotis sodalis
Miller and Allen.

Site of Infection:
Stomach.

Locality:
Columbus (Franklin County) Ohio and Bat Cave (Carter County) Kentucky.

Description:
(Plate XIV, Figs. 53-58) Slender, transparent worms with fine transverse striations on cuticle.

Female 12.0 to 14.5 mm long. Body tapering from the head, 7 to 9μ in diameter, to a maximum diameter of 150 to 155μ near the posterior fourth of body. Body tapering again at posterior end, forming a cup-like termination

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27 to 30μ broad. Esophagus 4.2 to 4.5 mm long, dividing body about 1:1.9 to 1:2.2. Vulva situated about 37 to 40μ behind esophagus, opening on a penis-like prominence, 110μ long and 24 to 28μ in diameter. Embryonated, bipolar eggs pass single file into vagina. Eggs 64 to 68μ long by 29 to 35μ wide.

Male 5.8 to 7.5 mm long, tapering from a narrow head, 7μ in diameter, to a maximum body diameter of 40 to 45 microns. Body tapering again at posterior end to a diameter of 24 to 28 microns. Esophagus 2.2 to 2.5 mm long, dividing body about 1:1.6 to 1:2.0. Spicule reported but not observed. Caudal alae present, about 50μ long. A well-developed bursa opening ventrally, about 37μ long. Posterior end of body forks into two blunt lobes, each extending more than half the length of bursa. From these lobes finger-like bursal rays extend, supporting the bursa.

Discussion:

Twenty-one specimens, eighteen females and three males, were recovered from the stomachs of two (5.72 per cent) of thirty-five big brown bats, Eptesicus fuscus fuscus, and six (28.6 per cent) of twenty-one Indiana bats, Myotis sodalis.

A number of capillariids have been described from bats as the following list indicates: Capillaria
vespertilionis (Rudolphi, 1819); C. diesingii (Kolenati, 1856); C. speciosa (van Beneden, 1873); C. pusilla Travassos, 1914; C. angrensis Freitas, 1934; C. vintoi Freitas, 1934; C. pulchra Freitas, 1934; C. pereirai Freitas and Lent, 1935; and C. palmata Chandler, 1938. Chandler (1938) described the species, Capillaria palmata, from material of the intestine of Rafinesque’s bat, Nycticeius humeralis (Rafinesque), collected near Houston, Texas. Read (1949) listed C. palmata as the only capillariid from North American bats.

The species reported by the present author differed from C. palmata mainly in the size of the body and the eggs. The site of infection of this species was the stomach, whereas, C. palmata was found in the intestine. Another similar species, C. speciosa (van Beneden, 1873), has been taken from the stomachs of numerous European bats, but it differed from Capillaria sp. in body size, position of the vulva, size of the eggs, and other minor features.

**Life History:**

Unknown.
SUMMARY

(1) Eighty-eight bats, representing four different species, *Eptesicus fuscus fuscus* (Beauvois), *Pipistrellus subflavus subflavus* (F. Cuvier), *Myotis lucifugus lucifugus* (LeConte), and *Myotis sodalis* Miller and Allen, were examined for helminth parasites. The bats were collected at five different locations in Ohio and Kentucky.

(2) Two new species of trematodes, *Acantharium lunatum* and *Acantharium obovatum*, are described. The helminths include one species of cestode, eight species and one subspecies of trematodes, and three species of nematodes, numbering in all, twelve species and one subspecies.

(3) There was a 96.6 per cent infection in all the bats examined.

(4) The following lists give the parasites recovered from each species of bat and the percentages of infection:

**Eptesicus fuscus fuscus** (Beauvois)

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(1) Hymenolepis roudabushii</em></td>
<td>8.57%</td>
</tr>
<tr>
<td><em>(2) Prosthodendrium (P.) transversum</em></td>
<td>8.57</td>
</tr>
<tr>
<td><em>(3) Prosthodendrium (P.) ascidia navicula</em></td>
<td>57.20</td>
</tr>
<tr>
<td><em>(4) Acantharium microcanthum</em></td>
<td>5.72</td>
</tr>
<tr>
<td><em>(5) Acantharium lunatum n. sp.</em></td>
<td>14.30</td>
</tr>
<tr>
<td><em>(6) Acantharium obovatum n. sp.</em></td>
<td>8.57</td>
</tr>
<tr>
<td><em>(7) Plagiorchis (P.) micracanthos</em></td>
<td>11.40</td>
</tr>
<tr>
<td><em>(8) Physoccephalus sexalatus</em></td>
<td>28.60</td>
</tr>
</tbody>
</table>
(9) Ascarops strongylina ...................... 2.86%
(10) Capillaria sp. .......................... 5.72

Pipistrellus subflavus subflavus (F. Cuvier)

(1) Acanthatrium lunatum n. sp. ................ 80.70%
(2) Plagiorchis (P.) micracanthos .......... 16.10
(3) Physocophalus sexalatus ................. 16.10
(4) Ascarops strongylina .................... 12.90

Myotis lucifugus lucifugus (LeConte)

(1) Prosthodendrium (P.) ascidia navicula.. 100.00%
(2) Acanthatrium sp. .......................... 100.00

Myotis sodalis Miller and Allen

(1) Prosthodendrium (P.) transversum ...... 38.10%
(2) Prosthodendrium (P.) ascidia navicula.. 95.30
(3) Acanthatrium eptesici ...................... 4.77
(4) Limatulum gastroides ...................... 9.53
(5) Plagiorchis (P.) micracanthos .......... 42.80
(6) Physocophalus sexalatus .................. 9.53
(7) Capillaria sp. ........................... 28.60

(5) Brief discussions of the genus of cestode and the genera of trematodes are given.

(6) Descriptions are included of all of the twelve species and one subspecies of parasites obtained. Drawings were made of all the different helminths with the aid of a camera lucida or an arc-light projection apparatus.

(7) Sixteen new host-parasite relationships, involving all four species of bats, are reported.
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EXPLANATION OF PLATE I

Fig. 1: *Hymenolepis roudabushii*. Rostellar hook.

Fig. 2: *Hymenolepis roudabushii*. Scolex, showing crown of hooks, rostellar sac, and suckers.

Fig. 3: *Hymenolepis roudabushii*. Ventral view of mature proglottids.

Fig. 4: *Hymenolepis roudabushii*. Embryonated ovum.

Fig. 5: *Hymenolepis roudabushii*. Transverse section through genital pore, somewhat diagrammatic.

Fig. 6: *Hymenolepis roudabushii*. Gravid proglottid containing eggs.

C.....Cirrus
CH.....Crown of hooks
E.....Egg
ESV.....External seminal vesicle
GA.....Genital atrium
H.....Hook
ISV.....Internal seminal vesicle
OV.....Ovary
RS.....Rostellar sac
S.....Sucker
SR.....Seminal receptacle
T.....Testis
UT.....Uterus
V.....Vagina
VT.....Vitellarian
EXPLANATION OF PLATE II

Fig. 7: Prosthodendrium (P.) transversum. Ventral view of adult.

Fig. 8: Prosthodendrium (P.) transversum. Egg.

Fig. 9: Prosthodendrium (P.) transversum. Ventral view of enlarged section of prostate mass and region of acetabulum, showing acetabular pouch and muscular genital atrium. From living specimen.

A....Atrium
AC....Acetabulum
AP....Acetabular pouch
GP....Genital pore
IC....Intestinal cecum
M....Metraterm
CS....Oral sucker
OV....Ovary
PH....Pharynx
PM....Prostate mass
PP....Pars prostatica
SR....Seminal receptacle
SV....Seminal vesicle
T....Testis
UT....Uterus
VT....Vitellaria
EXPLANATION OF PLATE III

Fig. 10: **Prosthodendrium** (P.)* ascidia navicula.* Ventral view of young adult, showing only a few eggs in uterus.

Fig. 11: **Prosthodendrium** (P.)* ascidia navicula.* Egg.

Fig. 12: **Prosthodendrium** (P.)* ascidia navicula.* Egg.

Fig. 13: **Prosthodendrium** (P.)* ascidia navicula.* Ventral view of older adult, showing uterus filled with eggs.

AC....Acetabulum  
E.....Esophagus  
GP....Genital pore  
IC....Intestinal ceca  
OP....Operculum  
OS....Oral sucker  
OV....Ovary  
PH....Pharynx  
PM....Prostate mass  
SV....Seminal vesicle  
T.....Testis  
UT....Uterus  
VT....Vitellaria
EXPLANATION OF PLATE IV

Fig. 14: **Acantharium microcanthum.** Egg.

Fig. 15: **Acantharium microcanthum.** Atrial spines from adult, showing circumferential arrangement.

Fig. 16: **Acantharium microcanthum.** Ventral view of adult.

AC....Acetabulum
AS....Atrial spines
E.....Esophagus
GA....Genital atrium
GP....Genital pore
IC....Intestinal ceca
OS....Oral sucker
OV....Ovary
PH....Pharynx
PM....Prostate mass
T.....Testis
UT....Uterus
VT....Vitellaria
EXPLANATION OF PLATE V

Fig. 17: *Acantharium eptesici*. Dorsal view of adult.

Fig. 18: *Acantharium eptesici*. Enlarged section of cuticle, showing cuticular spines.

Fig. 19: *Acantharium eptesici*. Egg.

Fig. 20: *Acantharium eptesici*. Atrial spines enlarged, from adult worm in Fig. 17.

AC....Acetabulum
AS....Atrial spines
CS....Cuticular spines
GP....Genital pore
OP....Operculum
OS....Oral sucker
OV....Ovary
PH....Pharynx
PM....Prostate mass
T....Testis
UT....Uterus
VT....Vitellaria
EXPLANATION OF PLATE VI

Fig. 21: *Acanthatrium lunatum* n. sp. Ventral view of adult from *Pipistrellus subflavus subflavus*.

Fig. 22: *Acanthatrium lunatum*. Egg.

Fig. 23: *Acanthatrium lunatum*. Enlarged section of cuticle, showing cuticular spines.

Fig. 24: *Acanthatrium lunatum*. Atrial spines enlarged from adult worm in Fig. 21.

AC....Acetabulum
E.....Esophagus
GA....Genital atrium
GS....Oral sucker
OV....Ovary
PH....Pharynx
PM....Prostate mass
T.....Testis
UT....Uterus
EXPLANATION OF PLATE VII

Fig. 25: *Acantharium lunatum*. Egg.

Fig. 26: *Acantharium lunatum*. Oötype region, from living specimen.

Fig. 27: *Acantharium lunatum*. Ventral view of adult from *Eptesicus fuscus fuscus*.

Fig. 28: *Acantharium lunatum*. Atrial spines enlarged, one end of crescentic group twisted, showing brush-like arrangement of spines.

Fig. 29: *Acantharium lunatum*. Atrial spines enlarged from adult worm in Fig. 27.

AC... Acetabulum
AS... Atrial spines
E..... Esophagus
GA.... Genital atrium
GP.... Genital pore
IC.... Intestinal ceca
LC.... Laurer's canal
OS.... Oral sucker
OV.... Ovary
PH.... Pharynx
PM.... Prostate mass
SR.... Seminal receptacle
T..... Testis
UT.... Uterus
VD.... Vitelline duct
VT.... Vitellaria
EXPLANATION OF PLATE VIII

Fig. 30: *Acanthatrium obovatum* n. sp. Ventral view of genital atrium and acetabulum, showing atrial spines and common chamber into which atrium, genital pore, and acetabulum open. From living specimen.

Fig. 31: *Acanthatrium obovatum*. Ventral view of adult.

Fig. 32: *Acanthatrium obovatum*. Egg.

AC....Acetabulum  
AS....Atrial spines  
E....Esophagus  
GA....Genital atrium  
GP....Genital pore  
IC....Intestinal ceca  
M....Metraterm  
O....Ovum  
OP....Operculum  
OS....Oral sucker  
OV....Ovary  
PH....Pharynx  
PM....Prostate mass  
PP....Pars prostatica  
SV....Seminal vesicle  
T....Testis  
UT....Uterus  
VT....Vitellaria
EXPLANATION OF PLATE IX

Fig. 33: *Acanthatrium* sp. Ventral view of adult.

Fig. 34: *Acanthatrium* sp. Egg.

Fig. 35: *Acanthatrium* sp. Genital atrium enlarged, showing atrial spines.

Fig. 36: *Acanthatrium* sp. Enlarged section of cuticle, showing cuticular spines.

AC....Acetabulum
AS....Atrial spines
CS....Cuticular spines
GA....Genital atrium
GP....Genital pore
OP....Operculum
OS....Oral sucker
OV....Ovary
PH....Pharynx
PM....Prostate mass
T....Testis
UT....Uterus
VT....Vitellaria
EXPLANATION OF PLATE X

Fig. 37: *Limatulum gastroides*. Ventral view of adult.

Fig. 38: *Limatulum gastroides*. Egg.

Fig. 39: *Limatulum gastroides*. Ventral view of immature specimen.

Fig. 40: *Limatulum gastroides*. Enlarged section of cuticle showing cuticular spines.

AC....Acetabulum  
CP....Cirrus pouch  
EV....Excretory vesicle  
GP....Genital pore  
IC....Intestinal ceca  
OP....Opectulum  
OS....Oral sucker  
OV....Ovary  
PH....Pharynx  
SR....Seminal receptacle  
SV....Seminal vesicle  
T.....Testis  
UT....Uterus  
VT....Vitellaria
EXPLANATION OF PLATE XI

Fig. 41: **Plagiorchis (P.) micrakanthos.** Ventral view of adult.

Fig. 42: **Plagiorchis (P.) micrakanthos.** Ventral view of young mature fluke.

Fig. 43: **Plagiorchis (P.) micrakanthos.** Enlarged section of cuticle from adult in Fig. 41, showing cuticular spines.

Fig. 44: **Plagiorchis (P.) micrakanthos.** Egg from adult in Fig. 41.

Fig. 45: **Plagiorchis (P.) micrakanthos.** Egg from young form in Fig. 42.

Fig. 46: **Plagiorchis (P.) micrakanthos.** Enlarged section of cuticle from young fluke in Fig. 42, showing cuticular spines.

AC....Acetabulum
C.....Cirrus
CP.....Cirrus pouch
CS.....Cuticular spines
IC.....Intestinal ceca
OS.....Oral sucker
OV.....Ovary
PH.....Pharynx
T.....Testis
UT.....Uterus
EXPLANATION OF PLATE XII

Fig. 47: Physocephalus sexalatus. Encysted third-stage larva.

Fig. 48: Physocephalus sexalatus. Posterior end of third-stage larva.

Fig. 49: Physocephalus sexalatus. Anterior end of third-stage larva.

AE....Anterior end
BC....Buccal cavity
E.....Esophagus
EP....Excretory pore
ES....Excretory sinus
INT....Intestine
NR....Nerve ring
PE....Posterior end
PES....Proesophagus
R....Rectum
RG....Rectal gland
EXPLANATION OF PLATE XIII

Fig. 50: *Ascarops strongylina*. Encysted third-stage larva.

Fig. 51: *Ascarops strongylina*. Posterior end of third-stage larva.

Fig. 52: *Ascarops strongylina*. Anterior end of third-stage larva.

AE.....Anterior end
BC.....Buccal cavity
E.....Esophagus
EP.....Excretory pore
INT.....Intestine
NR.....Nerve ring
PE.....Posterior end
PES.....Proesophagus
R.....Rectum
RG.....Rectal gland
EXPLANATION OF PLATE XIV

Fig. 53: *Capillaria* sp. Anterior end of female.

Fig. 54: *Capillaria* sp. Embryonated egg.

Fig. 55: *Capillaria* sp. Female, region of vulva.

Fig. 56: *Capillaria* sp. Posterior end of female.

Fig. 57: *Capillaria* sp. Anterior end of male.

Fig. 58: *Capillaria* sp. Posterior end of male, Lateral view.

A.....Anus
AL.....Ala
BC.....Buccal cavity
BR.....Bursal ray
BU.....Bursa
DL.....Dorsal lobe
E.....Esophagus
INT.....Intestine
O.....Ovum
V.....Vulva
VA.....Vagina