A PARTIAL SURVEY OF THE TREMATODES OF MANITOBA WATER AND SHORE BIRDS

A THESIS

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by

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ABSTRACT

Thirty seven trematode species are described from twenty six separate bird hosts. Six new species as well as six undetermined species are included. A new genus, Xenisma, is proposed for a new species belonging to the isolated genera of the family Echinostomatidae. The six new species are: Parastrigea neorobusta, Cotylurus mcleodi, Stephanoprora lari, Xenisma wardlei, Echinostoma platyrhynchi, and Echinostoma manitobensis. The undetermined species are: Mesostephanus sp., Plagiorchis sp. 1, Plagiorchis sp. 2, Astiotrema sp., Hindia sp., and Haematotrephus sp.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This project was undertaken with a view to increasing our knowledge of the trematodes in the Province of Manitoba. Of necessity it was restricted to surveying a small segment of the animal life in the Province. Investigation of the water and shore birds was decided upon, as much material had already been collected from this group during a survey carried out to determine the varieties of cestodes in the Province by Neufeld (616).

The material examined was mainly that which was kindly given to the author by Mr. N. Neufeld, which had been collected by him along the Nelson and Hays Rivers in northern Manitoba, and at Whitewater Lake in southern Manitoba. Additional material was obtained by the author from the Netley marshes, south of Lake Winnipeg, and from Professor R. A. Wardle and Dr. J. A. McLeod from whom I was kindly loaned material which was already mounted. Birds brought in by hunters were examined for trematodes, and the trematode collection in the Zoology Department at the University of Manitoba was also employed in this survey.

Intensive work on schistosome dermatitis had been carried out in the Province by Wardle (475, 476), McLeod (306, 307,

309), McLeod and Little (310), and Swales (426), and much information, including life cycles on the schistosomes, was recorded. This information has been integrated into this work.

A resume on the helminthological work done in Manitoba has been included, as well as a summary of the research done across Canada on trematodes. It is hoped that this project will in some small way help to consolidate the work that has been done in Canada on the study of trematodes.

Twenty six bird hosts have been included in this survey, however due to the small number of birds examined, no definite conclusions can be made as to the host specificity of the parasites described.

CHAPTER II

HISTORICAL

The investigation of trematodes in Canada has been channeled towards the domesticated birds and animals, mainly from an economic point of view. However it has been realized for some time now, that to maintain our herds and flocks free of parasites, or to minimize them, we must know the life cycles of these parasites. Once this knowledge is gained, the weak link in the cycle can be determined, and we are then enabled to apply measures which can eliminate or reduce these parasites. Since these cycles include diverse types of life, we cannot limit our investigation to the domesticated animals, but must include the wild life as well.

In Canada, Allen (8, 9), Kennedy (251), Kingscote (254, 255), Knight (260), Law (282), Law and Kennedy (283) and Duff (153) have investigated the fur-bearing animals, however most of the investigation has centred on the parasitism of fishes. Lyster (292, 293, 294, 295), Bangham (25, 26, 539), Bangham and Venard (27, 540), Cameron (98, 99, 100, 101, 102, 103), Choquette (117, 118, 553), MacLulich (602), and Miller (609, 612) have covered the eastern portions of Canada quite intensively. In the west, Bangham and Adams (541) have checked the fresh water fish in British Columbia. Cooper (126) Heller (577), and McFarlane (298, 299) have checked the trem-

atode parasites of Canadian marine fishes, while Lyster (296), has done some investigating of Canadian sea mammals. One of the earliest workers in the field of Canadian parasitology was Stafford (649) who had investigated amphibians (412), fishes (413), marine vertebrates (415), and vertebrates in general (414). Cameron (550), Kingscote (256), Miller (611), and Parnel (369) also checked Canadian animals, the latter concentrating his study in the north eastern part of Canada. Miller (613) made a critical study of Stafford's early report on the parasites of Canadian animals. Ruminants have been investigated by Griffiths (573), Hadwen (184), Kingscote (256, 258) and Swales (424, 425), who reviewed the literature of Canadian helminthology up to 1933, restricting his study to the helminth parasites of domesticated and semi-domesticated mammals and economically important birds, (422, 423). Cannon (104, 105), investigated ducks, geese and starlings, Miller (610), pigeons, and Rayner (634) wild birds, in eastern Canada. In general, very little work has been done on the birds of Canada. In the Arctic areas, Brown et al (76) did some work at Igloolik in the North West Territories, while Cooper(127) investigated the trematodes and cestodes of the Canadian north as early as 1913. Cameron (97) looked into parasitism and public health in Canada. Hogarth (200) and Ross (391) reported bilharziasis in Canada, while Conklin and Baker (125) discovered the presence of the lancet fluke in 1930.

A break down of the helminthological investigations in Manitoba is as follows: (a)-Trematoda; Allen and Wardle (10) on a serious outbreak of infection of the dogs of northern Manitoba, McLeod (306, 307, 308, 309), McLeod and Little (310), Swales (426), and Wardle (475, 476), all of whom did quite extensive work on the schistosomes, with particular detail on schistosome dermatitis in the Province. Prosthogonimus was reported by Savage (395) in chickens. (b)-Cestoda; McLeod (305) investigated the genus Citellus, Kuitunen-Ekbaum (701), Nicholson (339, 340, 341, 342), Little (595), Newton (618), and Wardle (474) the fish, Boughton (545), the snowshoe rabbit, Riddle (637), the cats of Winnipeg, and Neufeld (616) the birds of Manitoba. (c)-Nematoda; Marchant (605) on the nemas of Manitoba soils, Smedley (699) marine and fresh water fish, and Rempel (635) who investigated the importance, overwinter survival, and geographic distribution of the internal parasites in sheep. (d)-Physiological and Technique; Green (572), Stewart-Hay (650), Harvey (576), and Wardle (671, 672, 673), all of whom confined their investigations to the cestoda. Hurst (584) investigated histological and toto-mount technique, using Dibothriocephalus latus and Triaenophorus nodulosus in his work as the availability of this material was extremely good.

Other trends in helminthological studies are as follows:

Histology; Ciordia (122), Monnig (333) and Willey (483). Germ cell cycles and embryology; Brook (72), Cort (134), Cort, Ameel, and Van der Woude (130, 131, 132, 561), Dingler (143), Dollfus (144), Hussey (226), and Linton (287), as well as Willey and Godman (486). Britt (69), Chordia (555), Short (697), and Short and Menzel (698) have done very interesting and important work on the chromosomes of the digenetic trematodes. Physiology; Goodchild (571), Senger (640), Ferguson (165, 166), and Wilmoth and Goldfischer (487, 488).

Relatively little is known of the role that insects may have in the life cycles of the trematodes. One of the earliest reports of trematodes parasitizing insects was reported by Soparkar in 1918. Since then occasional articles appear of other cases. Crawford (137), and Peters (693) reported water beetles of the family Dytiscidae as being parasitized by Allocreadium sp. of trematodes. Ono (361) discovered a plagiorchid which used dragon flies in their life cycle. Soparkar (409), Brumpt (79), and van Thiel (663) investigated the role that mosquitoes play in the life cycles of trematodes, and Lakela (688) discussed the role of dragon fly nymphs in this.

The taxonomy of the digenetic trematodes is in a state of constant change. It is very difficult to assign many trematodes to their proper niches, as their life cycles have not as yet been determined. It is hoped that as the mysteries of these life cycles are solved, that a workable scheme for classific-

ation will evolve. In the field of taxonomy, the following have contributed valuable work; Byrd (87), Cort and Brackett (129), Faust (159, 162, 163), Lal (273), La Rue (281), Manter (324), McMullen and Beaver (542), Nicoll (344), Neiland (615), Skrjabin (405, 406), Stunkard (417), Ulmer (661), Ward (670), Willey (481, 483), Chandler (552), Cort (128), Dubois (564, 568), Barker (20), Hunter (582), and Kuntz (590).

Recently, Manter has published important studies on the zoogeography of the trematodes (603). His study was restricted to the marine fishes, as this group is the only one in which a sufficient amount of literature has been published of the trematodes which parasitize them. He discussed the following regions; European North Atlantic, Mediterranean, Red Sea, Woods Hole area, Tortugas area, New Zealand and Japan, as well as the Indian coasts. The Japanese area has been extensively studied by Yamaguti (498-512), and many of the specimens he discovered have not been found elsewhere.

Of extreme importance is the compiling of Index Catalogues by Stiles and Hassall (651) and more recently Hassall et al (652). This catalogue covers all articles which have been written on any form of parasitism whether it be protozoan or helminth. The author here makes the suggestion that a similar catalogue restricted to trematodes, and arranged by families

would greatly facilitate all phases of research on the study of trematodes.

CHAPTER III

MATERIALS AND METHODS

A good portion of the material used in this study had been collected in 1949 and 1950, and had been preserved in 5% formalin. Portions of this material were then immersed in M.A.S. (Mercuric-Acetic-Sulfate) fixative and A.F.A. (Alcohol-Formol-Acetic) fixative to determine the benefits, if any, of the use or non use of these fixatives on this material. The material was repeatedly washed in distilled water over a period of 24 hours to remove all traces of the formalin and other fixatives before staining. It was found that this procedure was sufficient for most of the material, however difficulties were encountered with the larger and more muscular trematodes. It was found that staining of these muscular trematodes was uneven and that the stained portions did not agree with the internal organs of the trematode in question. It was assumed that this was due to insufficient washing of the material to remove the last traces of the formalin.

In the case of fresh material, the intestinal tract of the bird was cut up into convenient sections in order to keep track of the locality from which the parasite was recovered. The small intestine itself was divided into three portions being designated 'upper', 'middle', and 'lower' small intestine. The contents of each portion was scraped into individual

containers, and continually washed in lukewarm water to remove as much of the suspended and dissolved material as was possible. After a suitable elapse of time, this to allow the heavier trematodes to settle to the bottom, the major portion of the water in the container was poured out. The container was filled with lukewarm water again, and the process was repeated. Finally, when the supernatant liquid was clear enough to see through, portions of the residue on the bottom of the container containing the trematodes, were poured into shallow glass dishes. By the use of a binocular microscope, the trematodes were removed from this residue, and placed into vials containing various fixatives. The majority of the specimens were stained with carmine which appeared to give the most satisfactory results. Good results were also obtained in staining small specimens with haematin.

Several hundred small echinostomes and strigeids were recovered from a Lesser Scaup duck, and the major portion of this material was used to experiment with several varieties of stains. The stains were employed either singly, or in various combinations with one another. It was from this investigation that the carmine stains appeared to be superior to all others with this material. However, a startling and possibly useful stain revealed itself in the case of using Wright's Triple Stain. Several strigeids and echinostomes were immersed

in this stain, and it was found that the vitelline follicles in the strigeid absorbed a brilliant green, leaving the rest of the specimen a light shade of pink. In the case of the echinostomes, they all assumed an overall lighter pink shade than the strigeids, and without the vitelline follicles absorbing any of the green as was noted in the case of the strigeids.

An unusual effect was noted in the case of removing a mounted specimen of Hypoderaeum conoideum from the slide. The specimen was immersed in xylol to remove the mounting medium and then put into fresh xylol. Accidentally the xylol evaporated completely leaving the specimen dry. On putting the specimen into beechwood creosote to clear it, the excretory system of the specimen appeared to be brought out. The clearing agent did not perfuse the specimen completely but left dendritic shapes which were laterally symmetrical in appearance. On standing further, it was seen that the clearing agent was slowly beginning to fill into the dendritic tubules. Photomicrographs were taken before the clearing agent obliterated all signs of the excretory system. Fig.1, page 12 shows this.

A method was discovered whereby the ventral glands on the notocotylids could be observed and counted. By removing the specimen under the binocular microscope, and applying a

PLATE I

Fig. 1. Excretory system of *Hypoderaeum conoideum* x48

Fig. 1.

corner of some absorbent substance, such as a blotter, to remove the excess clearing agent, the glands were then seen to stand out in relief, and could very easily be observed.

The formulae and procedures of the fixatives and stains used to best advantage in this study were as follows:

Mercuric-Acetic-Sulfate (M.A.S.) fixative.

Mercuric chloride (saturated aqueous soln.)--98 ml.
Glacial acetic acid---------- 2 ml.
Sodium sulfate---------- 1 gm.

(1)-Fix 1-24 hrs. depending upon size of specimen.

(2)-Before staining, wash specimen in .5% iodine in 70% alcohol until iodine begins to remain in the wash solution.

(3)-Specimen is ready for staining .

Alcohol-Formol-Acetic (A.F.A.) fixative.

Alcohol (50%)----------100 ml.
Formalin (100%)---------- 6.5 ml.
Glacial acetic acid---------- 2.5 ml.

(1)-Leave specimen in fixative until it is opaque.

(2)-No washing of specimen required prior to staining.

(3)-Fixative is replaced with two changes of 50% alcohol, allowing 20 min. to 1 hour each time.

(4)-Remove specimens to 70% alcohol, and they may remain here until ready to be stained.

Grenacher's Borax Carmine stain.

Carmine---------- 3 gms.
Borax (4% aqueous solution)----------100 ml.

(1)-Boil carmine for half an hour in borax solution.

(2)-Let stand at room temperature for 2 days, with occasional shaking.

(3)-Filter.

(4)-Mix filtrate with equal volume 70% alcohol.

(5)-Filter next day.

To stain

(a)-Leave specimen in stain from a few hours to a day depending upon size of the specimen.

(b)-Pass into acidified 70% alcohol (1 ml. acetic acid per 100 ml. of alcohol).

(c)-Leave specimen in for a day, or until tissue becomes transluscent.

(d)-Pass up the alcohol series (30%-50%-70%-80%-90%-95%-absolute alcohols) and mount specimen.

Ehrlich's Haematoxylin stain (original)

Glacial acetic acid	10 ml.
Haematoxylin	2 gms.
Potassium alum	in excess.
Distilled water	100 ml.
Absolute alcohol	100 ml.
Glycerol	100 ml.

(1)-Dissolve haematoxylin in acetic acid with 25 cc. of alcohol.

(2)-Add glycerol and remaining alcohol.

(3)-Dissolve alum in water with aid of heat.

(4)-Slowly pour warm solution into haematoxylin.

(5)-Expose solution to light and air for at least three weeks in order to ripen solution. When deep red color is aquired, stain is ready for use.

To stain

(a)-Leave specimen in stain for 20 min.

(b)-Wash in tap water until specimen appears blue.

(c)-If overstained, redden for few seconds in acid water (10 drops concentrated H Cl per 100 ml. water), then blue again in tap water.

(d)-Counterstain for 30-60 sec. in eosin (yellow)

(e)-Rinse with distilled water.

(f)-Pass rapidly up the alcohol series.

Haematin stain

A (Potassium alum---------- 50 gms) dissolve first.
(Distilled water----------1000 cc)

B (Haematin---------- 1 gm.) mix in mortar.
(95% alcohol---------- 10 cc.)

(1)-Add B to A slowly stirring.

(2)-Add one small crystal of thymol as a preservative.

(3)-Filter stain before using, each time.

To stain

(a)-Bring specimen to be stained down to water stage of the alcohol series.

(b)-Wash in distilled water, add stain, leave 1 hr.

(c)-Wash in 3 changes tap water, 5 min. each time.

(d)-Destain in 35% acid alcohol until blue changes to pink.

(e)-Intensify in NH_4OH (2 drops per 500 ml. water) for 20 min.

(f)-Wash several times in tap water.

(g)-Take specimen back up alcohol series .

(h)-Clear and mount.

Coelestin Blue B stain

Coelestin blue B	.5 gm.
Iron alum	5.0 gm.
Glycerol	14.0 ml.
Sulfuric acid (concentrated)	2.0 ml.
Distilled water	100.0 ml.

(1)-Boil water, coelestin blue B, and iron alum 20 min.

(2)-Allow to cool.

(3)-Add glycerol and sulfuric acid.

To stain

(a)-Stain specimen about 3 min.

(b)-Rinse in water several times.

(c)-Pass up the alcohol series, clear and mount.

Xylol based permount was the mounting medium used, while beechwood creosote was the clearing agent.

Literature consulted for this chapter was: (84), (173), (176), (179), (188), (311), (546), (638), (645, 646, 647, 648) and 6674).

CHAPTER IV

TAXONOMY AND DESCRIPTION

Classification of hosts

The classification used here is that of Wetmore (677). Identification of hosts was made by the use of Peterson's guides, (631, 632).

Class Aves-Birds

Subclass Neornithes-True birds

Superorder Neognathae-Typical birds

Order Gaviiformes-Loons

Family Gaviidae-Loons

Gavia immer-Common loon

Order Colymbiformes-Grebes

Family Colymbidae-Grebes

Colymbus holboelli-Holboell's grebe

Order Pelecaniformes-Tropic birds, Pelicans, allies

Suborder Pelecani-Pelecans, boobies, cormorants

Superfamily Suloidea-Boobies, cormorants & allies

Family Phalacrocoracidae-Cormorants

Phalacrocorax auritus-Double-crested cormorant

Order Anseriformes-Screamers, ducks, geese, swan

Suborder Anseres-Ducks, geese, and swans

Family Anatidae-Ducks, geese, and swans

Subfamily Anatinae-Surface feeding ducks

Anas platyrhynchos platyrhynchos-Mallard

Anas strepera-Gadwall

Anas acuta tzitzihoa-Pintail

Anas discors-Blue-winged teal

Spatula clypeata-Shoveller

Subfamily Aythyinae-Diving ducks

Aythya valisineria-Canvas-back duck

Aythya affinis-Lesser scaup duck

A. marila nearctica-Greater scaup duck

Glaucionetta albeola-Bufflehead

G. clangula americana-American golden-eye

Subfamily Merginae-Mergansers

Mergus serrator-Red-breasted merganser

Order Gruiformes-Cranes, rails and allies

Suborder Grues-Cranes, limpkins, trumpeter, rails

Superfamily Ralloidea-Rails

Family Rallidae-Rails, gallinules, coots

Fulica americana-Coot

Order Charadriformes-Shorebirds, gulls, auks

Suborder Charadrii-Shorebirds

Superfamily Charadrioidea-Plovers, sandpipers

Family Scolopacidae-Woodcock, snipe & allies

Erolea melanotos-Pectoral sandpiper

Micropalma himantopus-Stilt sandpiper

Totanus flavipes-Lesser yellow-legs

Limnodromus griseus-Dowitcher

Limosa fedoa-Marbled godwit

Bartramia longicauda-Upland plover

Suborder Lari-Gulls, terns, skimmers

Family Laridae-Gulls, terns, skimmers

Subfamily Larinae-Gulls

Larus argentatus-Herring gull

Larus pipixcan-Franklin's gull

Larus delawarensis-Ring-billed gull

Subfamily Sterninae-Terns

Sterna hirundo hirundo-Common tern

Chlidonias nigra surinamensis-Black tern

Classification of trematodes

Phylum Platyhelminthes Claus, 1880

Class Trematoda Rudolphi, 1808

Subclass Digenea Van Beneden, 1858

Order Fasciolata Nicoll, 1936

Superfamily Paramphistomoidea Stiles & Goldberger, 1910

Family Paramphistomidae Fischoeder, 1901

Subfamily Zygocotylinae Stunkard, 1916

Genus Zygocotyle Stunkard, 1916

Z. lunata (Diesing, 1836) Stunkard, 1916

Superfamily Notocotyloidea Nicoll, 1935

Family Notocotylidae Lühe, 1909

Subfamily Notocotylinae Kossack, 1911

Genus Notocotylus Diesing, 1839

Subgenus Notocotylus Dubois, 1951

N. t. triserialis Diesing, 1839

Subgenus Hindia Lal, 1935

Hindia species

Superfamily Cyclocoeloidea Henry, 1923

Family Cyclocoelidae Kossack, 1911

Subfamily Cyclocoelinae Stossich, 1902

Tribe Haematotrephea Witenberg, 1926

Genus Haematotrephus Stossich, 1902

Haematotrephus species

Superfamily Echinostomatoidea Faust, 1929

Family Echinostomatidae Poche, 1926

Subfamily Echinostomatinae (Looss, 1899)

Genus Echinostoma Rudolphi, 1809

E. revolutum (Frölich, 1802) Looss, 1899

E. platyrhynchi n. sp.

Genus Echinoparyphium Dietz, 1910

E. elegans (Looss, 1899)

Subfamily Echinochasminae Odhner, 1910

Genus Echinochasmus Dietz, 1909

E. manitobensis n. sp.

Subfamily Echinochasminae (cont'd)

Genus Stephanoprora Odhner, 1902

Stephanoprora lari n. sp.

Isolated genera

Genus Hypoderaeum Dietz, 1909

Hypoderaeum conoideum (Block, 1782) Dietz, 1909

Genus Petasiger Dietz, 1909

Petasiger chandleri Abdel-Malek, 1952

Genus Drepanocephalus Dietz, 1909

Drepanocephalus spathans

Genus Xenisma nom. nov.

Xenisma wardlei n. sp.

Family Cathaemasiidae (Fuhrmann, 1928)

Subfamily Cathaemasiinae Dollfus, 1950

Genus Cathaemasia Looss, 1899

Cathaemasia nycticoracis Olsen, 1940

Superfamily Plagiorchioidea Dollfus, 1930

Family Plagiorchidae Lühe, 1901

Subfamily Plagiorchinae Pratt, 1902

Genus Plagiorchis Lühe, 1899

Plagiorchis sp. 1.

Plagiorchis sp. 2.

Genus Astiotrema Looss, 1900

Astiotrema sp.

*Family Brachylaemidae Joyeux and Foley, 1930

Subfamily Leucochloridiinae Poche, 1907

Genus Leucochloridium Carus, 1835

L. cyanocittae McIntosh, 1932

Order Strigeata La Rue, 1926

Supersuperfamily Strigeida Poche, 1925

Superfamily Strigeides Dubois, 1936

Subsuperfamily Strigeines Dubois, 1936

Family Strigeidae Railliet, 1919

Subfamily Strigeinae Railliet, 1919

Subsubfamily Strigeini Dubois, 1936

Genus Parastrigea Szidat, 1928

Parastrigea neorobusta n. sp.

Subsubfamily Cotylurini Dubois, 1936

Genus Cotylurus Szidat, 1928

Cotylurus communis Hughes, 1928) La Rue, 1932

C. cornutus (Rudolphi, 1808) Szidat, 1928

C. brevis Dubois and Rausch, 1950

C. Erraticus (Rudolphi, 1809) Szidat, 1928

C. mcleodi n. sp.

Subsuperfamily Diplostomines Dubois, 1936

Family Diplostomidae Poirier, 1886

Subfamily Diplostominae Monticelli, 1888

Subsubfamily Diplostomini Dubois, 1936

Genus Diplostomum v. Nordmann, 1832

D. huronense (La Rue, 1927) Hughes, 1929

D. spathaceum (Rudolphi, 1819) Braun, 1893

D. pelmatoides Dubois, 1932

D. baeri Dubois, 1937

D. gavium (Guberlet, 1922) Hughes, 1929

Genus Posthodiplostomum Dubois, 1936

P. prosostomum Dubois and Rausch, 1948

Superfamily Cyathocotylides Dubois, 1936

Family Cyathocotylidae Poche, 1925

Supersubfamily Prohemistomidi Dubois, 1938

Subfamily Prohemistominae Lutz, 1935

Subsubfamily Prohemistomini Dubois, 1938

Genus Mesostephanus Lutz, 1935

Mesostephanus sp.

*Family Schistosomatidae Looss, 1899, emend. Poche, 1907

Subfamily Schistosomatinae Stiles & Hassall, 1898

Genus Ornithobilharzia Odhner, 1912

O. filamenta McLeod, 1940

O. aviani McLeod, 1940

Genus Austrobilharzia Johnston, 1917

A. lari (McLeod, 1937) Penner, 1953

A. canadensis (McLeod, 1936) Penner, 1953

A. manitobensis (McLeod, 1936) Penner, 1953

Subfamily Bilharziellinae Price, 1929

Genus Trichobilharzia Skrjabin & Zakharow, 1920

T. querquedulae (McLeod, 1937) Wu, 1953

Families marked with an asterisk (*), are not meant to be included in the superfamilies appearing above them.

Detailed description

Family Paramphistomidae

Zygocotyle lunata (Diesing, 1836) Stunkard, 1916

Several specimens of Z. lunata were obtained from the lower small intestine of the Lesser scaup duck Aythya affinis, the intestinal caecae and small intestine of the Pintail Anas acuta, and the intestinal caecae of the Mallard Anas p. platyrhynchos. As far as can be ascertained, this is the first report of Z. lunata from the Lesser scaup and Pintail. It has been reported previously from the following hosts:

Baldpate-Mareca americana (149)
Blue-wing teal-Anas discors (532)
Domestic duck-A. platyrhynchos (139), 6655), (149)
Black duck-A. rubripes (104), 1149)
Green-wing teal-A. carolinensis (374)
A. boschas (617)
A. melanotus (680), (374)
A. ipecuteri (680), (374) (104)
Domestic goose-Anser a. domesticus (374), (617), (139),
Domestic chicken-Gallus gallus (90), (617)
Red-head duck-Aythya americana (149), (374)
Wild turkey-Meleagris gallopavo intermedia (641)
Curlew-Numenius a. arquata (139)
Wilsons snipe-Capella gallenago gallenago (374)
Himantopus wilsonii (374), (680)
Ox-Bos taurus (139), (374), (387), (617)
Elk-Cervus dichotomus (374), (563), (617)

Many of the specimens recovered from the intestinal tract were still alive. This was very interesting due to the hosts having been dead for two days prior to the recovery of the worms. Unfortunately time did not permit the investigation of how long the worms could have survived under these abnormal conditions of temperature.

Figs. 10 and 11, page 44, show the aspects of two specimens varying greatly in size. Comparisons of the dimensions of these two specimens with those of specimens from various sources are shown in Table I, page 26. Fig. 15, page 45, shows the convolutions of the caecae in an immature specimen. Figs. 16 and 17, page 45, are photomicrographs of a specimen obtained from Pintail duck.

Willey (485) in his study of the life cycle and bionomics of Z. lunata, discovered that flukes of the same age vary in size according to the number within the host. They apparently continue growing long after attaining sexual maturity. Range in size is from 3.1 by 1.4-9.2 by 4.7 mm.

One other species of this genus has been reported by Dollfus (146) from the dugong, Dugong dugong. Hilmy (578) described four new Paramphistomes from the dungong under the names Solenorchis travassosi, S. gohari, S. naguilmahfouzi and S. baeri. However Dollfus, stating that the pharyngeal pouches are difficult to see, and may have atrophied, trans-

TABLE I

COMPARISON OF MEASUREMENTS OF ZYGOCOTYLE LUNATA FROM VARIOUS SOURCES

	* Freedman Mallard Manitoba	** Freedman Mallard Manitoba	Caballero Chicken Mexico	*** Price Ox Panama	**** Price W. snipe Texas
Length	3.870	7.304	9.000	6.000	3.000
Width	1.260	2.573	2.900	3.000	1.500
Or. sucker	0.158 d.	0.225 d.	0.253 d.	0.650	0.286 d.
Ph. pouches	0.113 x 0.072	0.338 x 0.199	0.351 x 0.234	0.250 x 0.130	0.130 x 0.065
Esophagus	0.360	0.498	1.170	0.455	0.260
Esophageal bulb	0.144 x 0.135	0.485 x 0.291	0.390 x 0.292	0.416 x 0.260	0.169 x 0.156
Anterior testis	0.270 x 0.270	0.415 x 0.664	0.975 x 1.404	0.650 x 0.390	0.364 x 0.221
Posterior testis	0.265 x 0.270	0.341 x 0.747	0.994 x 1.267	0.650 x 0.520	0.390 x 0.234
Ovary	0.090 x 0.180	--------	0.409 x 0.624	0.156 x 0.260	0.143 x 0.091
Acetabulum	1.035 x 0.630	1.743 x 1.079	1.925 x 1.500	1.100 x 1.200	0.550 x 0.520
Gen. pore to anterior	0.793	1.700	2.200	-----	-----
Eggs	0.045 x 0.090	1.088 x 0.083	0.151 x 0.098	0.143 x 0.090	0.125 x 0.075

All measurements in mm.

* Specimen shown in Fig. 10, page 44.
** Specimen shown in Fig. 11, page 44.
*** Maximum dimensions given, Price (374).
**** Same as preceding line. (Wilsonss snipe).

ferred the four new species to the genus Zygocotyle, claiming that they were the same as the specimens which he obtained from the dugong, with slight individual differences. Hilmy had erected the new subfamily Solenorchinae, and new genus Solenorchis to contain the apparent new species. These are now invalidated by Dollfus naming the five supposed varieties Z. travassosi (Hilmy, 1949) Dollfus, 1950.

Other literature consulted was: (89), (142), (171), (264), (286), (337), (406), (410), (451, 452), (469), (482), (484, 486), (500), (604), (679), (680), (682), (687).

Family Notocotylidae Lühe, 1909

Notocotylus triserialis triserialis Diesing, 1839

Specimens were obtained from the small intestine, caeca, and rectum of the Mallard, Pintail, Shoveller, and Lesser scaup. Many species of Notocotylus have been reported, however it appears to the writer, after examining the literature, that many are synonymous. Dubois (149) has made a detailed study of this group, reducing N. intestinalis, N. stagnicolae, and N. urbanensis to synonymy with N. t. triserialis. This species has been reported from the Blue goose (Chen caerulescens) (104), Wood duck (Aix sponsa) (189), Muskrat (Fiber zibethicus) (189), (260), (636).

Table II, page 28, compares a typical specimen collected

TABLE II

COMPARISON OF MEASUREMENTS OF NOTOCOTYLUS TRISERIALIS TRISERIALIS FROM VARIOUS SOURCES

	Freedman* Shoveller Manitoba	Wu** Experimental Ottawa	Dubois*** Mallard & Shov. Wisconsin
Length	4.750	4.32	2.64
Width	1.140	1.10	0.070
Esophagus	0.40	0.18	0.145
Oral sucker	0.19 x 0.19	0.15 x 0.19	0.115 x 0.140
Cirrus	0.75 x 0.03	----------	----------
Testes	0.60 x 0.28	0.69 x 0.33	0.360 x 0.210
Ovary	0.28 x 0.28	0.25 x 0.20	0.180 x 0.180
Ventral glands	14 15 14	16-19, 14-16, 16-19	14-16, 14-15, 14-16
Metraterm	0.180	0.125	0.566
Cirrus pouch	1.70	-----	0.850 x 0.085
Egg	-------	0.023 x 0.013	0.021 x 0.013

All measurements in mm.

* Specimen shown in Fig. 3, page 31.

** Wu (497)

***Dubois (149)

by the writer, with several others reported in the literature. A typical specimen, Fig. 3, is pictured on page 31, while Figs. 6 and 7 on page 32show the anterior and posterior aspects respectively.

Literature consulted was: (30, 31), (45), (65), (139), (149), (19), (46, 48), (104), (175), (189), (192), (195), (196), (197), (134), (268), (270, 271), (283), (289), (291), (325), (331), (334), (345), (427), (434), (436, 437), (461), (497), (498), (500, 502, 508, 509), (513), (555), (418), (617), (655), (642), (644), (669, 670), (679), (681), (695), (649), (684).

Hindia species

Two specimens were recovered from the intestinal caeca of the Coot (Fulica americana). Due to the size and opacity of the specimens, it was extremely difficult to differentiate most of the internal organs. However, sufficient details were observed to place this species in the genus Hindia by the use of Dubois' key (149). The dimensions are as follows: Length-2.40, Width-1.40, Esophagus-0.25, Oral sucker-0.22 by 0.16, Cirrus-0.60 by 0.03, Bifurcation of caecae to first of the median glands-0.28, Distance of vitellaria from extreme anterior-1.30, Testes (not distinct)-0.30 by 0.20, Ovary-0.26 by 0.21, Ventral glands-lateral 11, median 8 or 9 ?. Distance of vitellaria to lateral border-0.25, Metraterm-

0.55, Distance between genital pore and bifurcation of the caecae-0.07, Cirrus pouch-0.55. The uterus appeared to be intracecal, while the vitellaria extended from the lower borders of the testes to about the middle of the length of the body of the specimen. No spines were seen on the cuticle.

Literature consulted was: (12), (33), (82), (272), (427), (548), and (348). These specimens are shown in Figs. 4 & 5, page 31.

Family Cyclocoelidae

Haematotrephus species

Three specimens were found in the body cavity of the Upland plover (Bartramia longicauda). Witenberg's classification (490) is followed here. Dimensions in mm. of one specimen are as follows: Length-8.231, Width at oral sucker-0.660, Width at widest part-1.485, Oral sucker-0.165 by 0.221, Length of esophagus-about 0.945, Ovary-0.429 by 0.264, Anterior testis-round 0.363 diam., Posterior testis-ovoid 0.495 by 0.363, Eggs-0.099 by 0.050. Vitellaria extend extrcecally from about the level of the bifurcation almost to the excretory cavity at the extreme posterior.

Fig. 2 on page 31 shows the complete specimen, while Figs. 8 and 9 on page 33 show details of the anterior and posterior portions respectively.

Literature consulted here was: (19), (78, 80), (71), (93), (145), (168), (172), (180), (189), (244, 245), (253), (266),

PLATE II

Fig. 2. *Haematotrephus species* from the body cavity of the Upland plover *Bartramia longicauda*. Ventral view.

Fig. 3. *Notocotylus triserialis triserialis* from the Shoveller duck. Ventral view.

Fig. 4. *Hindia species*. Ventral view.

Fig. 5. *Hindia species*. Lateral view.

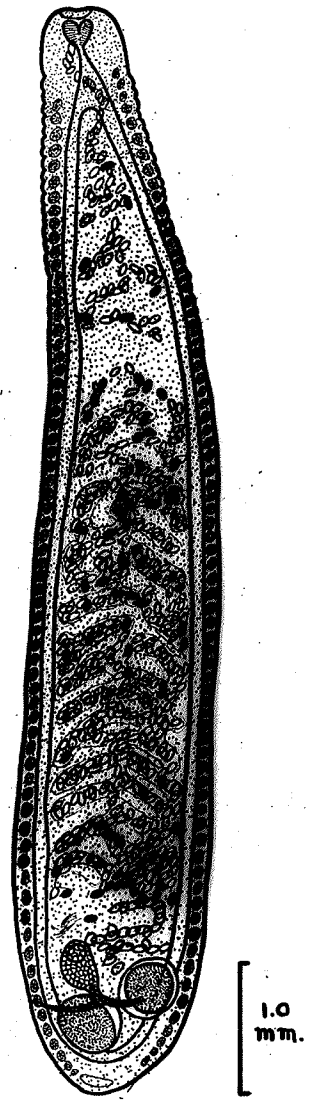


FIG. 2

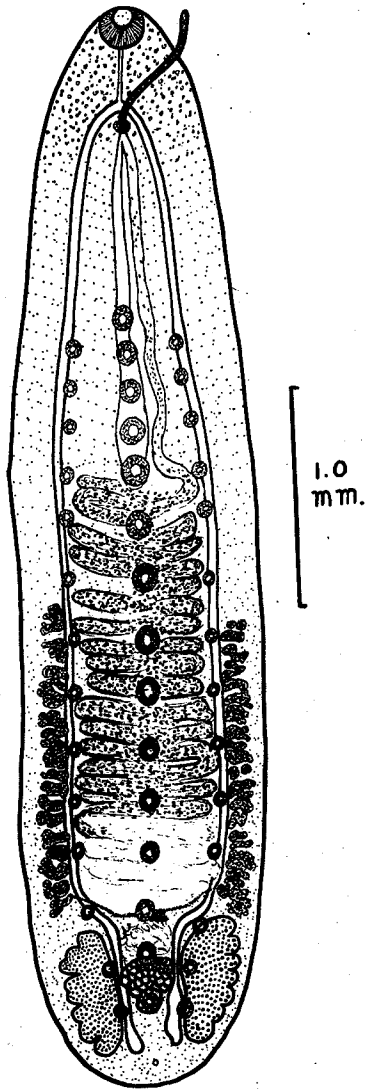


FIG. 3

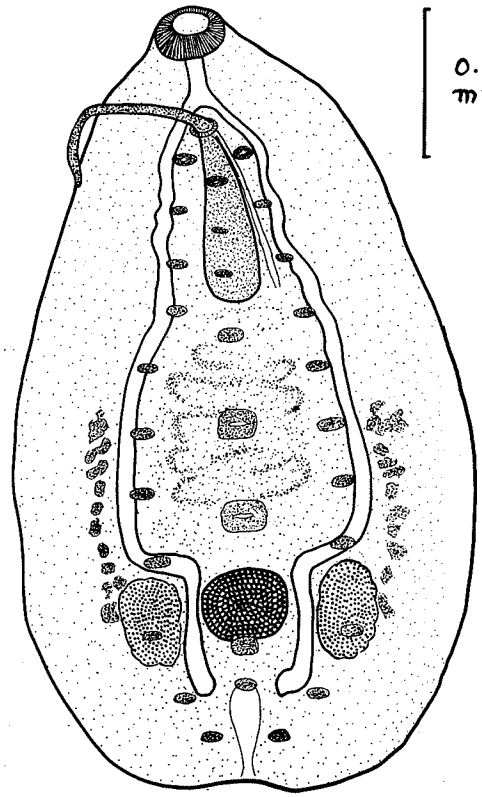


FIG. 4

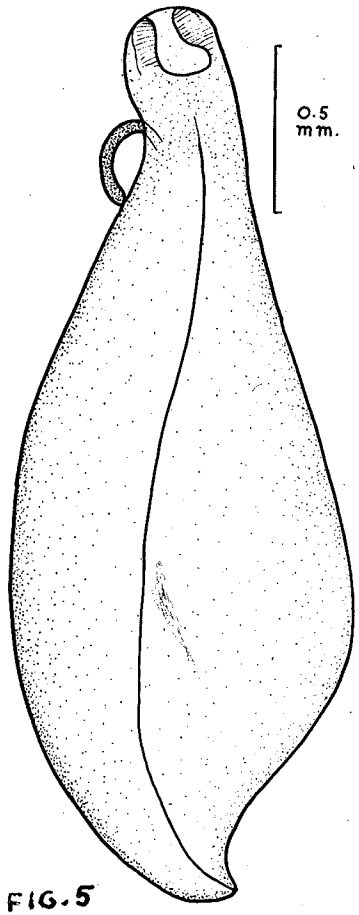


FIG. 5

PLATE III

Fig. 6. Photomicrograph anterio portion of *Notocotylus t. triserialis*.
Ventral view. x35.

Fig. 7. Photomicrograph posterior portion of *Notocotylus t. triserialis*.
Ventral view. x35.

Fig. 6

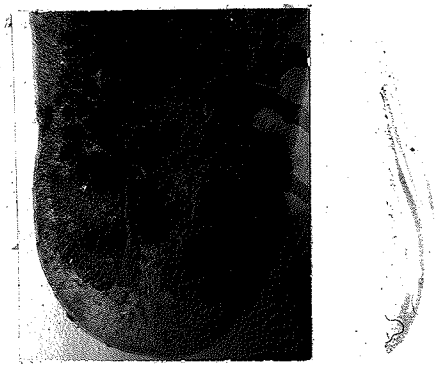


Fig. 7

PLATE IV

Fig. 8. Photomicrograph anterior portion of *Haematotrephus species*.
Ventral view. x45

Fig. 9. Photomicrograph posterior portion of Haematotrephus species.
Ventral view. x53.

Fig. 8

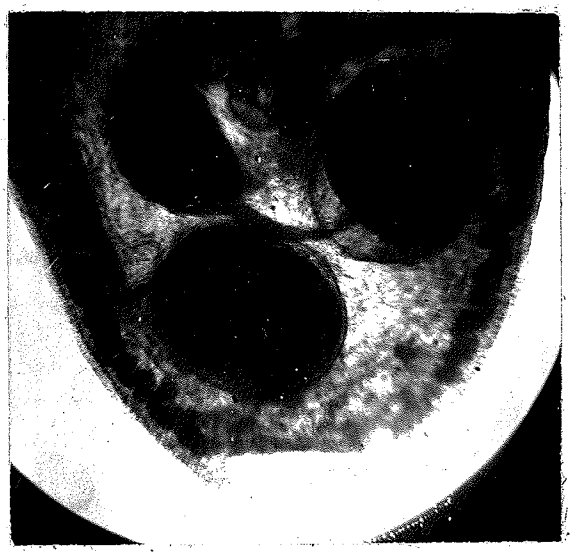


Fig. 9

(236), (325), (348), (443, 444), (447, 446, 450), (456), (491), (492), (498), (407), (461), (500), (509), (530), (617), (644), (654), (679), (687).

Family Echinostomatidae

Echinostoma revolutum (Frölich, 1802) Looss, 1899

Several specimens were recovered from the large intestine of the Canvas-back duck, and were found to agree quite closely to the descriptions given by various authors. Following are the dimensions in mm. of a typical specimen: Length-13.308, Width at level of ovary-1.578, Oral sucker-0.421 diam., Pharynx-0.526 by 0.316, Esophagus-0.894 by 0.263, Acetabulum-0.947 diam, Cirrus pouch-0.631 by 0.263, Cirrus-0.526 by 0.105, Ovary-0.421 diam., Shell gland complex-0.579 diam., Anterior testis-0.868 by 0.631 ovoid, Posterior testis-0.857 by 0.631 ovoid, Distance between Shell gland complex and anterior testis-0.158, Distance between testes-0.211, Eggs-numerous 0.079 by 0.052. Vitellaria extend from the level of the posterior margin of the acetabulum to within 0.316 of the posterior end of the worm. Two worms are shown on page 46, Figs. 18 and 19.

Literature consulted: (14), (34), (36), (51), (94), (113), (120), (121), (131), (140), (157), (234), (235), (240), (278), (332), (389), (394), (405), (457), (460), (461), (470),

(498), (500), (520), (521), (524), (607), (636), (640).

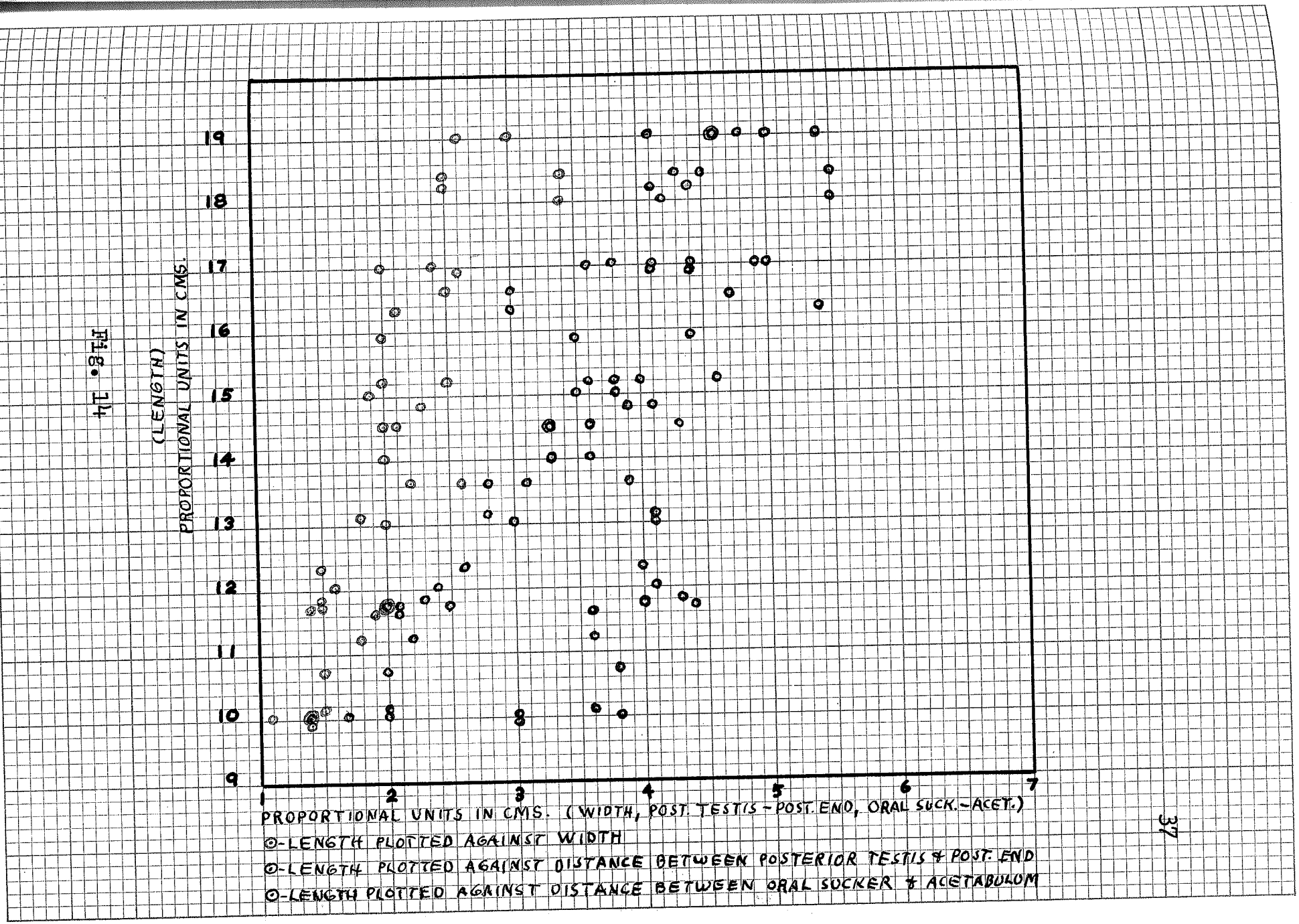
Echinostoma platyrhynchi n. sp.

A single specimen was recovered from the intestinal ceca of a Mallard. It has very close affinities to E. robustum as pictured by Yamaguti (502). The main differences are to be noted in the greater lobulation of the testes, and the lower situation of the genital organs in E. robustum. The eggs in E. platyrhynchi are only about half as large as those in E. robustum. The dimensions in mm. of E. platyrhynchi are as follows: Length-6.656, Width at acetabulum-0.845, Width at ovary-1.152, Collar-0.410, Oral sucker-0.166 diam. subterminal, Pharynx-0.205 by 0.128, Esophagus-0.435, Genital pore-0.094 by 0.128, Cirrus pouch-0.358 by 0.230, Acetabulum-0.538 diam., Distance between acetabulum and anterior end-1.024, Distance between acetabulum and ovary-1.536, Ovary-0.256 diam., Shell gland complex-0.128 by 0.358, Anterior testis.358 by 0.259, Posterior testis-0.512 by 0.256, Distance between testes-0.044, Distance between testes and posterior end-2.202, Spines-0.051 by 0.248 approxim ately 36, 2 rows, with 6 corner spines, Vitelline follicles-0.065 diam, Vitellaria extend from about 0.15 below acetabulum to within 0.205 of the posterior end. Eggs-0.054 by 0.031 numerous. Fig. 21, page 46.

Literature consulted here:(502), (534).

Echinoparyphium elegans (Looss, 1899)

Over 460 specimens were recovered from the upper third portion of the small intestine of a Lesser scaup. At the same time over 193 specimens of Cotylurus brevis were obtained from the same location, as well as 4 specimens of Xenisma wardlei n.g., n.sp. Several views are depicted on page 47, Figs. 23 to 25. Figs. 39 to 43 page 66, show the crown spines in greater detail, while Fig. 95, page 88, shows 6 specimens arranged according to the maturity of the specimen. They were picked at random, and after arranging them it became apparent that the distance between the oral sucker and the anterior border of the acetabulum remained virtually constant. It was thought that this was an indication that growth in the species took place posterior to the acetabulum. Thirty eight specimens were then projected and enlarged by means of a photographic micro enlarger, and the following dimensions were scaled off in centimeters for convenience: Length, width, distance between posterior border of posterior testis to posterior end of worm, and distance between the oral sucker and the anterior border of the acetabulum. The specimens ranged in length from 1.65 mm. to 3.16 mm. The graph on page 37 shows a scatter diagram of all the above mentioned dimensions plotted against the length of the specimen. In studying this scatter diagram it is seen at once that the relationship is



⊙-LENGTH PLOTTED AGAINST WIDTH

⊙-LENGTH PLOTTED AGAINST DISTANCE BETWEEN POSTERIOR TESTIS & POST. END

⊙-LENGTH PLOTTED AGAINST DISTANCE BETWEEN ORAL SUCKER & ACETABULOM

not simple as was supposed originally when studying the specimens arranged in Fig. 95, page 88. Magnification of the projected specimens was 60 times, and as mentioned above, the dimensions were scaled off in centimeters and plotted on the graph in proportional units. Broad trends can be observed.

Following are the dimensions of E. elegans obtained by the writer: Length-3.375 to 3.537, Width-0.473 to 0.540, Crown spines-upto 45 in two unequal rows, with 4 corner spines, marginal spines 0.054 by 0.014 to 0.068 by 0.014, corner sp. 0.074 by 0.020. Some specimens had spines with obvious kinks in them as indicated in Fig. 43, page 66. Cirrus pouch-0.243 by 0.135, Cirrus-0.202 by 0.047 to 0.258 by 0.041, Acetabulum-0.270 diam. to 0.311 diam. by 0.338 in depth, Distance between acetabulum and oral sucker-0.837 to 1.040, Ovary-0.135 diam. to 0.149 diam., Distance between acetabulum and ovary-0.270 to 0.392, Shell gland complex-0.135 diam. to 0.162 diam., Anterior testis-0.243 by 0.149 to 0.338 by 0.229, Posterior testis-0.284 by 0.176 to 0.351 by 0.203, Distance between posterior border of posterior testis to posterior end of worm-0.810 to 0.959, Vitelline follicles-0.068 diam to 0.108 diam., Extent of vitellaria quite variable from specimen to specimen, and even within a single specimen, the vitellaria need not reach to the same extent on both sides of the specimen as Fig. 23 page 47, indicated. Oral sucker-0.041 diam. to 0.068

diam., Prepharynx-0.057 by 0.016 to 0.095 by 0.014, Pharynx-0.068 by 0.054 to 0.096 by 0.054, Esophagus-0.675 by 0.673 by 0.054, Eggs-0.068 by 0.057 to 0.081 by 0.047 (15-20 eggs).

All measurements are in mm., and all specimens measured were adults.

Literature consulted: (1), (15), (21), (38, 42), (50), (52), (142), (198), (202), (201), (217), (236), (249), (250), (139), (260), (263), (276), (330), (352, 353), (389), (393), (394), (420), (441), (463), (461), (465), (480), (498), (500), (509), (515), (522), (523), (525, 526), (614), (633), (657), (641), (679), (687).

Echinochasmus manitobensis n. sp.

This was obtained from the intestinal ceca of the Pintail duck, and is depicted in Figs. 20, and 38 pages 46 and 65, respectively. The dimensions in mm. are as follows: Length-1.951, Width at level of acetabulum-0.405, Width at level of ovary-0.474, Width at level of posterior testis-0.405, Width near posterior end of worm-0.284, Collar-0.221, Oral sucker-0.079 by 0.075, Prepharynx-absent, Pharynx-0.095, Esophagus, 0.237 by 0.008, Crown spines-0.039 by 0.016 (19), Body spines-0.015 by 0.010, Acetabulum-0.269 diam., Ovary-0.095 diam., Shell gland complex-0.032 by 0.071, Anterior testis-0.158 by 0.229, Posterior testis-0.219 by 0.198,

Distance between posterior border of acetabulum and anterior border of ovary-0.024, Distance between testes-0.008, Eggs-approximately 10, 0.074 by 0.050. This species shows very close affinities to E. perfiolatus the chief differences being no prepharynx, and eggs about ¾ the size found in E. perfiolatus, in E. manitobensis.

Literature consulted: (22, 23, 24), (41), (199), (252), (139), (246), (263), (323), (232), (277), (232), (335), (377), (338), (265), (321), (404), (407), (461), (439), (440), (445), (458), (461), (465), (468), (493), (498), (509), (514), (633), (679) and (687).

Stephanoprora lari n. sp.

Twenty three specimens were obtained from the intestinal tract of several Herring gulls. Fig. 22, page 47, shows the morphology of this species. Dimensions in mm. are as follow: Length-6.327, Width-0.444, Oral sucker-0.088 by 0.085, Prepharynx-0.133 by 0.022, Pharynx-0.088 diam., Esophagus-0.488 by 0.067, Genital pore-0.065 diam. and 0.065 from acetabulum, Cirrus pouch-0.155 by 0.089, Acetabulum- 0.266 diam. and 0.599 from anterior border of ovary, Ovary-0.167 diam. and 0.266 from shell gland complex, Shell gland complex-0.155 diam., and 0.044 from anterior testis, Anterior testis-0.466 by 0.222, Posterior testis-0.511 by 0.225, Distance

between testes-0.178, Distance between posterior border of posterior testis to posterior end of worm-2.442, Vitellaria extend to within 0.222 of posterior end, Vitelline follicles-0.18 by 0.062, Crown spines-at least 16 (most of the specimens were deficient in spines) 0.044 by 0.020, Eggs-6 to 8, 0.067 by 0.040.

Following, is a key to the genus Stephanoprora Odhner, 1910, modified after the key given by Beaver (35) to contain the new species S. lari:

1. (2) Cephalic spines 26 in number-ornata Odhner, 1902
2. (3) Cephalic spines 24 in number-ozakii (Asada, 1926)
3. (1,2) Cephalic spines 22 or less in number----------4
4. (11) Vitellaria distinctly post. to junct. of testes-5
5. (6) Acetabulum wider than body-singularis (Lutz, 1924)
6. (5) Acetabulum not wider than body proper----------7
7. (10) Angle spines distinct from border spines---------8
8. (9) Vitellaria extend to middle of posterior testis---denticulatus (Rud., 1802)
9. (7) Vitellaria confined to post-testicular region-microcestius (Kurova, 1927)
10. (4) Angle spines not distinct from border spines-----pendula (Looss, 1899)
11. (3) Vitellaria at junction of testes or more ant.---12
12. (15) Uterus very short, being less than length of region of body anterior to genital pore----------13
13. (14) Body stout; testes large occupying 1/4 to 1/2 of hind-body---------spinosa Odhner, 1911

14. (12) Body slender; testes occupying less than 1/4 of hind body---conciliata (Dietz, 1909)

15. (11) Uterus of medium length, being greater in length than the region of body anterior to genital pore----------16

16. (17) Eggs greater than 0.080 mm.-magniovata Yamag.,1933

17. (16) Eggs less than 0.080 mm. in length----------18

18. (17) Ovary in close proximity to shell gland complex-------polycestus (Dietz, 1909)

19. (18) Ovary relatively far removed from shell gland complex----------lari n. sp.

Literature consulted: (29), (35), (7), (104), (170), (140, 142), (139), (230), (236), (288), (289), (269), (360), (366), (457), (453), (498), (509), (549), (607), (670), (679), (687).

Hypoderaeum conoideum (Block, 1782) Dietz, 1909

Several specimens were recovered from the small intestine of four Pintail ducks. The dimensions are compared in mm., with those from various sources, in Table III, page 43. Figs. 12 and 13, page 44, show the variations found in the species. The crown spines and cirrus extruding are shown in Figs. (34, 35) and 36 respectively, on page 64.

Literature consulted: (104), (139), (140, 141, 142), (146), (178), (328), (334), (350), (385), (418), (421), (438), (469), (470), (498), (500), (617), (679), (687).

TABLE III

COMPARISON OF MEASUREMENTS OF *HYPODERAEUM CONOIDEUM* FROM VARIOUS SOURCES

	Freedman* Pintail Manitoba	Zerecero ** Bl.w.teal Mexico	Freedman *** Pintail Freedman	Rees Experim. England	Singh **** Pintail India
Length	8.866	8.399	6.575	10.200	7.84
Width	1.117	1.350	1.284	1.570	0.87
Collar	0.377	-----	-----	0.600	0.390
Marginal spines	0.014 x 0.003	0.019 x 0.006	-----	------	0.021
No. spines	upto 33 double	-------	-----	(43 to 45)	(47) single row
Corner spines	-------	-------	-----	------	0.025
Or. sucker	0.180 x 0.131	0.148 x 0.230	0.184 x 0.184	0.28 x 0.210	0.185 x 0.185
Pharynx	0.131 x 0.129	0.185 x 0.157	0.104 x 0.131	-----	0.15 x 0.105
Acetabulum	0.873 dm. x.698 dp.	0.897 x 1.036	0.710 x 0.710	-----	0.703
Ovary	0.349 x 0.349	-----	0.342 x 0.342	0.41 x 0.26	0.26 x 0.26
Shell gland complex	0.384 x 0.384	-----	0.316 x 0.316	---- x 0.45	0.15 x 0.15
Anterior testis	0.803 x 0.349	0.777 x 0.388	0.710 x 0.263	0.98 x ----	0.722 x 0.333
Posterior	0.942 x 0.316	0.898 x 0.324	0.684 x 0.316	0.90 x ----	0.796 x 0.32
Eggs	0.052 x 0.031	0.101 x 0.065	0.068 x 0.042	0.11 x 0.06	0.092x 0.053

All measurements in mm.

* Specimen shown in Fig. 13, page 44.

** All measurements maximum values given (532)

*** Specimen shown in Fig. 12, page 44.

**** *Echinostoma microspina* n. sp. It is the writer's opinion that this is synonymous with *H. conoideum*.

PLATE V

Fig. 10. Zygocotyle lunata from the intestinal caca of the Mallard. Ventral view.

Fig. 11. Zygocotyle lunata from the intestinal ceca of the Mallard. Ventral view.

Fig. 12. Hypoderaeum conoideum from the small intestine of the Pintail. Ventral view.

Fig. 13. Hypoderaeum conoideum from the small intestine of the Pintail. Ventral view.